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Hazardous Waste Bureau

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Mr. John Kieling, Manager
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Dear Mr. Kieling

Kirtland Air Force Base is pleased to submit the "Final Long-Term Monitoring Plan Landfill Sites LF- 001, LF- 002 and LF- 008, December 2014". The "Final Operation and Maintenance Work Plan Landfills Sites LF- 001, LF- 002, and LF- 008 December 2014" is also included in this submittal. Additionally, the "Final Uniform Federal Policy Quality Assurance Project Plan Landfill Sites LF-001, LF-002, and LF-008 December 2014" is included.

Please contact Mr. Cole Crosgrove at (505) 853-3098 or at cole.crosgrove@kirtland.af.mil, if you have any questions.

Sincerely

TOM D. MILLER, Colonel, USAF
Commander

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File

KAFB4224

KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

FINAL LONG-TERM MONITORING PLAN
Landfill Sites LF-001, LF-002, and LF-008

December 2014

377 MSG/CEI
2050 Wyoming Boulevard SE
Kirtland AFB, New Mexico 87117-5270

KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

FINAL LONG-TERM MONITORING PLAN
LANDFILL SITES LF-001, LF-002, LF-008

December 2014

Prepared for:

Air Force Civil Engineer Center
Department of the Air Force, 772nd ESS/PKB
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Contract FA8903-13-C-0008

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NOTICE

This Long-Term Monitoring (LTM) Plan was prepared for the Air Force Civil Engineer Center (AFCEC) by URS Group, Inc. (URS) in association with FPM Remediations, Inc. (FPM) to aid in the implementation of a final remedial action plan under the Environmental Restoration Program (ERP). As the report relates to actual or possible releases of potentially hazardous substances, its release prior to an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the ERP, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this report premature or inaccurate.

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14. ABSTRACT
This Long Term Monitoring Plan specifies the activities that will be performed in support of groundwater monitoring and well gauging to be conducted at Landfill Sites LF-001, LF-002, and LF-008, Kirtland Air Force Base, New Mexico. The purpose of the plan is to provide guidance for the groundwater sampling and gauging of the 20 groundwater monitoring wells that are installed at the landfill sites.

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Sites LF-001, LF-002, and LF-008, groundwater monitoring, volatile organic compounds, alkalinity, dissolved and total metals, nitrate/nitrite, nitrogen, radium-226/radium-228, chloride, fluoride, and sulfates, total dissolved solids, gross alpha and gross beta, and field parameters.

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DECEMBER 2014

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

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TOM D. MILLER, Colonel, USAF
Commander, 377th Air Base Wing

This document has been approved for public release.

KIRTLAND AIR FORCE BASE
377th Air Base Wing Public Affairs

PREFACE

This LTM Plan addresses the groundwater monitoring activities to be implemented at LF-001, LF-002 and LF-008, Solid Waste Management Units 6-1, 6-2 and 6-4, at Kirtland Air Force Base (AFB), New Mexico.

This work will be performed under the authority of the requirements of the AFCEC Contract No. FA8903-13-C-0008. This program is conducted under the Kirtland AFB Environmental Restoration Section Chief, Mr. Ludie Bitner, and the Kirtland AFB Project Manager, Mr. Cole Crosgrove. URS, as a subcontractor to FPM, has prepared this LTM Plan as defined in the Performance-Based Remediation Contract for Cannon, Holloman, and Kirtland AFBs located in New Mexico, and Luke AFB Base located in Arizona. Mr. Richard Wells is the URS Group, Inc. Installation Manager for ERP Sites at Kirtland AFB.

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ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
DTIC	Defense Technical Information Center
EPA	U.S. Environmental Protection Agency
ERP	Environmental Restoration Program
FPM	FPM Remediations, Inc.
ft	feet
GWQB	Ground Water Quality Bureau
HDS	heat-dissipation sensor
KAFB	Kirtland Air Force Base
LTM	Long-Term Monitoring
MAP	Management Action Plan
MPE	Measuring Point Elevation
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
SM	standard method
SOP	Standard Operating Procedure
SWMU	Solid Waste Management Unit
URS	URS Group, Inc.
USAF	U.S. Air Force
VOC	volatile organic compound
WCR	water content reflectometer
yd^3	cubic yards

1.0 INTRODUCTION

This Long-Term Monitoring (LTM) Plan addresses groundwater monitoring activities that will be performed at Solid Waste Management Unit (SWMU) 6-1, Landfill 1 (LF-001), SWMU 6-2, Landfill 2 (LF-002), and SWMU 6-4, Landfills 4, 5, and 6 (LF-008) at Kirtland Air Force Base (AFB), New Mexico. This plan was prepared in accordance with the requirements of the Air Force Civil Engineer Center (AFCEC) Contract No. FA8903-13-C-0008. URS Group, Inc. (URS), as a subcontractor to FPM Remediations, Inc. (FPM), has prepared this LTM Plan in accordance within the Performance-Based Remediation Contract for Cannon, Holloman, and Kirtland AFBs located in New Mexico, and Luke AFB located in Arizona. Monitoring requirements are further delineated in the *Draft Uniform Federal Policy Quality Assurance Project Plan, Landfill Sites LF-001, LF-002, and LF-00)* (U.S. Air Force [USAF], 2014a).

1.1 Purpose and Scope

The plan describes the voluntary LTM activities that will be performed at the landfill sites. This plan addresses the following elements:

- A general site map showing Kirtland AFB in relation to the State of New Mexico and City of Albuquerque and the locations of LF-001, LF-002, and LF-008;
- Site maps showing the location of the 20 groundwater monitoring wells;
- General site description and history;
- Groundwater monitoring requirements; and
- Documentation and reporting requirements.

The groundwater monitoring activities may be revised to reflect changes in the monitoring scope or schedule upon agreement with the New Mexico Environment Department (NMED).

Landfill operation and maintenance activities are discussed in the December 2014 *Operations and Maintenance Work Plan, Landfill Sites LF-001, LF-002, and LF-008* (2014b).

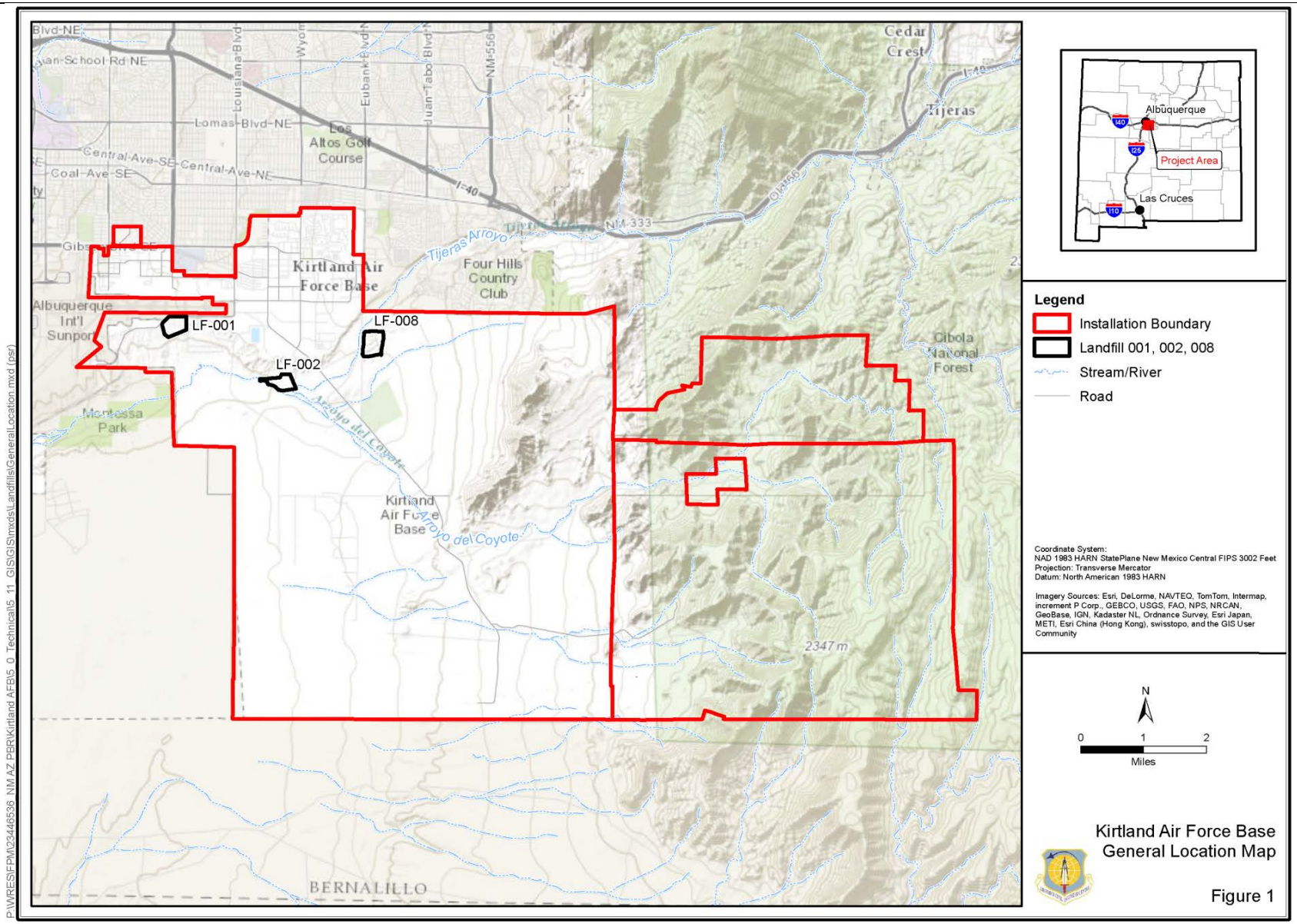

Figure 1. LF-001, LF-002, LF-008 Site Location Map

2.0 BACKGROUND

2.1 Site Descriptions

Three private airfields predate the Kirtland AFB, formerly named Albuquerque Army Air Base, with military operations becoming the primary focus in 1941. The base was renamed in 1942 honoring Col. Roy C. Kirtland, a pioneer in Army aviation. Flight crews were trained in the early 1940s at Kirtland's three schools—advanced flying, bombardier training, and multi-engine school. Later that decade, the focus of base operations shifted to developing aircraft modifications for weapons delivery, researching ballistic characteristics, and testing weapons. Manzano Base was named in 1952 and was located on the former Site Able, created under the Armed Forces Special Weapons Command. Sandia Base began operating as the Albuquerque Airport Training Station in 1942 and served historically as a nuclear weapons installation. In 1971, Kirtland, Manzano, and Sandia bases were merged and were managed under one command.

2.1.1 Landfill 1

LF-001 is located in the northwestern area of Kirtland AFB, directly south of the main east-west runway for the base and Albuquerque International Airport (Figure 2). Southgate Avenue forms the northern and northwestern site boundaries, Ammo Road runs parallel to the eastern boundary, and an abandoned railroad grade forms the southern boundary. Kirtland AFB Production Well No. 2 (KAFB-2) is located approximately 150 feet (ft) northeast of the landfill, downgradient of former monitoring well KAFB-0111. LF-001 is not located within the Tijeras Arroyo 100-year flood plain.

Although disposal activities date back to 1951, the site was operated primarily between 1960 and 1975 as a trench-and-fill landfill. The landfill contains an estimated 425,000 cubic yards (yd^3) of municipal waste and up to 175,000 yd^3 of construction and demolition debris. Field activities conducted at the site have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. A detailed summary of the site's background and history, results of previous investigations, corrective measures, and current status is presented in the Environmental Restoration Program (ERP) Site-Specific Summaries (USAF, 2005a), which were prepared as a supplement to the 2004 update of the Management Action Plan (MAP) (USAF, 2005b).

The LTM Program was initiated at LF-001 in May 1996. As described in the LTM Plan (USAF, 1997), the program consisted of quarterly gauging of eight monitoring wells (KAFB-0107, -0110, -0111, -0112, -0113, -0114, -0115, and -0117) and semiannual sampling of four of these wells (KAFB-0113 located upgradient with KAFB-0111, -0114, and -0115 located downgradient). Declining water levels have led to the need for new wells as existing wells went dry. Wells KAFB-0118, KAFB-0119, KAFB-0120, and KAFB-0121 serve as the monitoring points for LF-001. Gauging has been performed on a quarterly basis with groundwater sampling being performed annually.

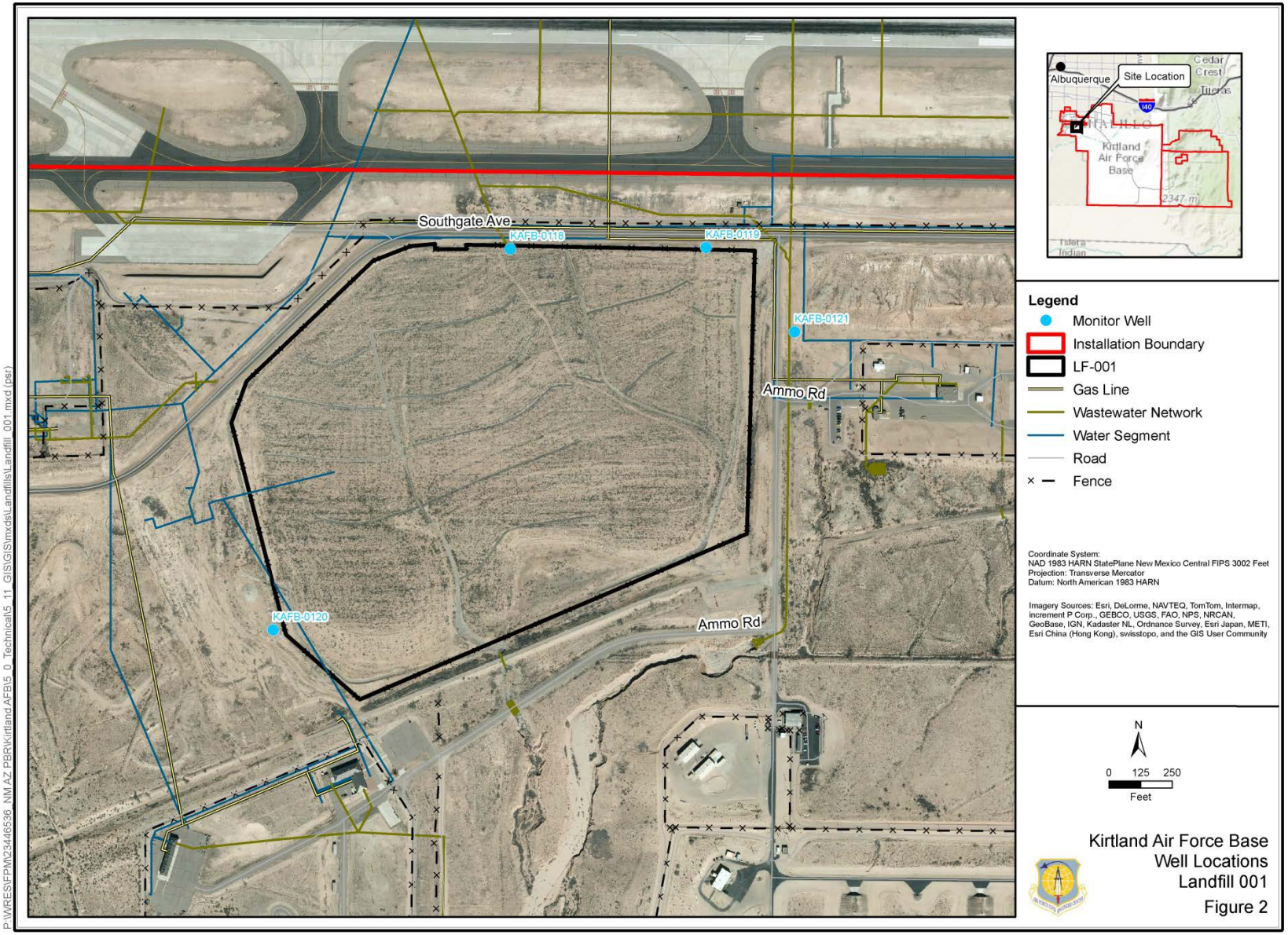

Figure 2. Well Locations, Landfill 001

2.1.2 Landfill 2

SWMU 6-2, Landfill 2 (LF-002) is located between the Trestle Aircraft Testing Facility and Advanced Research Electromagnetic Simulator facilities to the north and the active channel of the Tijeras Arroyo to the south (Figure 3). The eastern and western boundaries are currently defined by security fences. Production Well KAFB-8 is located approximately 2,100 ft northeast of the landfill, and Production Well KAFB-4 is 2,400 ft to the north. Field activities have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. A detailed summary of the site's background and history, results of previous investigations, corrective measures, and current status is presented in the ERP Site-Specific Summaries (USAF, 2005a), which was prepared as a supplement to the 2004 update of the MAP (USAF, 2005b). Based on the 100-year flood plain map provided in the *Integrated Natural Resources Management Plan for Kirtland Air Force Base (Final Year Revision-October 2012)* (USAF, 2012a), it appears that the southern toe of the landfill borders the 100-year flood plain and may potentially be impacted should a major flood affect the Tijeras Arroyo.

LF-002 operated between 1942 and 1965 as a trench-and-fill landfill. The current volume of waste is estimated to be 1,321,700 yd^3. Two buried pipelines are located near LF-002. The 21-inch City of Albuquerque's Tijeras Interceptor sanitary sewer line runs east-west across the northern region of the landfill, approximately 400 ft south of well KAFB-0213. The second buried pipeline is the treated sewage effluent line (ST-051) that carried effluent from the Sewage Lagoons to the Golf Course Main Pond. ST-051 is currently used to pump nitrate-rich water from Production Well No. 7 (KAFB-7) to the Golf Course Main Pond for irrigation. This line was relocated outside of the landfill boundary during construction of the evapotranspiration cover. An access road was constructed for the sanitary sewer.

The LTM Program was initiated at LF-002 in May 1996. As described in the LTM Plan (USAF, 1997), the program consisted of quarterly gauging of six groundwater monitoring wells (KAFB-0213, -0214, -0215, -0216, -0217, and -0218) and semiannual sampling of four of these wells (KAFB-0215 located upgradient with KAFB-0214, -0216, and -0218 located downgradient). Declining water levels have led to the abandonment of some wells and installation of replacement wells. Currently, quarterly well gauging is performed at wells KAFB-0213, KAFB-0219, KAFB-0220, KAFB-0221, KAFB-0222, and KAFB-0223 with groundwater sampling performed on an annual basis

2.1.3 Landfill 8

SWMU 6-4, Landfills 4, 5, and 6 (LF-008) is located on the northwestern region of Kirtland AFB and is bounded by the Tijeras Arroyo to the north and the covered slope of the active construction and demolition debris landfill (LF-268) about 150 ft east of Power Line Road to the east (Figure 4). The site is made up of three former contiguous landfills (Landfills 4, 5, and 6). Based on flood plain maps, the site is not located within the 100-year flood plain. Field activities conducted at the site have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. A detailed summary of site's background and history, results of previous investigations, corrective measures, and current status is presented in the ERP Site-Specific Summaries (USAF, 2005a), which was prepared as a supplement to the 2004 update of the MAP (USAF, 2005b).

The City of Albuquerque and Kirtland AFB jointly operated Landfill 4 from 1964 to 1969 as a general refuse landfill. Construction and demolition debris and trees were placed in the northeastern part of Landfill 4 and general refuse was placed in two natural arroyos in the western part of the site. The estimated volume of waste in Landfill 4 is about 600,000 yd^3 buried over an area of approximately 25 acres. Kirtland AFB operated Landfills 5 and 6, located north of Landfill 4, from mid-1960 through

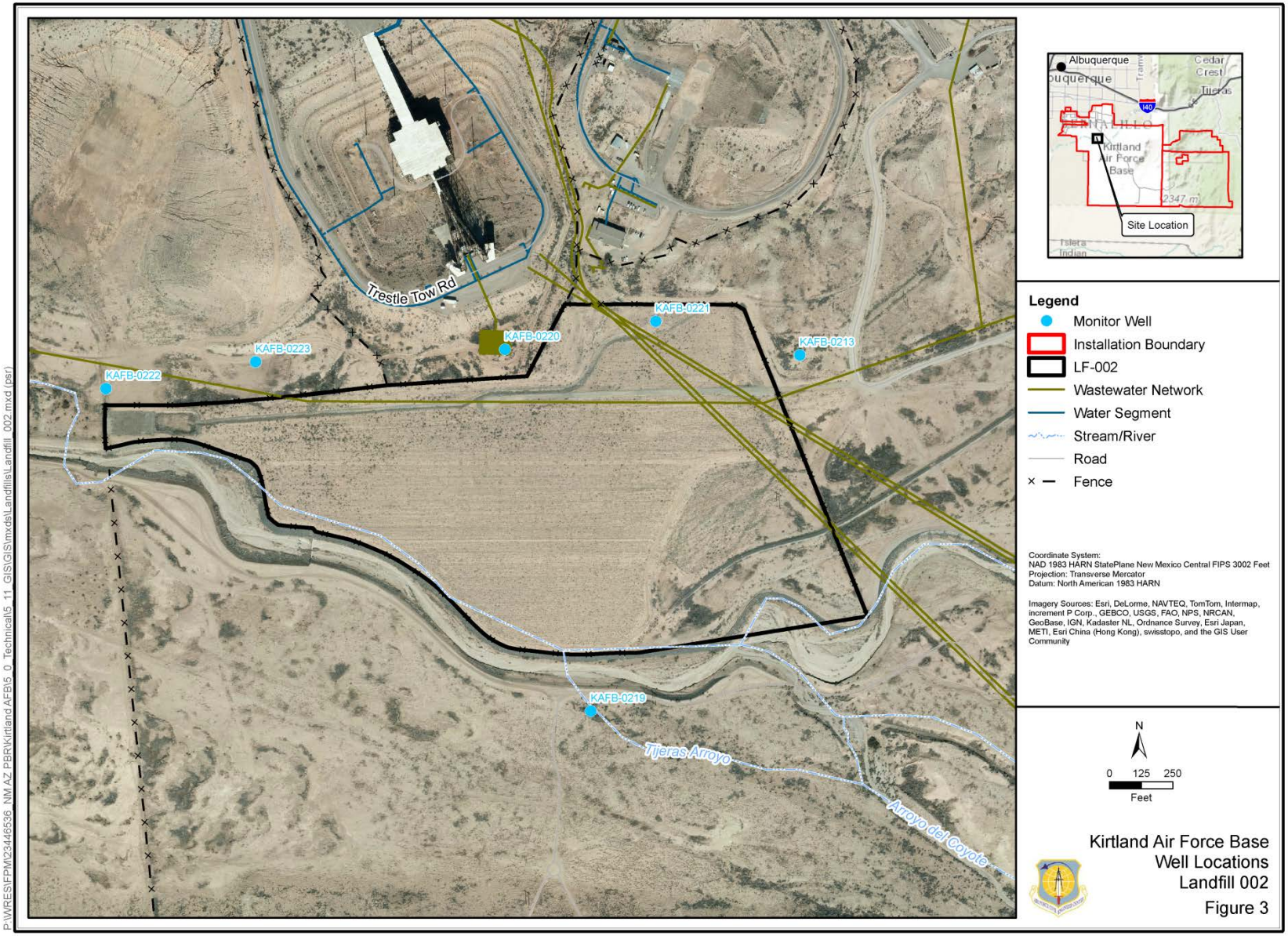

Figure 3. Well Locations, Landfill 002

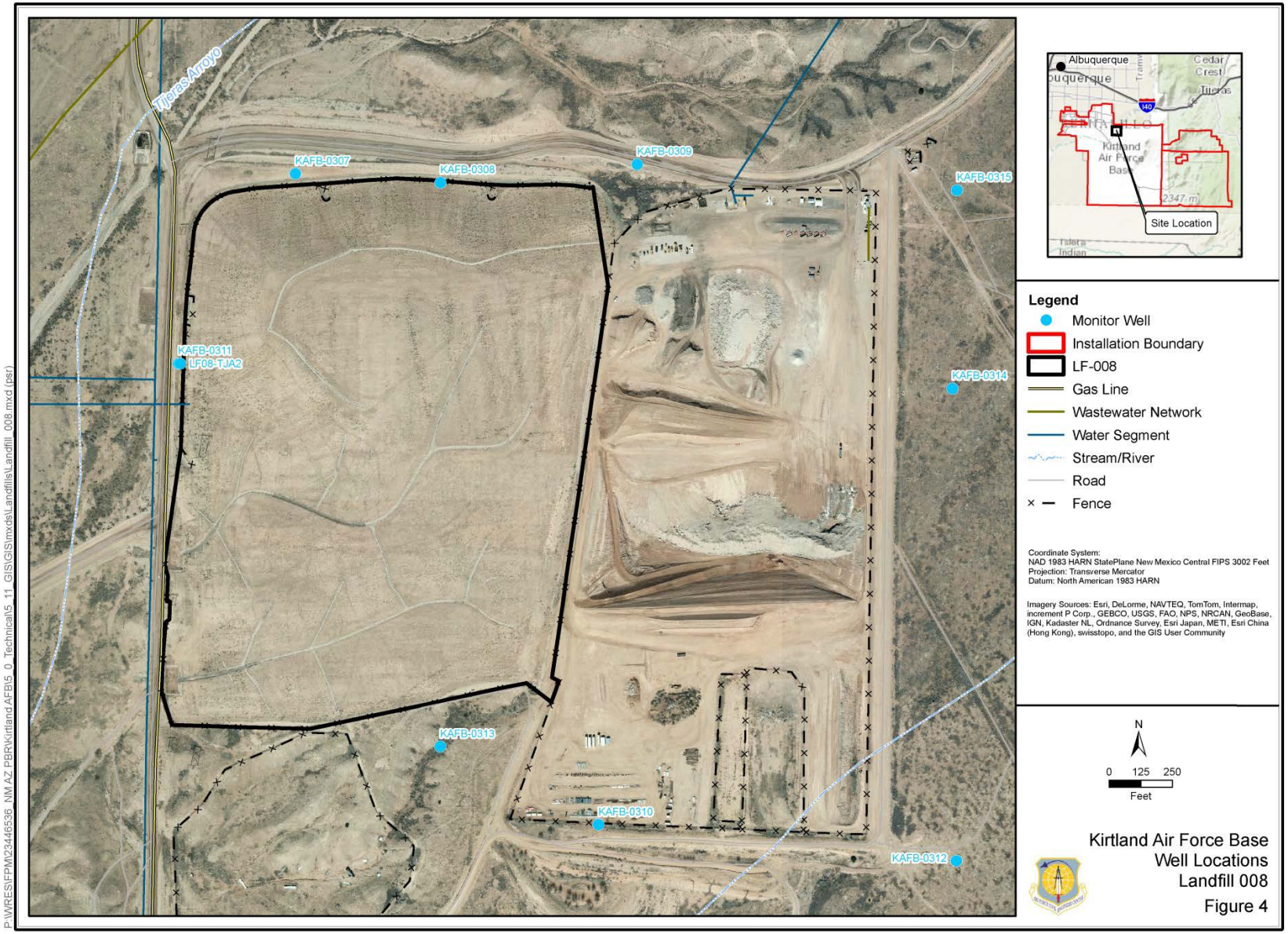

Figure 4. Well Locations, Landfill 008

1989. Construction and demolition debris was placed in Landfill 5 and other refuse was disposed in Landfill 6. The estimated volume of waste in Landfills 5 and 6 is about 1,746,000 yd^3 buried over an area of approximately 40 acres.

Monitoring at LF-008 has been conducted under two separate programs—the Groundwater Monitoring System Plan (USAF, 1995) and the LTM Program—to fulfill the requirements of the NMED Solid Waste Bureau for the active portion of the landfill (LF-268) and of the NMED Hazardous Waste Bureau for the inactive portion (LF-008). Each of the programs included gauging and sampling of the 10 monitoring wells at the site, but the results were applied in different ways to determine whether a release from the landfill has occurred. Five wells are sampled to monitor the regional aquifer (KAFB-0307, -0308, -0309, and -0311, and upgradient well KAFB-0312), and five wells are sampled to monitor the perched aquifer (sidegradient well KAFB-0310, upgradient well TJA-2, and KAFB-0313, -0314, and -0315).

The *Annual Monitoring and Maintenance Activities Report, for Solid Waste Management Unit (SWMU) 6-1, Landfill 1 (LF-001); SWMU 6-2, Landfill 2 (LF-002); and SWMU 6-4, Landfills 4, 5, and 6 (LF-008)* (USAF, 2012b) provides information pertaining to the most recent monitoring well installations and groundwater monitoring results at LF-001, LF-002, and LF-008.

3.0 LONG-TERM GROUNDWATER MONITORING

3.1 Monitoring Requirements

As the groundwater monitoring contractor, URS will conduct gauging and sampling in accordance with the Base-Wide Plans (USAF, 2004), Standard Operating Procedures (SOPs) B5.6, B4.1, and B4.4, the 2014 O&M Plan and this LTM plan. The monitoring events will be coordinated with the LTM gauging and sampling events (quarterly gauging events scheduled for October, January, April, and July and annual sampling event scheduled for April), and scaled back over time. Groundwater monitoring, including water level gauging, will be performed at the 20 wells installed in the vicinity of LF-001, LF-002, and LF-008, identified as follows:

- Landfill 1 (LF-001) – Regional wells KAFB-0118, -0119, -0120, and -0121
- Landfill 2 (LF-002) – Regional wells KAFB-0213, -0219, -0220, -0221, -0222, and -0223
- Landfills 4, 5, and 6 (LF-008) – Perched aquifer wells KAFB-0310, -0313, -0314, -0315, and TJA-2; regional aquifer wells KAFB-0307, -0308, -0309, -0311, and -0312

The locations of the 20 groundwater monitoring wells are shown in Figures 2, 3, and 4.

Groundwater samples will be analyzed for the parameters listed in Table 3-1. Sample handling, analyses, and quality assurance/quality control procedures will comply with the Base-Wide Plans and the *Draft Uniform Federal Policy Quality Assurance Project Plan, Landfill Sites LF-001, LF-002, and LF-008* (USAF, 2014a).

Table 3-1. Groundwater Sample Analysis and Methods

ANALYTES	METHODS
Volatile organic compounds	EPA-846 Method 8260B, EPA 624
Alkalinity (LF-008 only)	EPA SM 2320B
Dissolved and total metals [1] Mercury (cold vapor with prep)	EPA 6010B/7000S EPA SW 7470
Radium-226/radium-228	EPA 903.1/904.0
Nitrate/nitrite and nitrogen	EPA 300.0
Chloride, fluoride (no distillation), sulfates	EPA 375.3
Total dissolved solids	EPA 160.1
Gross alpha (picocuries/liter)/gross beta (milligrams/year)	EPA 900.0m or SOP
Field parameters: pH, dissolved oxygen, oxidation reduction potential, specific conductance, turbidity, and temperature	Field measurements using portable meters

[1] Total and dissolved aluminum, arsenic, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, tin, uranium, vanadium, and zinc
EPA – U.S. Environmental Protection Agency
SM – standard method
SOP – standard operating procedure

This frequency will continue for a period of four years to provide additional data upon which trending analyses can be completed using appropriate statistical analyses software such as the MAROS software or other appropriate tools (i.e., Mann-Kendall). After four years, monitoring and gauging will be reduced to a biennial schedule. Data for individual wells and analytes will be statistically evaluated to determine whether monitoring frequencies can also be adjusted.

Various statistical tests exist to determine whether a significant temporal trend exists in a given data set. For simple linear regression, the statistical test of whether the slope is significantly different from zero is equivalent to testing whether the correlation coefficient is significantly different from zero. To perform the test, the correlation coefficient is first calculated. The correlation coefficient is then used to calculate the t-statistic, which is then compared to a critical value for $t_{1-\alpha/2}$ at a specified significance level (usually 95 percent) to determine whether there is a significant correlation between the two variables (in this case, an analyte's concentration versus time). Historical and current data sets will be combined to perform the trend analysis taking care to ensure that the data sets are comparable. Any adjustment to monitoring frequency will be documented in an annual monitoring report and require concurrence of the USAF and NMED.

If the calculated t is greater than the critical value as obtained from a table of statistical t-values, then the null hypothesis is rejected, and it can be concluded that there is no significant positive or negative statistical trend in the data. Conversely, if the calculated t is less than the critical value, then the null hypothesis is not rejected, and it can be concluded that there is a significant positive or negative statistical trend in the data.

The results of the monitoring efforts will be reported in the annual reports and submitted to the USAF and NMED.

3.2 Pre-Sampling Activities.

Kirtland AFB personnel will be contacted, a minimum of 20 days prior to each monitoring event to allow for coordination of regulatory oversight activities and to allow time for base personnel to provide notification to NMED. The project laboratory will also be notified of each groundwater sampling event, including the number of samples expected to be collected for each specified analysis.

3.3 Health and Safety

All field work will be completed in accordance with the *Kirtland Air Force Base, Albuquerque, New Mexico, Final Health and Safety Plan – Basewide* (USAF, 2014c). A daily safety tailgate meeting will be conducted at the beginning of each work day. This will include reviewing site-specific safety concerns and the job safety analyses. Personal protective equipment required for this work is not expected to exceed Level D which includes steel-toed boots, nitrile gloves for sample collection, leather gloves, hard hats, safety glasses, and a high-visibility reflective safety vest when on site.

3.4 Groundwater Level Measurements

Groundwater level measurements will be collected in accordance with the requirements delineated in URS standard operating procedure (SOP)-13, "Static Water Level and Total Depth Measurement," provided in Appendix A of the *Draft Uniform Federal Policy Quality Assurance Project Plan, Landfill Sites LF-001, LF-002, and LF-008* (USAF, 2014a). During the course of collecting water level measurements, observations of well condition will be collected and recorded. Water level measurements will be collected from the 20 monitoring wells located at landfill sites on a quarterly basis. Static water levels and total well depth will be measured prior to purging activities.

Table 3-2. Landfill Sites Monitoring Wells

Well	Diameter (inches)	Total Depth (feet below MPE)	Top of Screen (feet below MPE)	Bottom of Screen (feet below MPE)	Screen Slot Size (inches)	Measuring Point Elevation (feet)[a]
KAFB-0118	5	499.6	458.77	488.77	0.01	5,318.02
KAFB-0119	4	498	452.27	482.27	0.01	5,313.09
KAFB-0120	4	461.5	429	459	0.01	5,286.89
KAFB-0121	4	480.75	445.75	475.75	0.01	5,304.93
KAFB-0213	4	451.88	379.88	429.88	0.02	5,279.33
KAFB-0219	4	428	396	426	0.01	5,261.02
KAFB-0220	4	456	424	454	0.01	5,262.43
KAFB-0221	4	442.5	410.5	440.5	0.01	5,271.69
KAFB-0222	4	401	366	396	0.01	5,244.98
KAFB-0223	4	411	376	406	0.01	5,251.82
KAFB-0310	4	456.64	401.64	446.64	0.01	5,413.81
KAFB-0313	5	375.25	350.25	370.25	0.01	5,416.31
KAFB-0314	5	455.17	430.17	450.17	0.01	5,453.08
KAFB-0315	5	479	449	474	0.01	5,463.44
TJA-2	4	305	275	295	0.02	5,349.81
KAFB-0307	4	461.33	406.33	451.33	0.01	5,361.86
KAFB-0308	4	498.96	463.96	488.96	0.01	5,378.98
KAFB-0309	4	536.63	501.63	526.63	0.01	5,409.13
KAFB-0311	4	469.54	434.54	459.6	0.01	5,350.62
KAFB-0312	5	538.6	504.6	529.6	0.01	5,429.50

[a] Measuring point elevation is taken at the top of casing.
MPE – Measuring Point Elevation

3.5 Sample Collection Methods

Groundwater samples will be collected in accordance with the requirements delineated in SOP-15, "Groundwater Purging and Sampling," provided in Appendix A of the *Draft Uniform Federal Policy Quality Assurance Project Plan, Landfill Sites LF-001, LF-002, and LF-008* (USAF, 2014a). Each well will be purged and sampled in accordance with the SOP. During the purging of each well, field parameter data will be collected in accordance with SOP-16, "Water Quality Measurements Using a Multiple Parameter Water Quality Meter," also provided in Appendix A of the project Quality Assurance Project Plan (QAPP). Well purging will comply with the requirements delineated in Section 6.5.17.4, "Well Purging," of the *Hazardous Waste Treatment Facility Operating Permit, EPA ID No. NM9570024423* (NMED, 2010).

3.6 Equipment Maintenance

Pump maintenance will be performed as needed on sampling pumps under the LTM Program. The monitoring wells at LF-001, LF-002, and LF-008 do not have dedicated pumps. Well TJA-2 is sampled and gauged in conjunction with SNL equipment and personnel. If performance issues occur, the pumps will be removed from the wells using a winch rig and sent to the manufacturer for maintenance.

3.7 Equipment Decontamination

Non-dedicated sampling equipment will be decontaminated between sample locations following the procedures described in SOP-20, "Decontamination," provided in Appendix A of the *Draft Uniform Federal Policy Quality Assurance Project Plan, Landfill Sites LF-001, LF-002, and LF-008* (USAF,

2014a). Dedicated sampling equipment will not require decontamination. Equipment decontamination will comply with the requirements delineated in Section 6.5.3, "Decontamination Procedures," of the *Hazardous Waste Treatment Facility Operating Permit, EPA ID No. NM9570024423* (NMED, 2010).

3.8 Sample Labels

Each sample will be labeled with a unique identifier and recorded in the field logbook (SOP-1, "Use and Maintenance of Field Log Books" provided in Appendix A of the project QAPP) as it is collected. The sample identification will be documented on the chain-of-custody form. Data pertinent to each sample such as sample identification, location, color, time, and date will be recorded on field data sheets. Each analytical sample will be assigned a unique number in the following format:

- Groundwater Sampling Location (i.e., KAFB-0118); and
- Date sampled (MMDDYY)

Under this sample designation format, sample "KAFB-0118-072514" corresponds to a sample collected from monitoring well KAFB-0118 on July 25, 2014.

3.9 Chain-of-Custody

All samples will be accompanied by a chain-of-custody in accordance with SOP-26, "Chain-of-Custody" provided in Appendix A of the project QAPP. The chain-of-custody form will be completed by the field sampling technician collecting the sample and will accompany each sample cooler. Whenever a sample is transferred to another responsible party in an unsealed cooler, the receiving party must sign-off on the chain-of-custody form.

The original chain-of-custody form will accompany the samples to the laboratory with a copy retained by field staff, and a final copy will be returned with the analytical results.

4.0 LONG-TERM LANDFILL COVER MONITORING

ET Covers installed at each of the landfill sites include monitoring systems that provide data on the performance of the covers. The monitoring system includes equipment used to determine to what depth precipitation infiltrates the landfill cover by measuring soil moisture. A flux meter and large-scale lysimeter take direct measurements of changes in soil moisture. Heat Dissipation Sensors (HDSs) determine soil-water potential and Water Content Reflectometers (WCRs) measure volumetric soil content. The HDS measurements are used to characterize the movement of water through the cover on a longer term basis (monthly, seasonally, and annually). The WCR measurements provide higher resolution of rapid moisture movement that occurs during and immediately following a precipitation event, and can corroborate HDS measurements. Readings from all of this equipment when compared validate or invalidate each of the measurements and support conclusions regarding cover performance.

The landfill inspection programs include lysimeter checks and data downloads at least monthly and after rain events of 5 inches or more. Additional detail on ET Cover monitoring is included in the December 2014 *Operation and Maintenance Work Plan, LF-001, LF-002, and LF-008* (2014b).

5.0 QUALITY ASSURANCE PROJECT PLAN

The objective of this investigation is to provide groundwater sample analytical data of sufficient quality and quantity to adequately characterize and monitor groundwater underlying the SWMU sites (LF-001, LF-002, and LF-008). This LTM Plan is used in conjunction with the *Final Uniform Federal Policy Quality Assurance Project Plan, Landfill Sites LF-001, LF-002, and LF-008* (USAF, 2014a) to ensure that the functional activities, organization, and quality assurance/quality control protocols are achieved in accordance with the project's data quality objectives.

As outlined in the QAPP, quality assurance objectives are specified to ensure that data produced are of a known and sufficient quality for determining whether a risk to human health or the environment exists. Minimum precision, accuracy, and completeness measurements and minimum detection limits are quantitative objectives specified in the QAPP. Representativeness and comparability are qualitative objectives. During the sampling discussed in this plan, field quality control samples will be collected and analyzed to evaluate the achievement of the precision and accuracy objectives specified in the QAPP. Overall, both field and laboratory precision will be evaluated through the results of duplicate groundwater samples, equipment rinsates, and field blanks. The duplicate samples, equipment rinsates, and field blanks will be analyzed for the same suite of analytes as the regular groundwater samples. For each quarterly groundwater monitoring event, one field duplicate, one equipment rinsate, and one field blank will be collected. Trip blanks to be analyzed for volatile organic compounds (VOC) will be included in each cooler containing VOC samples shipped to the laboratory.

Environmental analyses are critical, because decision-making based on inaccurate measurements or data of unknown quality can have significant economic and health consequences. Data verification and validation will be performed as specified in the QAPP to ensure data meet the project requirements. Method data validation is the process whereby analytical data are reviewed against set criteria to ensure that the results conform to the requirements of the analytical method and any other specified requirements. All laboratory-generated data will be validated in accordance with the requirements of the QAPP. The field-generated data will not be validated, but the quality of the field-generated data will be ensured through adherence to established operating procedures and use of equipment calibration and standardization, as appropriate.

5.1 Duplicate Samples

Field duplicates are samples that are collected at the same time, from the same source, and at the same depth or sample location as the associated field sample. Field duplicates are submitted to the project laboratory as separate samples. The purpose of collecting field duplicates is to assess the consistency of the overall sampling effort, including collection, shipping, and analysis. The purpose of submitting them to the laboratory is to assess the consistency or precision of the laboratory's analytical system. Duplicate samples are collected and analyzed for the same parameters as the primary samples to evaluate sampling and analytical precision. Field duplicates are collected at a frequency of 10 percent of the primary samples collected, with a minimum of one duplicate collected. The precision goal for field duplicate analyses will be plus or minus a 30 relative percent difference.

5.2 Equipment Blanks

Field equipment blanks are samples that are prepared in the field by pouring deionized water over decontaminated sampling equipment and collecting the water in laboratory provided sampling containers. The water is analyzed as a sample. The field equipment blank gives an indication of contamination from field procedures (e.g., improperly cleaned sampling equipment, cross-contamination). One equipment rinsate blank will be collected during each annual groundwater monitoring event.

5.3 Trip Blanks

Trip blanks are used to evaluate if VOCs may have been introduced to the primary samples during shipment, handling, or storage. Trip blanks are prepared by the laboratory, shipped to the project site, and then transported back to the laboratory with the field samples. Trip blanks will be analyzed for VOCs only. Trip blanks will be submitted and analyzed with each cooler containing VOC samples.

5.4 Data Validation/Verification

The laboratory will provide a minimum of a Level II QC laboratory data package. In addition, URS will request that a minimum of 10 percent of all samples be reported with a Level IV QC laboratory data package. Following receipt of the Level II or Level IV data package from the laboratory, URS will perform data validation and verification to evaluate the reliability and defensibility of the analytical data. This process involves reviewing the data against a known set of criteria to verify data validity prior to URS submitting the data.

All laboratory analytical data will undergo Stage 2A Verification and Validation Checks as defined in the *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA, 2009). Stage 2A expands beyond the data verification requirements to address the verification and validation checks for the compliance of sample related QC, including method blanks, surrogate recoveries, deuterated monitoring compound recoveries, laboratory control sample recoveries, duplicate analyses, matrix spike and matrix spike duplicate recoveries, serial dilutions, post-digestion spikes, and standard reference material traceability. In addition, sample holding times are evaluated and the frequency of QC samples is checked for appropriateness.

Ten percent of laboratory analytical data will undergo Stage 2B/3 Verification and Validation Checks as defined in the guidance. Stage 2B builds upon Stage 2A to address compliance of instrument-related QC, including initial calibration data, continuing calibration data, method specific instrument performance checks, and frequency of instrument QC samples. Stage 3 includes the final step of recalculation of instrument and sample results from the laboratory instrument responses, and comparison of recalculated results to laboratory reported results.

6.0 INVESTIGATION-DERIVED WASTE

The investigation-derived waste generated during the LTM will include spent and unused sample material, personal protective equipment, miscellaneous sampling supplies, decontamination water, and purge water. Waste will be managed in accordance with the *Environmental Restoration Program Investigation-Derived Waste Management Plan* (USAF, 2009). Prior to performing sampling, the field team leader will discuss with the field sampling personnel waste reduction methods. Practices to be instituted to support waste minimization include, but are not limited to, the following:

- Restriction of materials (especially hazardous materials) to those needed for performance of work;
- Substitution of recyclable materials for disposable items;
- Reuse of items, when practical;
- Segregation of contaminated from uncontaminated waste; and
- Segregation of reusable items (such as personal protective equipment and tools).

Waste characterization will be evaluated based on the comparison of analytical results with applicable regulatory levels.

Wastewater from pre-sampling well purging and equipment decontamination will be stored in tanks pending the receipt of the groundwater analytical results. A sign posted on each tank will identify the contents and convey a warning that no material should be added or removed. The tank will be labeled "Investigation-Derived Waste" and will include the date that the purge water was put in the tank. Waste characterization will be performed by reviewing the groundwater sample analytical results from the wells. The detected constituent concentrations will be compared to the New Mexico Water Quality Control Commission Regulations, Part 2, 3103, A, B, and C groundwater quality standards (20 New Mexico Administrative Code 6.2).

A Notice of Intent to discharge purge and decontamination water will be prepared following each sampling event and submitted to KAFB personnel for submittal to the NMED Ground Water Quality Bureau (GWQB) for approval prior to discharging any groundwater to surface. Results from laboratory analyses will be summarized and concentrations evaluated for individual containers based on the volume added from the wells from which the purge water and decontamination water originated. The maximum concentrations will be used to determine whether purge water meets the discharge requirements. The decision tree provided by the NMED GWQB and presented in Figure 3 will be used to aid in determining the disposal requirements. After NMED provides their approval, the water will be discharged to the ground surface at the site. If the results indicate that the water cannot be released to the ground surface, it will be transported to an approved facility for disposal.

All personal protective equipment and disposable equipment will be placed in double plastic bags and sealed for disposal in dumpsters at the base.

As part of the contract with the subcontracted laboratories, all laboratory and sample waste is managed in accordance with the subcontract. Analytical waste streams may include unused/unaltered sample material, analytical residues, and sample containers. Unused/unaltered sample material will be generated from the sampling activities in the form of groundwater not required for analysis. Generally, the laboratory will be responsible for disposal of the unused/unaltered sample material. In those cases where samples must be returned from the laboratory, this excess material will be documented and disposed in accordance with the

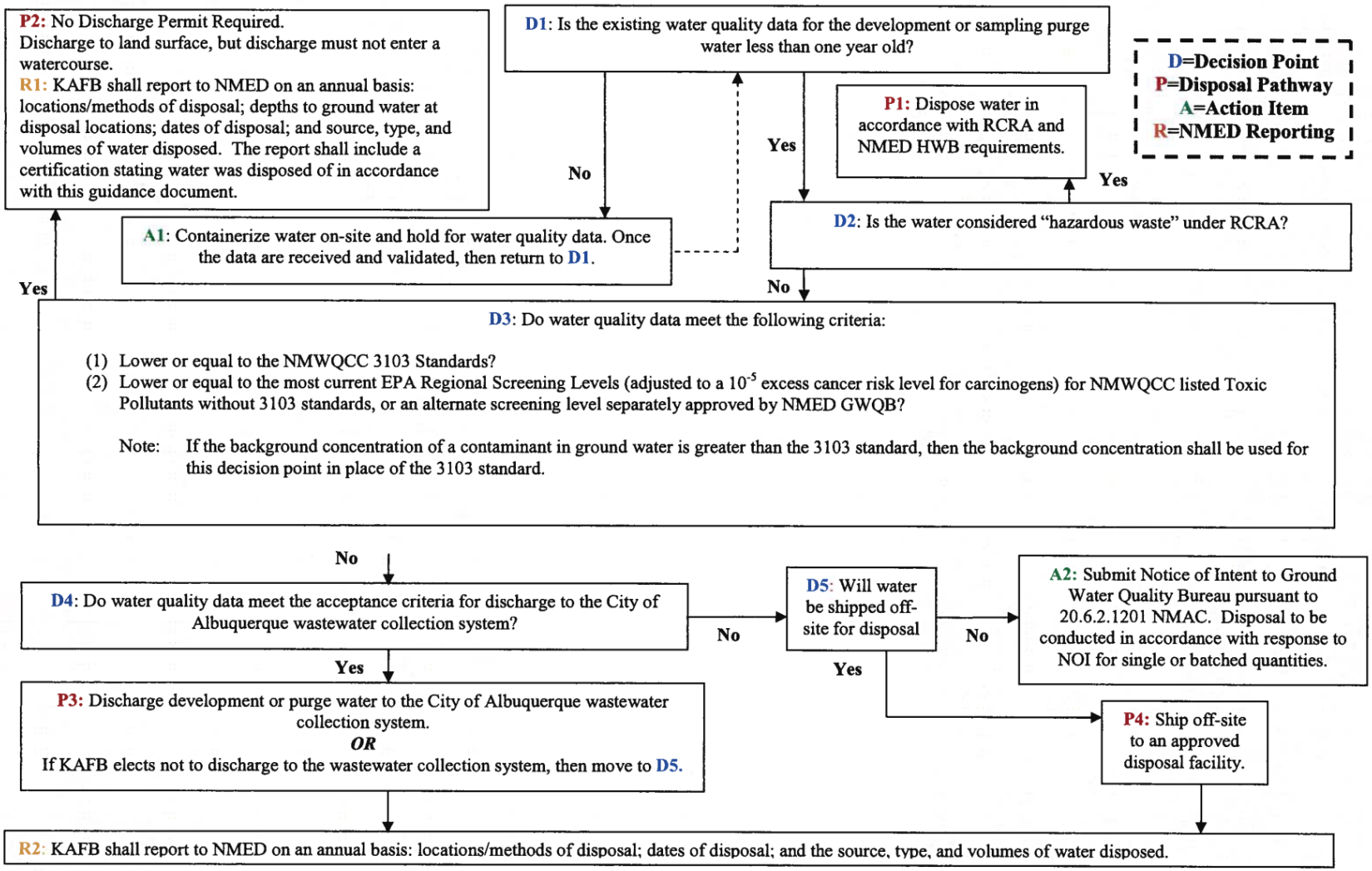

Figure 5. Kirtland AFB Development and Sampling Purge Water Decision Tree

EPA – U.S. Environmental Protection Agency
GWQB – Ground Water Quality Bureau
KAFB – Kirtland Air Force Base
NMAC – New Mexico Administrative Code
NMED – New Mexico Environment Department
NMWQCC – New Mexico Water Quality Control Commission
RCRA – Resource Conservation and Recovery Act

requirements for disposal of purge and decontamination water. Analytical residues will be generated from the sample analytical activities conducted by the subcontracted laboratories. Although the laboratories are required to dispose of analytical residues under terms of the subcontract, the potential does exist for return of analytical residues. If analytical residues are returned, this will be documented and the waste disposed at an appropriate facility.

Sample containers will become a waste stream following analyses. The laboratories are required to dispose of the sample containers in accordance with established waste management procedures. Sample containers will only be returned to the project should unused/unaltered sample material need to be returned as discussed above.

7.0 RECORDKEEPING

URS will maintain a field logbook in accordance with SOP-1, "Use and Maintenance of Field Log Books," found in Appendix A of the project QAPP (USAF, 2014a), which requires that field logbooks be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the logbook. The primary document used to record site data is the field logbook. Entries will be made in indelible ink and corrections made by a single stroke through the error with the recorder's initials. All entries to the logbook will include, at a minimum:

- Location, date, start and finish times;
- Names of personnel present;
- Names of visitors;
- General weather conditions;
- Health and safety briefings;
- Details of work performed;
- Summary of samples collected;
- Field measurement readings and field equipment calibration information;
- Photograph log and drawings/sketches; and
- General observations

8.0 REPORTING

Upon receipt of analytical results from all annually scheduled sampling activities, URS will prepare a written report summarizing the groundwater monitoring. The annual monitoring report will summarize field activities, observations, and results. The report will include the evaluation of trends and statistical analysis, as appropriate.

Analytical results will also be presented within the report in a table format, and include sample identifier, date and time of collection, sample location, and concentrations. Analytical results will be compared to the applicable New Mexico Groundwater Quality Control Commission standards. Field notes and laboratory reports will be included as appendices within the report.

In addition, within 90 days of sample collection, all data will be exported for upload to AFCEC's Environmental Restoration Program Information Management System database.

Table 8-1. LTM Report Summary

Task	Report Contents	Frequency	Submittal
Groundwater Elevation Measurements	Provided in LTM Annual Report summarizing base-wide results LTM program results for fiscal year: Groundwater gauging data in tabular form Field notes Groundwater elevation contour map	Quarterly, in December, March, June, and September (coordinated with LTM gauging events)	Kirtland AFB and NMED
Pump Maintenance	Provided in LTM Annual Report summarizing base-wide LTM program results for fiscal year: Description of pump maintenance activities	Approximately every 18 months (coordinated with LTM Program pump maintenance activities)	Kirtland AFB and NMED
Annual Groundwater Monitoring Report	Summary of analytical results from groundwater monitoring well sampling Monitoring data in tabular form compared to applicable standards Data/trend evaluations Analytical laboratory reports Field notes Data validation report	Annually in November	Kirtland AFB and NMED
LTM – long-term monitoring AFB – Air Force Base NMED – New Mexico Environment Department			

9.0 REFERENCES

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KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

FINAL OPERATIONS AND MAINTENANCE WORK PLAN
Landfill Sites LF-001, LF-002, and LF-008

December 2014

377 MSG/CEI
2050 Wyoming Boulevard SE
Kirtland AFB, New Mexico 87117-5270

KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

FINAL OPERATIONS AND MAINTENANCE WORK PLAN
LANDFILL SITES LF-001, LF-002, and LF-008

December 2014

Prepared for:

Air Force Civil Engineer Center
Department of the Air Force, 772nd ESS/PKB
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This Operations and Maintenance Work Plan was prepared for the Air Force Civil Engineer Center by URS Group, Inc. in association with FPM Remediations, Inc. to aid in the implementation of a final remedial action plan under the Environmental Restoration Program. As the report relates to actual or possible releases of potentially hazardous substances, its release prior to an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the Environmental Restoration Program, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this report premature or inaccurate.

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14. ABSTRACT
This Operations and Maintenance Work Plan specifies the activities that will be performed at Sites LF-001, LF-002, and LF-008, Kirtland Air Force Base, New Mexico. The purpose of the plan is to provide guidance for implementing measures to mitigate the continuing erosion problems that have historically impacted the previously constructed evapotranspiration covers, define the routine monitoring requirements for the covers, and describe the long-term maintenance activities to ensure that covers continue to be protective of human health and ecological receptors.

15. SUBJECT TERMS
Sites LF-001, LF-002, and LF-008, long-term monitoring, evapotranspiration covers, long-term maintenance

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
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TOM D. MILLER, Colonel, USAF
Commander, 377th Air Base Wing

This document has been approved for public release.

KIRTLAND AIR FORCE BASE
377th Air Base Wing Public Affairs

PREFACE

This Operations and Maintenance Work Plan specifies the activities that will be performed at Sites LF-001, LF-002, and LF-008, Solid Waste Management Units 6-1, 6-2, and 6-4, at Kirtland Air Force Base, New Mexico. The purpose of the plan is to provide guidance for implementing measures to mitigate the continuing erosion problems that have historically impacted the previously constructed evapotranspiration covers, define the routine monitoring requirements for the covers, and describe the long-term maintenance activities to ensure that the covers continue to be protective of human health and ecological receptors.

This work will be performed under the authority of the requirements of the Air Force Civil Engineer Center Contract No. FA8903-13-C-0008. This program is conducted under the Kirtland Air Force Base Environmental Restoration Section Chief, Mr. Ludie Bitner, and the Kirtland Air Force Base Project Manager, Mr. Cole Crosgrove. URS Group, Inc., as a subcontractor to FPM Remediations, Inc., has prepared this Operations and Maintenance Plan as defined in the Performance-Based Remediation Contract for Cannon, Holloman, and Kirtland Air Force Bases located in New Mexico, and Luke Air Force Base located in Arizona. Mr. Richard Wells is the URS Group, Inc. Installation Manager for Environmental Restoration Program Sites at Kirtland Air Force Base.

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ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
cy	cubic yards
ERP	Environmental Restoration Program
ET	evapotranspiration
FPM	FPM Remediations, Inc.
ft	feet or foot
HDPE	high-density polyethylene
HDS	heat-dissipation sensor
KAFB	Kirtland Air Force Base
MAP	Management Action Plan
NMED	New Mexico Environment Department
O&M	Operations and Maintenance
SWMU	Solid Waste Management Unit
URS	URS Group, Inc.
USAF	U.S. Air Force
WCR	water content reflectometer

1.0 INTRODUCTION

This Operations and Maintenance (O&M) Work Plan addresses the inspection and maintenance activities that will be performed at Solid Waste Management Unit (SWMU) 6-1, Landfill 1 (LF-001), SWMU 6-2, Landfill 2 (LF-002), and SWMU 6-4, Landfills 4, 5, and 6 (LF-008) at Kirtland Air Force Base (AFB), New Mexico. This plan was prepared in accordance with the requirements of the Air Force Civil Engineer Center (AFCEC) Contract No. FA8903-13-C-0008. URS Group, Inc. (URS), as a subcontractor to FPM Remediations, Inc. (FPM), has prepared this O&M Plan in accordance within the Performance-Based Remediation Contract for Cannon, Holloman, and Kirtland AFBs located in New Mexico, and Luke AFB located in Arizona. The long-term groundwater monitoring requirements for the landfills are provided in the *Draft Long-Term Monitoring Plan, Landfill Sites LF-001, LF-002, and LF-008* (U.S. Air Force [USAF], 2014a) as supported by the requirements delineated in the *Draft Uniform Federal Policy Quality Assurance Project Plan, Landfill Sites LF-001, LF-002, and LF-008* (USAF, 2014b).

1.1 Purpose and Scope

The purpose of the plan is to provide guidance for implementing measures to mitigate the continuing erosion problems that have historically impacted the previously constructed evapotranspiration (ET) covers, define the routine monitoring requirements for the covers, and describe the long-term maintenance activities to ensure that the covers continue to be protective of human health and ecological receptors.

The plan describes the inspection and repair activities that will be performed at the landfill sites shown on Figure 1. This plan contains the following elements:

- A general site map (Figure 1) showing Kirtland AFB in relation to the State of New Mexico and City of Albuquerque and the locations of LF-001, LF-002, and LF-008
- Site maps showing the ET covers constructed at each of the three landfills
- General site description and history
- Routine landfill inspection program
- Routine lysimeter monitoring requirements
- Documentation and reporting requirements for monitoring activities
- Measures to be implemented to mitigate the erosion problems that have historically impacted the ET covers previously constructed at each of the landfills
- Long-term maintenance activities performed to ensure that the covers remain protective of human health and ecological receptors

The monitoring activities may be revised to reflect changes in the monitoring scope or schedule upon agreement with the New Mexico Environment Department (NMED).

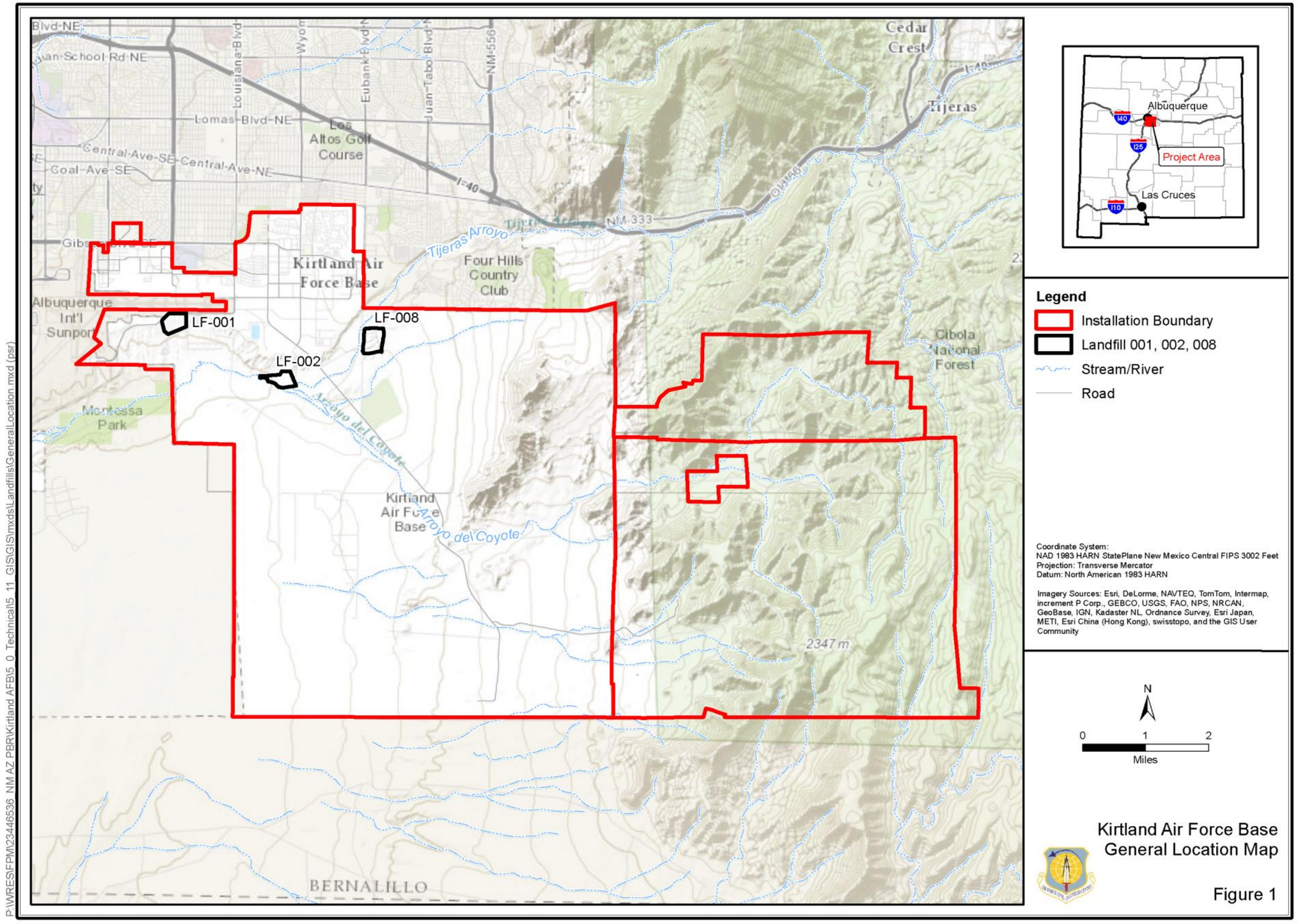

Figure 1. LF-001, LF-002, and LF-008 Site Location Map

2.0 BACKGROUND

2.1 Site Descriptions

Three private airfields predate the Kirtland AFB, formerly named Albuquerque Army Air Base, with military operations becoming the primary focus in 1941. The base was renamed in 1942 honoring Colonel Roy C. Kirtland, a pioneer in Army aviation. Flight crews were trained in the early 1940s at Kirtland's three schools: advanced flying, bombardier training, and multi-engine school. Later that decade, the focus of base operations shifted to developing aircraft modifications for weapons delivery, researching ballistic characteristics, and testing weapons. Manzano Base was named in 1952 and was located on the former Site Able, created under the Armed Forces Special Weapons Command. Sandia Base began operating as the Albuquerque Airport Training Station in 1942 and served historically as a nuclear weapons installation. In 1971, Kirtland, Manzano, and Sandia bases were merged and were managed under one command.

2.1.1 Landfill 1 (LF-001)

LF-001 is located in the northwestern area of Kirtland AFB, directly south of the main east-west runway for the base and Albuquerque International Sunport. Figure 2 provides an overview of the Landfill 1 cover based on the July 28, 2014 inspection conducted by URS. Southgate Avenue forms the northern and western site boundaries, Ammo Road runs parallel to the eastern boundary, and an abandoned railroad grade forms the southern boundary. Kirtland AFB Production Well No. 2 (KAFB-2) is located approximately 150 feet (ft) northeast of the landfill, downgradient of former monitoring well KAFB-0111.

Although disposal activities date back to 1951, the site was operated primarily between 1960 and 1975 as a trench-and-fill landfill. The landfill contains an estimated 425,000 cubic yards (cy) of municipal waste and up to 175,000 cy of construction and demolition debris. Field activities conducted at the site have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. The landfill was regraded and an ET Cover including drainage controls was constructed. A detailed summary of the site's background and history, results of previous investigations, corrective measures, and current status is presented in the Environmental Restoration Program (ERP) Site-Specific Summaries (USAF, 2005a), which were prepared as a supplement to the 2004 update of the Management Action Plan (MAP) (USAF, 2005b).

The following issues were observed during the most recent inspection conducted by URS on July 28, 2014:

- Minor rilling on the western and southern slopes of the cap
- Channels and catch basins have varying degrees of vegetation
- Moderate piping (6 to 12 inches deep) near channel 3

Figure 2. Landfill 1 (LF-001)

2.1.2 Landfill 2 (LF-002)

SWMU 6-2, LF-002 is located between the Trestle Aircraft Testing Facility and Advanced Research Electromagnetic Simulator facilities to the north and the active channel of the Tijeras Arroyo to the south. Figure 3 depicts the current condition of the Landfill 2 cover as observed during the July 28, 2014 inspection conducted by URS. The eastern and western boundaries are currently defined by security fences. Kirtland AFB Production Well No. 8 is approximately 2,100 ft northeast of the landfill, and Production Well No. 4 (KAFB-4) is 2,400 ft to the north. Field activities have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. The landfill was regraded and an ET Cover including drainage controls was constructed. A detailed summary of the site's background and history, results of previous investigations, corrective measures, and current status is presented in the ERP Site-Specific Summaries (USAF, 2005a), which was prepared as a supplement to the 2004 update of the MAP (USAF, 2005b).

LF-002 operated between 1942 and 1965 as a trench-and-fill landfill. The current volume of waste is estimated to be 1,321,700 cy. Two buried pipelines are located near LF-002. The 21-inch City of Albuquerque's Tijeras Interceptor sanitary sewer line runs east-west across the northern region of the landfill, approximately 400 ft south of well KAFB-0213. The second buried pipeline is the treated sewage effluent line (ST-051) that carried effluent from the Sewage Lagoons to the Golf Course Main Pond. ST-051 is currently used to pump nitrate-rich water from Production Well No. 7 (KAFB-7) to the Golf Course Main Pond for irrigation. This line was relocated outside of the landfill boundary during construction of the ET cover. An access road was constructed for the sanitary sewer pipeline.

The following issues were observed during the most recent inspection conducted by URS on July 28, 2014:

- Fiber roll displacement and sediment overbanking fiber rolls near channel 2
- Major rilling (>12 inches deep) on southeastern slope

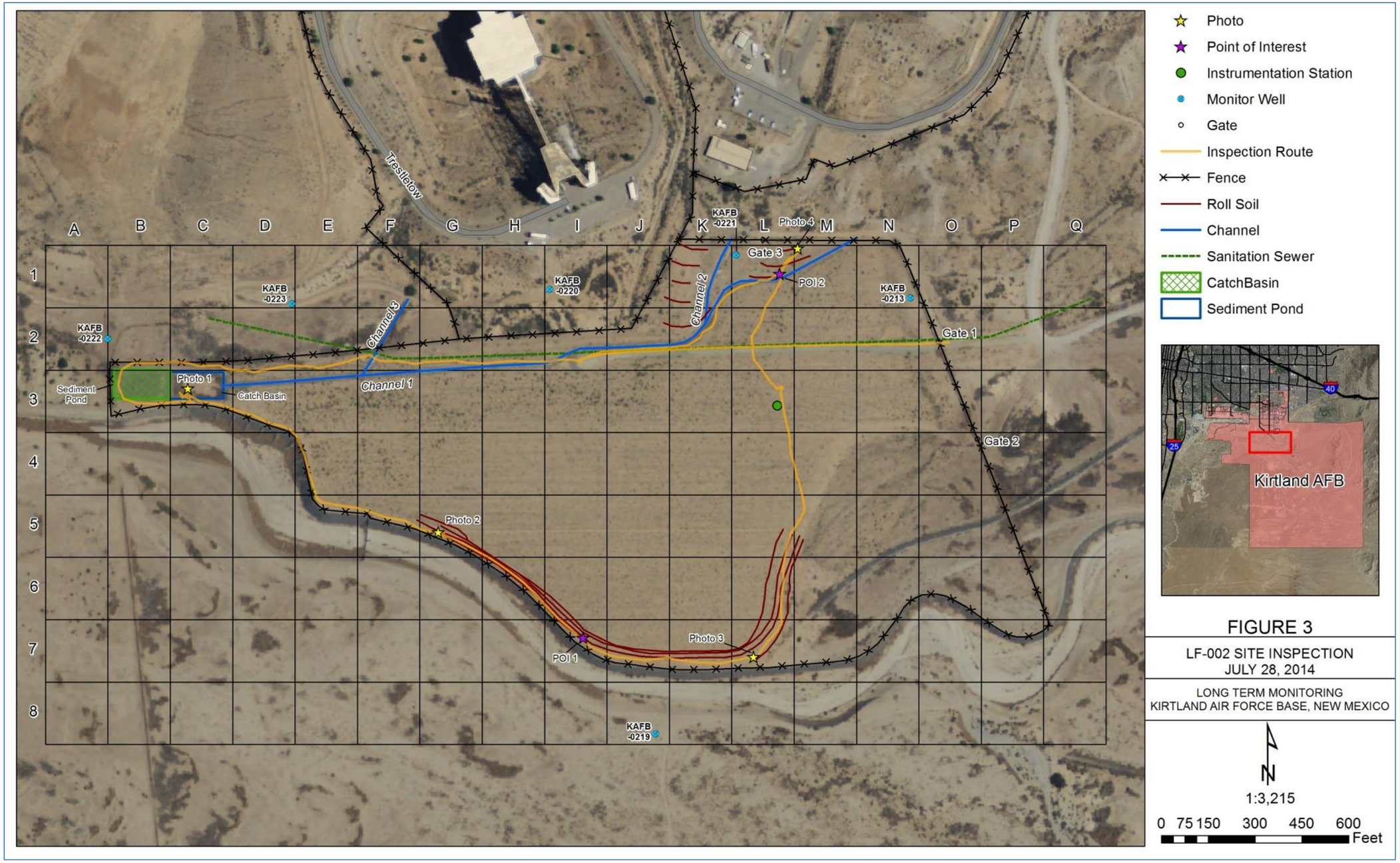

Figure 3. Landfill 2 (LF-002)

2.1.3 Landfill 8 (LF-008)

SWMU 6-4, Landfills 4, 5, and 6 (LF-008) is located on the northwestern region of Kirtland AFB and is bounded by the Tijeras Arroyo to the north and the covered slope of the active construction and demolition debris landfill (LF-268) about 150 ft east of Power Line Road to the east. Current conditions of the cover at LF-008 are depicted in Figure 4 as found during the July 29, 2014 inspection conducted by URS. The site is made up of three former contiguous landfills (Landfills 4, 5, and 6). Although the landfill is near the Tijeras Arroyo, flood plain maps indicate that the site is not located within the 100-year flood plain.

The City of Albuquerque and Kirtland AFB jointly operated Landfill 4 from 1964 to 1969 as a general refuse landfill. Construction and demolition debris and trees were placed in the northeastern part of Landfill 4 and general refuse was placed in two natural arroyos in the western part of the site. The estimated volume of waste in Landfill 4 is about 600,000 cy buried over an area of approximately 25 acres. Kirtland AFB operated Landfills 5 and 6, located north of Landfill 4, from mid-1960 through 1989. Construction and demolition debris was placed in Landfill 5 and other refuse was disposed in Landfill 6. The estimated volume of waste in Landfills 5 and 6 is about 1,746,000 cy buried over an area of approximately 40 acres.

Field activities conducted at the site have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. The landfill was regraded and an ET Cover including drainage controls was constructed. A detailed summary of site's background and history, results of previous investigations, corrective measures, and current status is presented in the ERP Site-Specific Summaries (USAF, 2005a), which was prepared as a supplement to the 2004 update of the MAP (USAF, 2005b).

The following issues were observed during the most recent inspection conducted by URS on July 29, 2014:

- Minor piping (<6 inches deep) near instrumentation station on landfill cap
- Moderate to major rilling (>12 inches deep) on northern and western slopes
- Major rilling and fiber roll displacement in catch basin 4
- Construction and repair of upgrades to Channel 3 have been completed (by others)
- Large open bare spot is present where construction is taking place
- Low spot in cap potential ponding area
- Sediment covering trap Intake #1

Figure 4. Landfill 8 (LF-008)

3.0 MONITORING ACTIVITIES

Monthly inspections of the reclaimed landfills are currently required to assess the condition of the ET cover including the development of erosion features, drainage channels, and the establishment of vegetative cover. Mitigation measures proposed in this report are intended to address the observed conditions which diminish the performance of the ET cover including erosion rilling/gullies, surface depressions, fissures, and piping. Application of the mitigation measures proposed in this report improve the function of the ET cover and may justify less-frequent inspections as conditions improve.

Groundwater monitoring activities are discussed in the *Long-Term Monitoring Plan, Landfill Sites LF-001, LF-002, and LF-008* dated December 2014 (KAFB 2014a).

3.1 Health and Safety

All field work will be completed in accordance with the *Kirtland Air Force Base, Albuquerque, New Mexico, Final Health and Safety Plan – Basewide* (USAF, 2014c). A daily safety tailgate meeting will be conducted at the beginning of each work day. This will include reviewing site-specific safety concerns and the job safety analyses. Personal protective equipment required for this work is not expected to exceed Level D which includes steel-toed boots, nitrile gloves for sample collection, leather gloves, hard hats, safety glasses, and a high-visibility reflective safety vest when on site.

3.2 Definitions and Terms

The following terms are used to describe the engineered components and the observed conditions of the soil cover. The definitions of the terms are provided herein to maintain consistency in reporting. The terms are primarily those that have been previously used for the project. However, some previous terms have been replaced with new terms that better describe the item being discussed.

Catch Basin – Depression constructed at the terminus of a channel or pipe system to dissipate energy and transfer the stormwater runoff to the sediment pond.

Berm – Raised linear drainage feature used to direct flow laterally.

Channel – Depressed or excavated drainage feature used to collect and carry stormwater runoff.

Depression – Topographically low spot that can collect stormwater and does not have an apparent drainage outlet. These features can be identified by the presence of surface mud cracks or vegetation that has a higher density or variable composition than that of the surrounding cover.

Erosion Gully – Large-scale erosional feature 24 inches or greater in depth and of variable width.

Erosion Rilling – Small-scale erosional feature 0-24 inches in depth and of variable width, typically located on the upper reaches of the outer slopes and fiber rolls.

Evapotranspiration Cover – Isolation barrier of loosely compacted and vegetated soils comprised of 2.5 ft of ET cover and 0.5 ft of an erosion/vegetation layer.

Fissure – A long and narrow linear feature that is typically caused by differential settlement or consolidation of the landfill material underlying the ET cover. Fissures in early stages of development may have variable widths but typically have clean, un-eroded margins. Precipitation that collects in the gaps produced by fissures may bypass the ET cover and directly flow into the landfill material. Mature

fissures have rounded, eroded margins caused by the transport of surface materials by infiltrating precipitation.

Fiber Roll – A temporary erosion control and sediment control device made of straw, coconut fiber, or similar material formed into a tubular roll. The fiber roll is installed perpendicularly to the drainage gradient and held in place by wooden stakes.

Gabion – Riprap enclosed in a galvanized metal basket, installed in terminal portions of the channels where flow velocities, volumes, and tractive forces are greatest.

Geomembrane – Impermeable synthetic liner.

Geotextile – Non-woven, needle-punched synthetic fabric installed beneath riprap to retain underlying soil materials.

Grid Location – Grid shown on plan-view figures used for inspection reporting.

Inspection Route – Route taken while performing inspections. The route is typically mapped on the figures accompanying the inspection report.

Piping – Erosional feature caused by the transport of surface soils vertically downward through the ET cover. Typically located along maturing fissures, but may also be present individually.

Revegetation – Process of seeding and/or mulching following maintenance activities that have destroyed or diminished the vegetative cover.

Rock Berm – Berm constructed of rock riprap to either slow sheet flow or laterally direct surface water to a channel or pipe.

Sediment Pond – Impoundment constructed downstream of the catch basins to collect and manage sediment runoff from the project area.

3.3 Site inspections

Site inspections are performed to observe the condition of the reclaimed surface of the landfills, monitor the progression of undesirable conditions, and document areas that are being successfully maintained. The current inspection schedule for the landfill sites includes both monthly inspections and inspections after each precipitation event of 0.5 inch or greater. Inspections following rain events may substitute for the monthly inspection assuming subsequent rain events do not occur in the same month. Details of each inspection include identification of the feature, location, current and previous status information, notes/description, a rating of slight, moderate or high, and recommended/initiated corrective action. Each inspection report provides completed inspection forms, inspection photographs, and site maps, if appropriate.

3.3.1 ET Cover / Erosion

Monthly inspections will document areas of the reclaimed surface that are damaged or poorly performing and recommend appropriate corrective actions. These corrective actions may include redirecting the surface flow, repairing animal burrows that have caused soil transport down-slope, adding areas of riprap to slow the velocity of flow, repairing rills or fissures that may have formed from rain events or settling, replacing soils and revegetating, or other appropriate corrective measures. Inspectors will review the

perimeter of the landfill to document the condition of the fence and other access controls. Photographs taken during previous monthly inspection will be compared to observed conditions to assess the degradation and document locations where corrective measures have been successful.

3.3.2 Stormwater Drainage / Controls

Performance of the ET cover requires that the surface is freely drained and that the specified thickness of vegetated cover is in place across the surface. The existing drainage controls are designed to manage stormwater off of the surface and limit the development of erosion. Stormwater drainage and controls are most effective if site conditions allow them to function as they were designed. Inspectors will document any conditions that impair proper operation of these site features. Examples include the accumulation of excessive vegetation in channels, excess accumulation of silt, eroded berms, displacement of riprap, formation of rills or fissures after rain events or landfill settling, absence of vegetative cover, and excessive animal burrows.

3.3.3 Vegetation / Re-Vegetation

Inspections will note areas where vegetative cover is insufficient and in need of repair, typically resulting from recent repair activity or where erosion has undermined existing vegetation. The grid location of the areas will be recorded in the field notes and shown on the site inspection map.

3.3.4 Fencing

Fencing and gates used to control access to the landfill sites will be inspected periodically to identify any structural damage, vandalism, or maintenance needs (including repair or replacement of locks). Observed damage will be documented on inspection checklists and repairs will be initiated as soon as possible. Kirtland AFB personnel will be consulted to ensure that materials used in any repairs are of similar or higher quality than existing to meet site security needs.

3.3.5 Inspection and Monitoring Guidance

Tables 3-1, 3-2, and 3-3, excerpted from the *Annual Monitoring and Maintenance Activities Report for Solid Waste Management Unit (SWMU) 6-1, Landfill 1 (LF-001); SWMU 6-2 Landfill 2 (LF-002); and SWMU 6-4 Landfills 4, 5, and 6 (LF-008)* (USAF, 2012), summarize operations and maintenance and monitoring requirements applicable to the landfill sites addressed in this plan and provide guidance to the inspector as to conditions to be considered and possible routine maintenance responses for each type of feature.

Table 3-1. Summary of Landfill Maintenance and Monitoring Requirements Specific for LF-001

Feature	Inspection Frequency[1]	Location[2]	Inspection	Routine Maintenance
Channels	Monthly and after rain event ≥ 0.5 inch	Channels 1-4	Erosion; exposed liner; riprap displacement; gabions; excessive silt buildup; tumbleweed accumulation	Replace riprap; remove excess silt, debris, and tumbleweeds
Rock Berms	Monthly and after rain event ≥ 0.5 inch	Rock Berms 1-14	Erosion along and adjacent to berm; ponding and leakage through berm	Fill in low areas; minor grading at direction of Kirtland AFB
Cover surface, especially steeper slopes	Monthly and after rain event ≥ 0.5 inch	North-South Transects 1-11	Surface erosion; gully formation	Fill in gullies to restore grade
Stormwater and Sediment Control Basins	Monthly and after rain event ≥ 0.5 inch	Catch Basins 1-4	Excessive silt and debris buildup; accumulation of weeds; erosion	Remove excess silt and debris; remove accumulated weeds
Culverts, inflow and outflow	Monthly and after rain event ≥ 0.5 inch	Corrugated metal pipe culvert, Run-on Channel 1, north end of Channel 2	Excessive silt buildup; debris buildup; tumbleweed accumulation	Remove excessive silt and debris; remove accumulated tumbleweeds
Perimeter fence and gates	Monthly and after rain event ≥ 0.5 inch	Gates 1- 4	Structural integrity; tumbleweed and debris accumulation; locks on gates	Remove tumbleweed and debris; replace damaged or missing locks
Signage on perimeter fence	Monthly and after rain event ≥ 0.5 inch	Along fence	Inspect signage for damage. Note missing signage	Replace damaged or missing signage
Vegetation	Monthly and after rain event ≥ 0.5 inch	Over entire ET cover	Extent of vegetation cover; type of vegetation; general condition	Document condition of vegetation; site photographs
ET cover performance	Monthly and after rain event ≥ 0.5 inch	Monitoring panel	Lysimeter check and data download.	Note issues with sensor function/calibration or system enclosures.

[1] Inspection frequency may be reduced after stabilization of vegetative cover as determined by Kirtland AFB.
[2] Identification number refers to features described by station locations in monthly reports.
AFB – Air Force Base ET – Evapotranspiration

Table 3-2. Summary of Landfill Maintenance and Monitoring Requirements Specific for LF-002

Feature	Inspection Frequency[1]	Location[2]	Inspection	Routine Maintenance
Channels	Monthly and after rain event ≥ 0.5 inch	Channels 1-3	Buildup of excessive silt and debris; accumulation of tumbleweeds; erosion; displacement of riprap, exposed liner	Clean out excess debris, silt, and weeds; fill in eroded areas to restore channel configuration
Cover surface, especially steeper slopes	Monthly and after rain event ≥ 0.5 inch	North-South Transects 1-11	Surface erosion; gully formation	Fill in gullies to restore grade
Stormwater and Sediment Control Basins	Monthly and after rain event ≥ 0.5 inch	Catch Basin and Sediment Pond	Excessive silt and debris buildup; accumulation of weeds; blockage; erosion	Remove excess silt and debris; remove accumulated weeds; fill in eroded areas to restore feature design configuration
Culverts, inflow and outflow	Monthly and after rain event ≥ 0.5 inch	Corrugated Metal Pipe intakes 1 and 2	Excessive silt buildup; debris buildup; tumbleweed accumulation	Remove excessive silt and debris; remove accumulated tumbleweeds
Sanitary sewer access road and manhole covers	Monthly and after rain event ≥ 0.5 inch	Manholes 10-15	Erosion damage to road; damage to manhole covers from use of road	Fill in eroded areas to restore grade; replace damaged manhole covers
Perimeter fence and gates	Monthly and after rain event ≥ 0.5 inch	Fence and gates 1-3	Structural integrity; tumbleweed and debris accumulation; locks on gates	Remove tumbleweed and debris; replace damaged or missing locks
Signage on perimeter fence	Monthly and after rain event ≥ 0.5 inch	Along fence	Inspect signage for damage. Note missing signage	Replace damaged or missing signage
Vegetation	Monthly and after rain event ≥ 0.5 inch	Over entire ET cover	Extent of vegetation cover; type of vegetation; general condition	Document condition of vegetation; site photographs
ET cover performance	Monthly and after rain event ≥ 0.5 inch	Monitoring panel	Lysimeter check and data download.	Note issues with sensor function/calibration or system enclosures.

[1] Inspection frequency may be reduced after stabilization of vegetative cover as determined by Kirtland AFB.
[2] Identification number refers to features described by station locations in monthly reports.
AFB – Air Force Base ET – Evapotranspiration

Table 3-3. Summary of Landfill Maintenance and Monitoring Requirements Specific for LF-008

Feature	Inspection Frequency[1]	Location[2]	Inspection	Routine Maintenance
Channels	Monthly and after rain event ≥ 0.5 inch	Channels 1-5	Erosion; exposed liner; gabions; riprap/crushed concrete displacement; excessive silt buildup; tumbleweed accumulation	Replace riprap; remove excess silt, debris, and tumbleweeds
Rock Berms	Monthly and after rain event ≥ 0.5 inch	Rock Berms 1-11	Ensure diversion berms direct stormwater flows as designed	Fill in eroded or low areas
Cover surface, especially steeper slopes	Monthly and after rain event ≥ 0.5 inch	North-South Transects 1-10	Surface erosion, gully formation	Fill in gullies to restore grade
Stormwater Pipe Intakes and Outlets	Monthly and after rain event ≥ 0.5 inch	Pipe Intakes 1- 3 on top of landfill along Rock Berm 1	Buildup of excessive silt and debris; accumulation of weeds; erosion; blockage	Clean out excess debris, silt, and weeds; fill in areas of erosion to restore to original condition
Stormwater and Sediment Control Basins	Monthly and after rain event ≥ 0.5 inch	Catch Basins 1-6 and Sediment Ponds 1-3	Excessive silt and debris buildup; accumulation of weeds; erosion	Remove excess silt and debris; remove accumulated weeds
Perimeter fence and gates	Monthly and after rain event ≥ 0.5 inch	Gates 1-4	Structural integrity; tumbleweed and debris accumulation; locks on gates	Remove tumbleweed and debris; replace damaged or missing locks
Signage on perimeter fence	Monthly and after rain event ≥ 0.5 inch	Along fence	Inspect signage for damage. Note missing signage	Replace damaged or missing signage
Vegetation	Monthly and after rain event ≥ 0.5 inch	Over entire ET cover	Extent of vegetation cover; type of vegetation; general condition	Document condition of vegetation; site photographs
ET cover performance	Monthly and after rain event ≥ 0.5 inch	Monitoring panel	Lysimeter check and data download.	Note issues with sensor function/calibration or system enclosures.

[1] Inspection frequency may be reduced after stabilization of vegetative cover as determined by Kirtland AFB.
[2] Identification number refers to features described by station locations in monthly reports.
AFB – Air Force Base ET – Evapotranspiration

3.4 ET Cover Performance Monitoring

The ET covers installed at each landfill include monitoring systems that provide information on cover system performance. Data is gathered from the monitoring systems on a biweekly basis.

3.4.1 Instrumentation

The following equipment is installed at each landfill:

- Eight Campbell Scientific Model 229 heat-dissipation sensors (HDS)
- Eight Campbell Scientific Model CS616-L water content reflectometers (WCR)
- Decagon Devices drain gauge flux meter
- Large-scale lysimeter
- Campbell Scientific CR 800 datalogger
- Campbell Scientific AM16/32 multiplexer

- Campbell Scientific CE-4 4-channel excitation
- Raven XT cellular modem
- Campbell Scientific BP12 12-hr battery pack
- Campbell Scientific SP10R 10-watt solar panel with regulator
- Campbell Scientific ENC 16/18 waterproof enclosure

This equipment is used to determine to what depth precipitation infiltrates the landfill cover by measuring soil moisture. The flux meter and large-scale lysimeter take direct measurements of changes in soil moisture. The HDSs determine soil-water potential and the WCRs measure volumetric soil content. The HDS measurements are used to characterize the movement of water through the cover on a longer term basis (monthly, seasonally, and annually). The WCR measurements provide higher resolution of rapid moisture movement that occurs during and immediately following a precipitation event, and can corroborate HDS measurements. Readings from all of this equipment when compared validate or invalidate each of the measurements and support conclusions regarding cover performance. See Figure 5 for a diagram of the lysimeter access hatch. This diagram was extracted from Figure 6-2 provided in the *Final Annual Monitoring and Maintenance Activities Report for Solid Waste Management Unit (SWMU) 6-1, Landfill 1 (LF-001); SWMU 6-2, Landfill 2 (LF-002); and SWMU 6-4, Landfills 4, 5, and 6 (LF-008)* (USAF, 2013).

3.4.1.1 Heat Dissipation Sensors

Campbell Scientific Model 226 HDSs measure soil-water potential from 10-2,500 kilopascals. These sensors are comprised of an outer porous ceramic matrix that houses a heating element and thermocouple, contained in a hypodermic needle. The sensor functions when a 50-millivolt current is applied to the heating element by an excitation module. The resulting rise in temperature is measured by the thermocouple. The difference in temperature measured by the sensor before and after the current is applied is inversely proportional to the water content of the sensor and thus, the surrounding soil. The sensors must be calibrated in the soil type in which they are used.

3.4.1.2 Water Content Reflectometers

The Campbell Scientific Model CS616-L WCRs measure volumetric water content using time-domain measurement methods sensitive to dielectric permittivity. Each probe contains two 30-centimeter long stainless steel rods that connect to a probe head that houses an epoxy-coated circuit board. The differentially-driven probe rods form a transmission line that creates a wave with a velocity that is specific to the surrounding material (in this case, the surrounding landfill cover). The rods produce a waveform reflection which triggers a state change that results in the propagation of a new waveform. Because water has a dielectric permittivity that is significantly larger than other soil constituents, the oscillation frequency of these waves is dependent on the average water content of the landfill cover material.

3.4.1.3 Large-Scale Lysimeters

Each landfill ET cover has a large-scale lysimeter consisting of a 6-foot diameter steel stock tank which was installed 3 feet below ground surface. The tank bottoms are lined with 40-mil high-density polyethylene (HDPE) and the sides are lined with 60-mil HDPE, extending 3 feet above the bottom. Drains were installed in the tank bottoms with polyvinyl chloride piping that is used to transfer drainage water into a tipping bucket rain gauge.

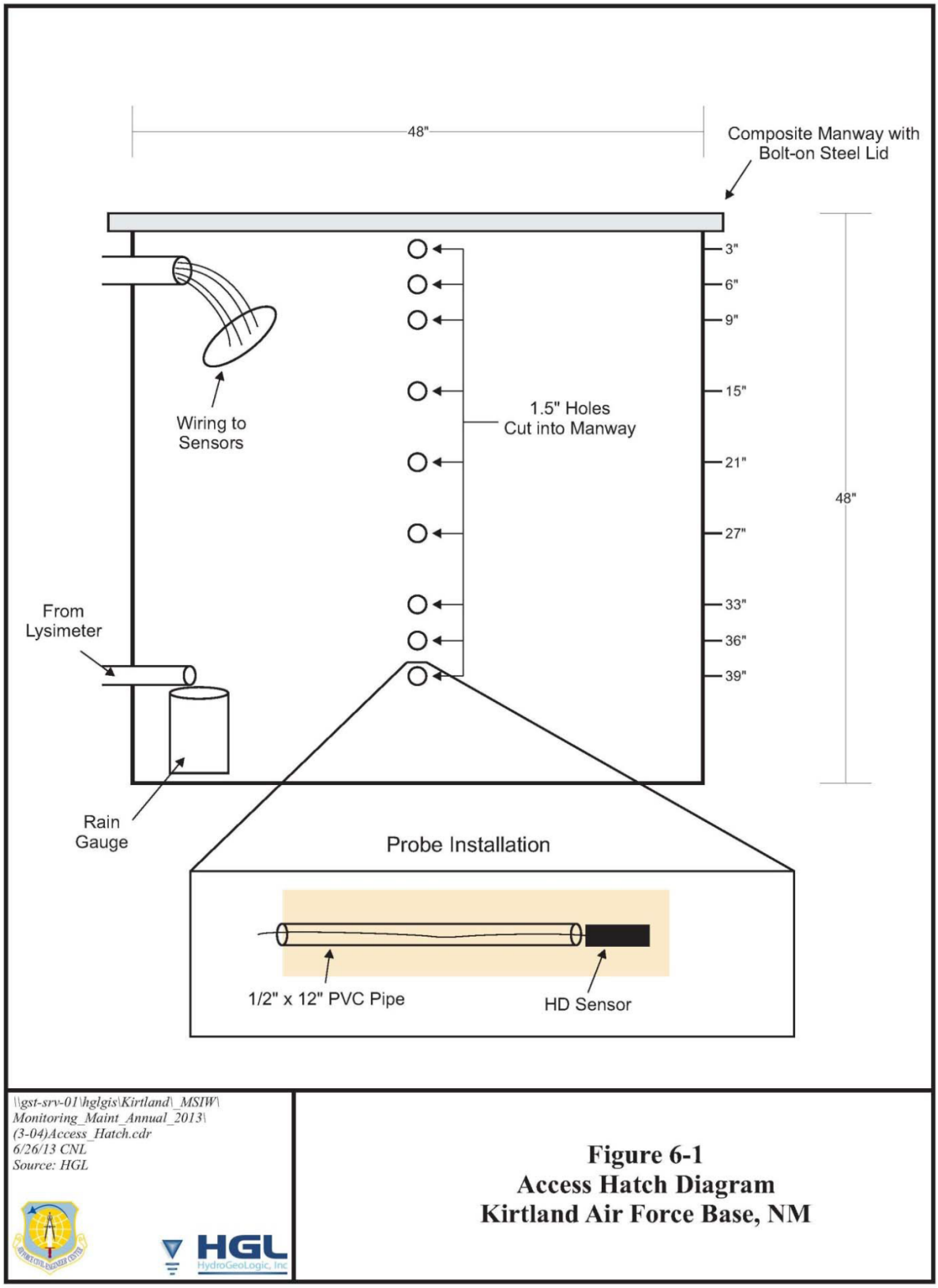

Figure 5. Lysimeter Access Hatch – Extracted from Figure 6-1 (USAF, 2013)

3.4.2 Instrumentation Maintenance Requirements

Items to be inspected periodically include the following:

- Function of sensors based upon data captured in the monitoring system
- Ensure calibration and identification tags on the sensors are legible
- Sensors are required to be calibrated based upon their performance
- Periodic replacement of the dessicant in the sensor and equipment enclosures
- Periodic cleaning of the solar panel glass
- Condition of tipping bucket enclosures for degradation

3.4.3 Instrumentation Repair

Based upon information contained in the September *2014 Annual Monitoring and Maintenance Activities Report for Solid Waste Management Unit (SWMU) 6-1, Landfill 1 (LF-001); SWMU 6-2, Landfill 2 (LF-002); and SWMU 6-4, Landfills 4, 5, and 6 (LF-008)*, operational issues remain with the ET Cover monitoring equipment. The report recommended that the issue of preferential flow along the vertical walls of the landfill lysimeters be addressed by sealing the walls with bentonite. It was also reported that the HDS units at LF-002 and LF-008 were not providing usable data and recommended that they be inspected to ensure that they have good contact with the surrounding soil and are correctly wired to the datalogger. Data issues were also reported for the WCRs at LF-008; sensor failure was suspected.

4.0 MITIGATION MEASURES

The ET covers have been demonstrated to provide an effective barrier for isolating landfill materials from atmospheric water, which can lead to increased methane and leachate production. The ET cover designed for these locations requires a 3-ft minimum thickness of soils and an established vegetative cover to properly function. Ongoing erosion decreases the depth of the soil horizon covering the landfill materials and repair activities damage the vegetative cover, which can take several seasons to fully recover.

The mitigation measures that are proposed in this report are prioritized to address the primary causes of currently observable erosion features to reduce the rate of erosional progression and provide a starting point for overall improvement.

The reclamation design includes a system of stormwater controls consisting of berms and channels. The berms are constructed of rock riprap located at or near grade breaks and at various intervals across broad slopes. The rock berms are intended to direct stormwater flows to either riprap lined channels or stormwater pipe inlets, both of which are designed to carry stormwater flows to catch basins located around the perimeter of the reclaimed landfills. Energy is dissipated in the catch basins and the stormwater then flows to the sediment basins located outside of the project area.

The general components of the reclamation design and stormwater controls appear to function. However, relatively minor improvements to their design are expected to result in an increased level of performance that should diminish some of the smaller erosion features such as erosional rilling that can progress across broad areas of the ET cover. The rock berms appear to be constructed completely of riprap. The riprap is generally porous and during high-intensity rainfall events do not appear to function in their intended purpose, allowing stormwater flows to pass through them and continue downstream causing erosional rilling. Including a soil component into their design will encourage stormwater flows to travel laterally to their intended concentration point for passage downslope in a controlled manner.

It is also apparent that the fiber rolls installed on the outer slopes of the ET cover are doing more harm to the integrity of the cover than good. Fiber rolls by definition are only to be employed as a short-term means for controlling sediment transport from freshly disturbed soil surfaces. Newly applied fiber rolls retain sediments by slowing sheet flows, which allow sediment to fall out of suspension. The permeability of the fiber rolls decreases over time as sediment is trapped within the fiber matrix, casing the fiber roll to become heavy and sag. Runoff during subsequent rainfall events is concentrated at the low point where the fiber roll has sagged and greatly increases the erosion potential in that particular location. This effect is multiplied as flows progress downstream and encounter other fiber rolls, initially causing erosional rilling before developing into erosional gullies. Full removal of the fiber rolls that are past service life and the re-distribution of the sediments accumulated on their upstream side should reduce the level of erosion currently observed.

The underlying landfill is composed of various materials possessing a wide degree of density and physical characteristics. The high variability of the materials lend themselves to producing unpredictable subgrade conditions for the ET cover. These variations in subgrade conditions are eventually expressed at the surface in multiple ways. The two primary expressions observed during the most recent and previous inspections include the formation of fissures and depressions. Both of these features significantly reduce the ability of the ET cover to isolate the landfill materials from the infiltration of precipitation. Fissures are linear features where the surface has separated, primarily caused by differential settlement or consolidation along a boundary. These features allow stormwater to accumulate within the aperture, and form a direct pathway to the interior of the landfill. A less-severe drainage condition develops when localized consolidation causes a depression to form, which in turn allows stormwater to pond on the top surface of the ET cover. Depressions are generally identified by the presence of high density vegetation

that is distinctly different from the surrounding vegetation and a cracked surface indicating that fine-grained clay/silt particles have deposited under a low-energy regime. Fissures may generally be addressed by placing fill soils along the visible extent of the fissure. Depressions of small size and watershed area may be addressed by excavating small channels to allow positive drainage.

All areas where the proposed mitigation measures are employed will require a concerted revegetation effort. Any disturbed surface of significant area should be seeded with an approved seed mix assumed to be similar to that which was originally specified.

4.1 Stormwater Controls

4.1.1 Rock Berms

The rock berms do not appear to be functioning as intended, allowing stormwater runoff to pass through rather than directing flows laterally to the channels or pipe inlets. URS proposes to rework the rock berms to redistribute and incorporate a portion of the nearby soil cover into the construction of the rock berm cross-section. Incorporating soil into the rock berm construction will decrease the overall permeability of the rock berm, and reduce the potential for stormwater to bypass the control. The soil will be borrowed from the area directly adjacent to the rock berm and create a channel that will be used to increase the carrying capacity of the rock berm. Similarly, a portion of the rock berm will be incorporated into the upstream depression forming the parallel channel to mitigate erosion.

4.1.2 Fiber Roll Removal

Fiber rolls that are currently located on the outer slopes of the ET cover are no longer functional and increase the erosional condition. URS proposes to disassemble the fiber rolls where they currently exist and use the mix of organic materials and sediments contained within and upstream of the fiber rolls to back fill the erosional rills and gullies located downstream of the obsolete fiber rolls. Areas where the size and volume of the erosional features exceed the volume of the material that can be locally garnered will be flagged. The flagged areas will be surveyed and a follow-up repair plan will be developed. Contiguous flagged areas requiring additional fill will be prioritized to limit the impact to the established vegetative cover. Isolated areas requiring additional fills will be observed during inspections to assess the erosional progression and addressed as necessary.

4.1.3 Drainage Improvement

Observed features that prevent free drainage of the ET cover including fissures and depression will be mitigated to improve the function of the ET cover in preventing the infiltration of precipitation into the interior of the landfills. The location of the fissures and depressions will be surveyed. Individual fissures will be addressed by placing a row of fill over the fissure, backfilling and compacting where possible. Systems of fissures that are closely located parallel to each other indicate that the relative elevation difference respective to the surrounding topography has likely formed a larger, linear depression that requires a significant quantity of imported fill to reestablish positive drainage. All imported fills will match the original specification for the top 6 inches of the ET cover.

4.1.4 Revegetation

All disturbed areas of significant size will be revegetated. A mixture of polymer, seed, and soil conditioner will be applied to the areas where a lack of vegetative growth is observed. A hand broadcast seeder is recommended in areas where heavy equipment use could result in an increase in erosion. Seeding will occur at a time of year when rainfall and growing conditions are conducive to establishing

vegetation. Personnel should avoid walking or driving over the revegetated areas to allow the seed to grow and increase the measure's effectiveness. Soil in areas that have been observed to have repeated issues with sustaining vegetative growth will be evaluated to determine if nutrients are lacking. Appropriate soil amendments will be added to correct issues, as appropriate.

5.0 PROJECT WASTE STREAMS

The waste streams generated during the O&M activities may include exposed landfill materials and field equipment (i.e., personal protective equipment, wipes, etc.). Waste will be managed in accordance with the *Environmental Restoration Program Investigation-Derived Waste Management Plan* (USAF, 2009). Prior to performing any mitigation activities, the field team leader will discuss with the field personnel waste reduction methods. Practices to be instituted to support waste minimization include, but are not limited to, the following:

- Restriction of materials (especially hazardous materials) to those needed for performance of work
- Substitution of recyclable materials for disposable items
- Reuse of items, when practical
- Segregation of contaminated from uncontaminated waste
- Segregation of reusable items (such as personal protective equipment and tools)

Waste characterization will be evaluated based on the comparison of analytical results with applicable regulatory levels.

All personal protective equipment and disposable equipment will be placed in double plastic bags and sealed for disposal in dumpsters at the base.

6.0 RECORDKEEPING

6.1 Field Log Book

URS will maintain a field log book in accordance with Standard Operating Procedure 1, "Use and Maintenance of Field Log Books," found in Appendix A of the draft project Quality Assurance Project Plan (USAF, 2014b), which requires that field log books be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the log book. The primary document used to record site data is the field log book. Entries will be made in indelible ink and corrections made by a single stroke through the error with the recorder's initials. All entries to the log book will include, at a minimum:

- Location, date, start and finish times
- Names of personnel present
- Names of visitors
- General weather conditions
- Health and safety briefings
- Details of work performed
- Summary of samples collected (if any)
- Field measurement readings and field equipment calibration information (if any)
- Photograph log and drawings/sketches
- General observations

6.2 Inspection Records

Copies of landfill inspection checklists are maintained in the Kirtland AFB electronic project files and will be compiled and reported in Long-Term Monitoring Reports prepared annually. These records will also include documentation of corrective actions that are recommended in response to inspection findings. Records of lysimeter checks and associated data will also be maintained.

6.3 Maintenance Records

Corrective measures implemented to repair issues observed during ET cover inspections will be tracked to determine whether the expected improvement is achieved and sustained. Photographs of the observed condition, the initiated repair, and follow-up observations will be maintained with inspection documentation.

7.0 REPORTING

Observations made during the course of the site inspections will be recorded in the field log books as discussed in Section 6.0 of this report. Information contained in the log books will be transferred to the attached inspection tables, which reflect the inspection requirements presented in Tables 3-1, 3-2, and 3-3 for each of the landfills. The inspection tables provide a concise means for tracking site conditions, and the status of any suggested remedial measures.

Annual Long-Term Monitoring Reports will be prepared in December of each year (beginning in 2014) to summarize activities occurring at the landfill sites during the calendar year. The report will provide details on landfill inspection findings, maintenance activities performed, quarterly well gauging data, groundwater monitoring results, and a summary of ET cover monitoring data. The report will provide trend analyses for pollutants of concern present in groundwater samples and the overall condition of the ET Cover. These trends will provide the basis for reducing monitoring frequencies in future reporting years. Documented reductions in occurrences of erosion will support future requests for reducing inspection frequencies.

An O&M Report will be prepared in early 2016 following implementation of landfill cover improvements approved by both Kirtland AFB and NMED. This report will describe the selected improvements, provide details on how and where they were executed at each landfill site, and discuss the expected outcomes in terms of reducing occurrences of erosion and improving the vegetative cover.

Table 7-1. Inspection Summary, LF-001

Item	Feature	Grid Location	Notes / Description of Observation	Rating MM/DD/YY	Rating MM/DD/YY	Rating MM/DD/YY	Rating MM/DD/YY	Recommended Corrective Action	Date	Corrective Action Status
1	Channel 1	K1 / H8								
2	Channel 2	G1 / J5								
3	Channel 3	C3 / F9								
4	Channel 4	A7 / D9								
5	Rock Berm 1	J2 / K2								
6	Rock Berm 2	J2 / H2								
7	Rock Berm 3	J2 / I4								
8	Rock Berm 4	G2 / H2								
9	Rock Berm 5	H3 / H4								
10	Rock Berm 6	F2 / D3								
11	Rock Berm 7	B3 / D3								
12	Rock Berm 8	G2 / D4								
13	Rock Berm 9	A4 / D4								
14	Rock Berm 10	G4 / D5								
15	Rock Berm 11	A5 / D5								
16	Rock Berm 12	H5 / D6								
17	Rock Berm 13	B6 / D6								
18	Rock Berm 14	H6 / E7								
19	Cover Surface /Vegetation Transect 1	A4 / A7								
20	Cover Surface /Vegetation Transect 2	B3 / B9								
21	Cover Surface /Vegetation Transect 3	C2 / C9								
22	Cover Surface /Vegetation Transect 4	D1 / D9								
23	Cover Surface /Vegetation Transect 5	E1 / E9								
24	Cover Surface /Vegetation Transect 6	F1 / F9								
25	Cover Surface /Vegetation Transect 7	G1 / G8								
26	Cover Surface /Vegetation Transect 8	H1 / H8								
27	Cover Surface /Vegetation Transect 9	I1 / I7								
28	Cover Surface /Vegetation Transect 10	J1 / J7								
29	Cover Surface /Vegetation Transect 11	K1 / K6								
30	Catch Basin 1	H8 / G9								
31	Catch Basin 2	E9 / E10								
32	Catch Basin 3	E9								
33	Catch Basin 4	F9 / F10								
34	Culvert	G1								
35	Perimeter Fence	-								
36	Gate 1	K7								
37	Gate 2	F1								
38	Gate 3	A4								
39	Gate 4	C10								
40	Signage	-								
41	Point of Interest / Other									
42	Point of Interest / Other									
43	Point of Interest / Other									

Rating

Slight	Initial feature development or of low concern
Moderate	Slow development or change not requiring repair/mitigation
High	Rapid development or imminently requiring repair/mitigation
Immediate	Requiring immediate repair/mitigation

Table 7-2. Inspection Summary, LF-002

Item	Feature	Grid Location	Notes / Description of Observation	Rating MM/DD/YY	Rating MM/DD/YY	Rating MM/DD/YY	Rating MM/DD/YY	Recommended Corrective Action	Date	Corrective Action Status
1	Channel 1	M1 / C3								
2	Channel 2	K1 / K2								
3	Channel 3	F1 / F3								
4	Cover Surface /Vegetation Transect 1	D3								
5	Cover Surface /Vegetation Transect 2	E2 / E5								
6	Cover Surface /Vegetation Transect 3	F2 / F5								
7	Cover Surface /Vegetation Transect 4	G2 / G5								
8	Cover Surface /Vegetation Transect 5	H2 / H6								
9	Cover Surface /Vegetation Transect 6	I2 / I7								
10	Cover Surface /Vegetation Transect 7	J1 / J7								
11	Cover Surface /Vegetation Transect 8	K1 / K7								
12	Cover Surface /Vegetation Transect 9	L1 / L7								
13	Cover Surface /Vegetation Transect 10	M1 / M7								
14	Cover Surface /Vegetation Transect 11	N1 / N7								
15	Cover Surface /Vegetation Transect 12	O2 / O6								
16	Cover Surface /Vegetation Transect 13	P5 / P6								
17	Catch Basin	C3								
18	Sediment Pond	B3								
19	Culvert (CMP Intake) 1	*								
20	Culvert (CMP Intake) 2	*								
21	Manhole 10	*								
22	Manhole 11	*								
23	Manhole 12	*								
24	Manhole 13	*								
25	Manhole 14	*								
26	Manhole 15	*								
27	Perimeter Fence	-								
28	Gate 1	O2								
29	Gate 2	O5								
30	Gate 3	L1								
31	Signage	-								
32	Point of Interest / Other									
33	Point of Interest / Other									
34	Point of Interest / Other									

Rating

Slight	Initial feature development or of low concern
Moderate	Slow development or change not requiring repair/mitigation
High	Rapid development or imminently requiring repair/mitigation
Immediate	Requiring immediate repair/mitigation

Table 7-3. Inspection Summary, LF-008

Item	Feature	Grid Location	Notes / Description of Observation	Rating MM/DD/YY	Rating MM/DD/YY	Rating MM/DD/YY	Rating MM/DD/YY	Recommended Corrective Action	Date	Corrective Action Status
1	Channel 1	J2 / D1								
2	Channel 2	H5 / A8								
3	Channel 3	H10 / A11								
4	Channel 4	B6 / B3								
5	Channel 5	I5 / H11								
6	Rock Berm 1	J2 / E5								
7	Rock Berm 2	G4 / F7								
8	Rock Berm 3	E6 / D7								
9	Rock Berm 4	C6 / C7								
10	Rock Berm 5	B8 / C10								
11	Rock Berm 6	H8 / H9								
12	Rock Berm 7	E8 / F9								
13	Rock Berm 8	E9 / D10								
14	Rock Berm 9	D7 / C10								
15	Rock Berm 10	D11 /C10								
16	Rock Berm 11	E11 /D10								
17	Cover Surface /Vegetation Transect 1	A2 / A11								
18	Cover Surface /Vegetation Transect 2	B1 /B11								
19	Cover Surface /Vegetation Transect 3	C1 / C11								
20	Cover Surface /Vegetation Transect 4	D1 / D11								
21	Cover Surface /Vegetation Transect 5	E1 / E11								
22	Cover Surface /Vegetation Transect 6	F1 /F11								
23	Cover Surface /Vegetation Transect 7	G1 / G11								
24	Cover Surface /Vegetation Transect 8	H1 / H11								
25	Cover Surface /Vegetation Transect 9	I1 / I11								
26	Cover Surface /Vegetation Transect 10	J1 / J4								
27	Pipe Intake 1	H2								
28	Pipe Intake 2	E2								
29	Pipe Intake 3	C4								
30	Catch Basin 1	B3								
31	Catch Basin 2	A8								
32	Catch Basin 3	A10 / A11								
33	Catch Basin 4	G1								
34	Catch Basin 5	D1								
35	Catch Basin 6	B4								
36	Sediment Pond 1	A3								
37	Sediment Pond 2	A8								
38	Sediment Pond 3	A10 / A11								
39	Perimeter Fence	-								
40	Gate 1	B1								
41	Gate 2	A10								
42	Gate 3	I10								
43	Gate 4	J3								
44	Signage	-								
45	Point of Interest / Other									
46	Point of Interest / Other									
47	Point of Interest / Other									

Rating

Slight	Initial feature development or of low concern
Moderate	Slow development or change not requiring repair/mitigation
High	Rapid development or imminently requiring repair/mitigation
Immediate	Requiring immediate repair/mitigation

8.0 REFERENCES

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KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

FINAL UNIFORM FEDERAL POLICY QUALITY ASSURANCE PROJECT PLAN

LANDFILL SITES – LF-001, LF-002, and LF-008

December 2014

377 MSG/CEI

2050 Wyoming Boulevard SE

Kirtland AFB, New Mexico 87117-5270

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KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

FINAL UNIFORM FEDERAL POLICY QUALITY ASSURANCE PROJECT PLAN FOR LANDFILL SITES, LF-001, LF-002, and LF-008

December 2014

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This Uniform Federal Policy-Quality Assurance Project Plan was prepared for the Air Force Civil Engineer Center by URS Group, Inc. in association with FPM Remediations, Inc. to aid in the implementation of a final remedial action plan under the Environmental Restoration Program. As the report relates to actual or possible releases of potentially hazardous substances, its release prior to an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the Environmental Restoration Program, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this report premature or inaccurate.

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14. ABSTRACT
This Quality Assurance Project Plan specifies the activities that will be performed in support of groundwater monitoring and well gauging activities to be conducted at Landfill Sites LF-001, LF-002, and LF-008, Kirtland Air Force Base, New Mexico. The purpose of the plan is to provide guidance for the groundwater monitoring program at the three landfill sites.

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Sites LF-001, LF-002, and LF-008, long-term groundwater monitoring

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KIRTLAND AIR FORCE BASE
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NATURAL RESOURCE INJURY

The Natural Resource Injury program is a mechanism designed to restore natural resources injured by hazardous substance releases. The Natural Resource Injury program requires parties responsible for contamination and injuries to pay for losses. The Natural Resource Injury program measures natural resource injuries and determines liability. A Natural Resource Injury program demonstrates the nature of injury and any environmental pathways. It also measures the extent of injury and the necessary restoration measures and costs. In certain cases, restoration may include replacement or acquisition of equivalents for habitats; populations of wildlife; and human services, including hunting, fishing, and recreational activities.

The Natural Resource Injury program is carried out by various federal, state, and tribal trustees for fish, wildlife, other living resources, water, lands, and protected areas. Trusteeship is derived from treaties (federal and tribal), statutes (federal and state), and other regulations. Federal agencies responsible for land management include the U.S. National Park Service; U.S. Fish and Wildlife Service; U.S. Bureau of Land Management; U.S. Department of Agriculture, including the U.S. Forest Service; U.S. Department of Defense; and the U.S. Department of Energy.

The Natural Resource Injury Program has established a restoration fund to be used to restore resources lost or injured by the release of hazardous materials and oil spills. The NRI program has been traditionally associated with the Comprehensive Environmental Response, Compensation, and Liability Act. The Comprehensive Environmental Response, Compensation, and Liability Act directed the Department of Interior to prepare rules for Natural Resource Injury at hazardous waste sites and for emergency incidents involving Comprehensive Environmental Response, Compensation, and Liability Act substances.

The Comprehensive Environmental Response, Compensation, and Liability Act and the Resource Conservation and Recovery Act provide tools to clean up contaminants from the environment. These cleanup programs focus on risks to human health and the environment but do not provide efforts for the restoration or compensation for natural resources. The programs are primarily carried out by the United States Environmental Protection Agency working with the states. These programs do not concentrate on restoring natural resources, although cleanup may prevent further injuries to natural resources. With regard to injuries to natural resources, the Comprehensive Environmental Response, Compensation, and Liability Act states the following: (1) responsible parties are liable for compensatory damages for injuries to natural resources owned, managed, or controlled by government agencies or Indian tribes; (2) government agencies and Indian tribes may assess and collect the damages, acting on behalf of the public as trustees for the injured natural resources; and (3) recovered damages must be used to restore, rehabilitate, replace, or acquire the equivalent of the injured natural resources. Therefore, the Natural Resource Injury program was established to ensure restoration and compensation where needed and appropriate.

Conclusions and Recommendations:

This Quality Assurance Project Plan is a planning document that will ensure the data that are collected will be of adequate quality to evaluate whether constituents exist in the soils or groundwater that pose an unacceptable risk to human health or the environment. The vegetation associations and wildlife found near the site are widely dispersed over Kirtland Air Force Base, so there would be no impact to biodiversity. Restricted access protocols and limited planned development at Kirtland Air Force Base have been strategically designed to limit environmental impacts.

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ENVIRONMENTAL JUSTICE CONSIDERATION

Presidential Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (59 Federal Register 7629), requires identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of federal programs, polies, and activities on minority and low-income populations. For purposes of this report, the population within a 50-mile radius around Kirtland Air Force Base was considered. Demographic and economic census information presented in Environmental Justice Guidance under the National Environmental Policy Act was used as a primary reference (Council on Environmental Quality, 1997).

Minority populations living within a 50-mile radius of Kirtland Air Force Base, which exceed 21.6 percent (%) of the general population according to U.S. Census Bureau (USCB) block census data, were evaluated with regard to health and environmental effects from activities at Kirtland Air Force Base. Similarly, low-income block groups (clusters of blocks) that exceeded New Mexico's state poverty percentage (15.7 %) were analyzed for effects from the corrective measure activities at Kirtland Air Force Base (USCB, 2010a).

Minority populations are considered to be all people of color except white people who are not Hispanic. In 2010, 31.6 % of New Mexico's population was minority. Neighborhoods having minority population percentages exceeding the minority population percentage of 31.6 % were identified on a block-by-block basis, using block census data (USCB, 2010b).

The USCB characterizes persons in poverty (low-income persons) as those whose incomes are less than a statistical poverty threshold. The threshold is a weighted average based on family size and age of family members. For instance, the 2010 census threshold for two adults and two children (family of four) was based on a household income of $22,113 (USCB, 2010c). In 2010, 25 % of New Mexico's population was listed in poverty or designated as having low income (USCB, 2010a). In this analysis, low income block groups were identified where the low-income population percentage in the block group exceeds the poverty percentage for the State of New Mexico.

According to 2010 census data, approximately 248,069 minority individuals from an approximate total population of 831,681 reside in the 50-mile radius of impact. This represents 30 % of the total radius of impact population (USCB, 2010d). Approximately 106,345 persons were identified as being low income or living in poverty, which represents approximately 12.7 % of the radius of impact population (USCB, 2010e).

Block group populations within the radius of impact that contained a poverty percentage that was less than the state poverty average of 15.7 % were not considered low income areas for this analysis. It was determined that these block groups did not contain a large number of low-income neighborhoods because the poverty percentage of these block groups was below the state poverty average of 15.7 % (USCB, 2010a).

This distribution of low-income population has strong correlation to minority populations of Blacks, Native Americans, and Hispanics. For example, portions of the Pueblo of Isleta, south of Kirtland Air Force Base, have high percentages of Native Americans who are low-income individuals. To the southeast of Kirtland Air Force Base, the rural area of Estancia is also low income and contains large Black and Native American populations. To the north of Kirtland Air Force Base, high concentrations of low-income populations are located in the Pueblos of San Felipe, Santo Domingo, and Jemez, as well as in the rural area of Cochiti. These rural areas to the north contain large Hispanic and Native American populations. The Laguna Pueblo, located to the west of Kirtland Air Force Base, has a large low-income

Native American population. High concentrations of low-income Hispanic populations reside immediately west of Kirtland Air Force Base in the South Valley neighborhood of Albuquerque.

The environmental and human health effects considered for this investigation include potential impacts to both soil and groundwater from contamination, restricted access by Native Americans to traditional cultural sites, biological resources, air quality, and noise. Based on the findings of this report, there are no identified negative impacts from the area of concern that would pose adverse health effects on the general human populations. Based on the analysis of any potential impacts, there would be no disproportionately high or adverse impacts to minority or low-income populations. Any impacts due to restrictions of access to cultural sites would be removed by coordination between Kirtland Air Force Base and the local tribes to develop processes to allow access during periods in which safety standards and practices would be maintained.

PREFACE

This Quality Assurance Project Plan was prepared in support of long-term groundwater monitoring and operation and maintenance of the landfill covers to be conducted at Landfill Sites LF-001, LF-002, and LF-008 at Kirtland Air Force Base, Albuquerque, New Mexico. Activities to be conducted include groundwater monitoring to monitor impacts on groundwater underlying the site and landfill cover inspection, monitoring, and maintenance.

This work is being performed under the authority of the Air Force Civil Engineer Center – Contract No. FA8903-13-C-0008. The work under this contract will be performed between 20 September 2013 and 20 September 2023. Brian Renaghan, AFCEC/Environmental Restoration Division, has been appointed as the Primary Contracting Officer's Representative for this contract. This program is conducted under the Kirtland Environmental Restoration Branch Chief, Ludie (Wayne) Bitner. Cole G. Crosgrove is the Kirtland Air Force Base Environmental Restoration Branch Project Manager. URS Group, Inc., as a subcontractor to FPM Remediations, Inc., has prepared this Uniform Federal Policy-Quality Assurance Project Plan as defined in the Performance Based Remediation Contract for Cannon, Holloman, and Kirtland Air Force Bases located in New Mexico, and Luke Air Force Base located in Arizona. Mr. Richard Wells is the URS Group, Inc. Installation Manager for the Environmental Restoration Project Sites at Kirtland Air Force Base.

This plan was prepared in accordance with contractual requirements, which stipulate that a plan be prepared according to the Uniform Federal Policy for Quality Assurance Project Plans.

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APPENDICES

A Standard Operating Procedures
B ESC Lab Sciences Quality Assurance Manual
C TestAmerica, Inc. Quality Assurance Manual

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ACRONYMS AND ABBREVIATIONS

%	percent
µg/L	micrograms per liter
<	less than
±	plus or minus
≤	less than or equal to
°C	degree Celsius
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
amsl	above mean sea level
bgs	below ground surface
CAS	Chemical Abstract Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMI	Corrective Measures Implementation
CoC	chain-of-custody
CPR	cardiopulmonary resuscitation
CSM	conceptual site model
cy	cubic yard
DoD	U.S. Department of Defense
DQO	data quality objective
DS	decision statement
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ERP	Environmental Restoration Program
ERPIMS	Environmental Restoration Program Information Management System
ESC	ESC Lab Sciences
ET	evapotranspiration
ft	feet
ft/day	feet per day
ft/ft	foot per foot
FTL	Field Team Leader
FPM	FPM Remediations, Inc.
FY	fiscal year
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
GWQB	New Mexico Ground Water Quality Bureau
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	hydrochloric acid
HNO_3	nitric acid
Hr	hour
H_2SO_4	sulfuric acid
HWB	Hazardous Waste Bureau
ICP/AE	inductively coupled plasma atomic emission
LCS	laboratory control sample
lf	linear feet
LOD	limit of detection
LOQ	limit of quantitation

ACRONYMS AND ABBREVIATIONS (Concluded)

LTM	long-term monitoring
MAP	Management Action Plan
MCL	maximum contaminant level
MDL	method detection limit
mL	milliliter
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NSDWR	National Secondary Drinking Water Regulation
OES	Optimized Exit Strategy
ORP	oxidation-reduction potential
PAR	precision of the absolute range
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
PDF	Portable Document Format
pH	indicates the hydrogen ion concentration – acidity or basicity
PSQ	principle study question
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QSM	Department of Defense Quality Systems Manual for Environmental Laboratories
ROI	Radius of Impact
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RSL	regional screening level
SM	Standard Method
SNL	Sandia National Laboratories
SOP	Standard Operating Procedure
SVOC	semi-volatile organic compound
SWMU	solid waste management unit
TCE	Trichloroethene
TestAmerica	TestAmerica, Inc.
UFP	Uniform Federal Policy
URS	URS Group, Inc.
USAF	United States Air Force
USCB	United States Census Bureau
USF	Santa Fe Group
USGS	United States Geological Survey
VOC	volatile organic compound
WQCC	Water Quality Control Commission

EXECUTIVE SUMMARY

This Quality Assurance Project Plan was prepared in support of long-term groundwater monitoring and landfill cover operation and maintenance activities to be conducted at Landfill Sites LF-001, LF-002, and LF-008 at Kirtland Air Force Base, Albuquerque, New Mexico. This plan was written in accordance with the Quality Assurance Project Plan requirements and elements set forth in the Intergovernmental Data Quality Task Force Uniform Federal Policy for Quality Assurance Project Plans by the U.S. Environmental Protection Agency, dated March 2005, which was adopted by the Air Force Civil Engineer Center (DoD, 2005). The Long-Term Monitoring Plan for Landfill Sites LF-001, LF-002, and LF-008 provides the procedural guidance for the groundwater monitoring activities to be conducted at these locations. Quality Assurance Project Plans written in the Uniform Federal Policy format integrate the technical and quality aspects of a project, including planning, implementation, and assessment and include all the elements of a Sampling and Analysis Plan.

On 11 April 2006, the Assistant Deputy Under Secretary of Defense for Environment, Safety and Occupational Health, Alex Beehler, issued a memorandum requesting U.S. Department of Defense components begin immediate implementation of the Uniform Federal Policy-Quality Assurance Project Plans. As a consequence, this plan was prepared using the layout of information provided in the electronic version of the worksheets. A roadmap providing association between select sections of interest to the New Mexico Environment Department from the U.S. Environmental Protection Agency Guidance for Quality Assurance Project Plans, dated December 2002, and the Uniform Federal Policy-Quality Assurance Project Plan worksheets is included in this plan.

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1.0 INTRODUCTION

Under the Air Force Civil Engineer Center (AFCEC) Contract No. FA8903-13-C-0008, URS Group, Inc. (URS), as a subcontractor to FPM Remediations, Inc. (FPM) has prepared this Quality Assurance Project Plan (QAPP) in accordance with the Performance-Based Remediation Contract for Cannon, Holloman, and Kirtland Air Force Bases (AFBs) located in New Mexico, and Luke AFB located in Arizona. This plan provides the guidance for sampling necessary to support groundwater monitoring and well gauging activities to be conducted at Landfill Sites LF-001, LF-002, and LF-008 located at Kirtland AFB, Albuquerque, New Mexico as shown in Figure 1.

On 11 April 2006, the Assistant Deputy Under Secretary of Defense for Environment, Safety and Occupational Health, Alex Beehler, issued a memorandum requesting U.S. Department of Defense (DoD) components begin immediate implementation of the Uniform Federal Policy (UFP) QAPPs (Beehler, 2006). AFCEC has implemented this policy and the requirement to prepare a UFP-QAPP for this project is required in the above-referenced contract. This plan is compliant with the electronic version of the UFP-QAPP worksheets provided by the U.S. Environmental Protection Agency (EPA) at the following URL: http://www2.epa.gov/fedfac/assuring-quality-federal-cleanup#ufp-qapp.

Kirtland AFB received comments from representatives of the New Mexico Environment Department (NMED) regarding a preference for documents organized according to the EPA *Guidance for Quality Assurance Project Plans EPA QA/G-5* (EPA, 2002). In an effort to comply with the mandated federal requirements and satisfy NMED preference, a roadmap between the *EPA QA/G-5* outline and the UFP-QAPP worksheets is provided in Table 1-1.

Table 1-1. Elements of EPA QA/R-5 in Relation to this QAPP

EPA QA/R-5 QAPP Element	UFP-QAPP
A1 Title and Approval Sheet	WS #1 & 2 – Title and Approval Page
A2 Table of Contents	Table of Contents
A3 Distribution List	WS #3 & 5 – Project Organization and QAPP Distribution WS #4, 7 & 8 – Personnel Qualifications and Sign-Off Sheet
A4 Project/Task Organization	WS #3 & 5 – Project Organization and QAPP Distribution WS #6 – Communication Pathways
A5 Problem Definition/Background	Section 1 – Introduction WS #10 – Conceptual Site Model
A6 Project/Task Description	WS #14 & 16 – Project Tasks & Schedule
A7 Quality Objectives and Criteria	WS #11 – Project/Data Quality Objectives WS #15 – Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
A8 Special Training/Certification	WS #4, 7 *8 – Personnel Qualifications and Sign-Off Sheet
A9 Documents and Records	WS #29 – Project Documents and Records
B1 Sampling Process Design	WS #17 – Sampling Design and Rationale
B2 Sampling Methods	WS #18 – Sampling Locations and Methods
B3 Sample Handling and Custody	WS #26 & 27 – Sample Handling, Custody, and Disposal
B4 Analytical Methods	WS #12 – Measurement Performance Criteria
B5 Quality Control	WS #12 – Measurement Performance Criteria WS #20 – Field Quality Control Sample Summary WS #28 – Analytical Quality Control and Corrective Action
B6 Instrument/Equipment Testing, Inspection, and Maintenance	WS #22 – Field Equipment Calibration, Maintenance, Testing and Inspection WS #24 – Analytical Instrument Calibration

EPA QA/R-5 QAPP Element	UFP-QAPP
B7 Instrument/Equipment Calibration and Frequency	WS #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection
B8 Inspection/Acceptance of Supplies and Consumables	WS #21 – Field Standard Operating Procedures
B9 Non-direct Measurements	WS #13 – Secondary Data Uses and Limitations
B10 Data Management	WS #14 & 16 – Project Tasks & Schedule, Section 2.10.3, Data Management, Review, and Evaluation
C1 Assessment and Response Actions	WS #31, 32 & 33 – Assessments and Corrective Action
C2 Reports to Management	WS #31, 32 & 33 – Assessments and Corrective Action
D1 Data Review, Verification, and Validation	WS #34 – Data Verification and Validation Inputs
D2 Validation and Verification Methods	WS #35 – Data Verification Procedures WS #36 – Data Validation Procedures
D3 Reconciliation with User Requirements	WS #37 – Data Usability Assessment

The *Long-Term Monitoring Plan, Landfill Sites LF-001, LF-002, and LF-008,* (United States Air Force [USAF], 2014a) provides the procedural guidance for the groundwater monitoring activities to be conducted at the landfill sites.

A QAPP written in the UFP format integrates the technical and quality aspects of a project, including planning, implementation, and assessment. Documents prepared in the UFP format are not restricted to laboratory quality requirements and contain information that may be presented in other planning documents. The UFP-QAPP Manual states the following:

> *"The QAPP document may be referred to by another name or incorporated into other project planning documents. The document for some programs or projects may be referred to as a Sampling and Analysis Plan, Work Plan, Field Sampling Plan, etc."*

Although the title of the document may differ, a plan written following the UFP-QAPP format contains the information required by the National Contingency Plan.

1.1 BACKGROUND

Three private airfields predate the Kirtland AFB, formerly named Albuquerque Army Air Base, with military operations becoming the primary focus in 1941. The base was renamed in 1942 honoring Colonel Roy C. Kirtland, a pioneer in Army aviation. Flight crews were trained in the early 1940s at Kirtland's three schools: advanced flying, bombardier training, and multi-engine school. Later that decade, the focus of base operations shifted to developing aircraft modifications for weapons delivery, researching ballistic characteristics, and testing weapons. Manzano Base was named in 1952 and was located on the former Site Able, created under the Armed Forces Special Weapons Command. Sandia Base began operating as the Albuquerque Airport Training Station in 1942 and served historically as a nuclear weapons installation. In 1971, Kirtland, Manzano, and Sandia bases were merged and were managed under one command.

The landfill sites addressed in this QAPP are located in the northwest portion of the installation boundary (Figure 1).

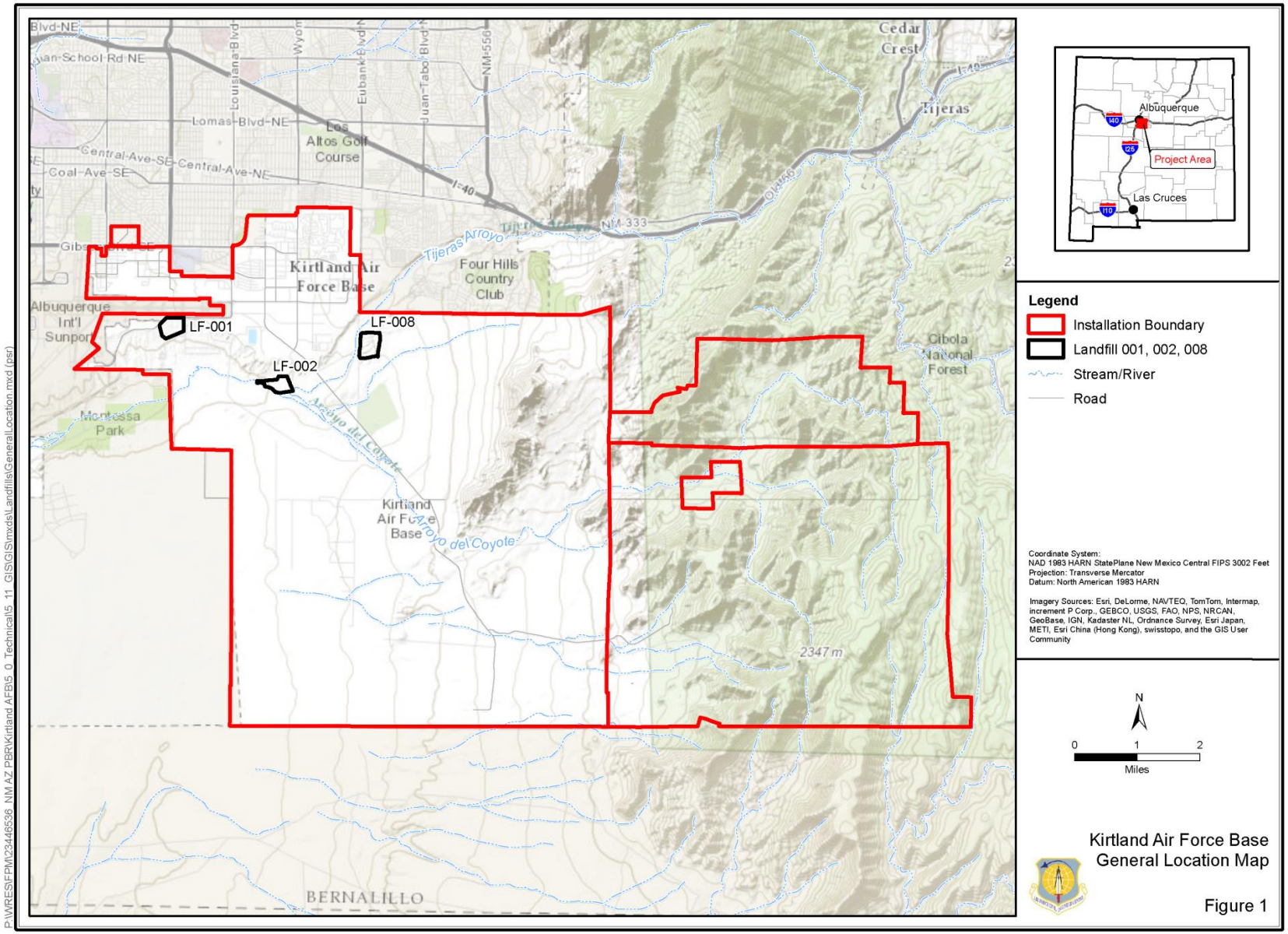

Figure 1. Location of Landfill Sites LF-001, LF-002, and LF-008

1.1.1 Landfill Site LF-001

LF-001 is located in the northwestern area of Kirtland AFB, directly south of the main east-west runway for the base and Albuquerque International Sunport (Figure 2). Southgate Avenue forms the northern and western site boundaries, Ammo Road runs parallel to the eastern boundary, and an abandoned railroad grade forms the southern boundary. Kirtland AFB Production Well No. 2 (KAFB-2) is located approximately 150 feet (ft) northeast of the landfill, downgradient of former monitoring well KAFB-0111. LF-001 is not located within the Tijeras Arroyo 100-year flood plain.

Although disposal activities date back to 1951, the site was operated primarily between 1960 and 1975 as a trench-and-fill landfill. The landfill contains an estimated 425,000 cubic yards (cy) of municipal waste and up to 175,000 cy of construction and demolition debris. Field activities conducted at the site have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. A detailed summary of the site's background and history, results of previous investigations, corrective measures, and current status is presented in the Environmental Restoration Program (ERP) Site-Specific Summaries (USAF, 2005a), which were prepared as a supplement to the 2004 update of the Management Action Plan (MAP) (USAF, 2005b).

The Long-Term Monitoring (LTM) Program was initiated at LF-001 in May 1996. As described in the LTM Plan (USAF, 1997), the program consisted of quarterly gauging of eight monitoring wells (KAFB-0107, -0110, -0111, -0112, -0113, -0114, -0115, and -0117) and semiannual sampling of four of these wells, one upgradient (KAFB-0113) and three downgradient (KAFB-0111, -0114, and -0115). Beginning in fiscal year 2003, wells at LF-001 were gauged on a quarterly basis and sampled annually during the fourth quarter. Declining water levels in the regional aquifer had prohibited groundwater sampling at KAFB-0111, -0114, and -0115, and gauging at KAFB-0111, -0112, and -0115. Replacement wells KAFB-0118 (for KAFB-0114) and -0119 (for KAFB-0111) were installed in October 2004. Replacement well KAFB-0121 (for KAFB-0115) and upgradient replacement well KAFB-0120 (for KAFB-0113) were installed in 2006.

A Corrective Measures Implementation (CMI) work plan was submitted to the NMED Hazardous Waste Bureau (HWB) in July 2004 to construct an Evapotranspiration (ET) cover system to minimize percolation through the landfill, leachate production, and potential impact to the groundwater (USAF, 2004). The ET cover at LF-001 covers 49 acres and was completed in June 2006.

From October 2006 through April 2007, major erosion repair activities were conducted at LF-001 to repair damage to the ET cover system and reduce future impacts to the site by controlling run-on from offsite sources. Repairs and improvements were also made to existing erosion control features, and areas damaged as a result of the severe storm events that occurred at Kirtland AFB during June through August 2006 were regraded and reconditioned. The repair activities were documented in the *Completion Report for Erosion Repairs at Solid Waste Management Unit (SWMU) 6-1, Landfill 1 (LF-001) and SWMU 6-4, Landfills 4, 5, and 6 (LF-008)* (USAF, 2007).

Damage to the ET cover system required major repairs in September 2010 and August 2011. The project involved piping repairs across the site and installation of 2,160 linear feet (lf) of 12-inch Excelsior wood fiber rolls and 2,965 lf of 9-inch Excelsior wood to address observed extensive rilling.

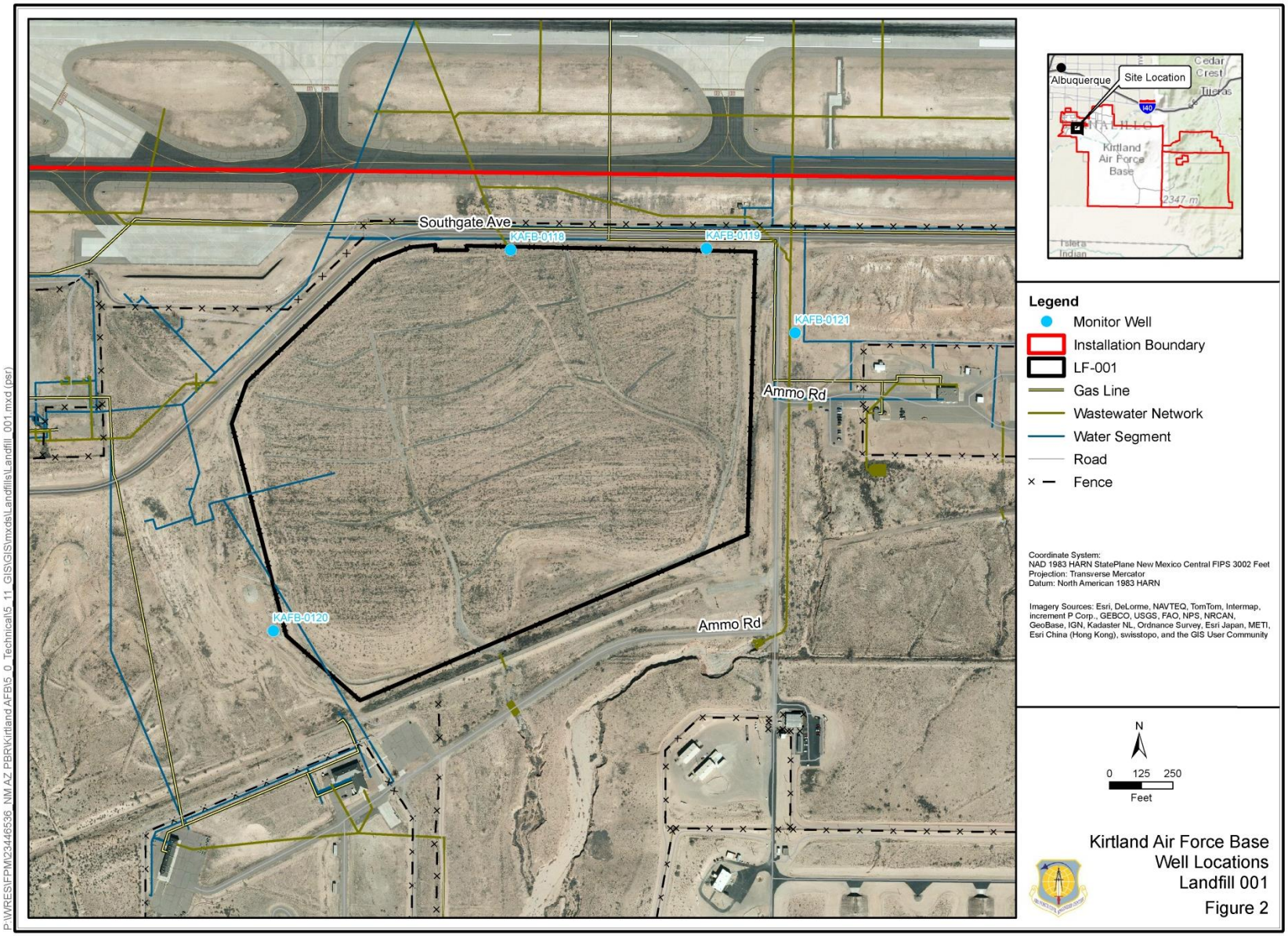

Figure 2. LF-001 Monitoring Well Locations

1.1.2 Landfill Site LF-002

SWMU 6-2, Landfill 2 (LF-002) is located between the Trestle Aircraft Testing Facility and Advanced Research Electromagnetic Simulator facilities to the north and the active channel of the Tijeras Arroyo to the south (Figure 3). The eastern and western boundaries are currently defined by security fences. Kirtland AFB Production Well No. 8 is approximately 2,100 ft northeast of the landfill, and Production Well No. 4 (KAFB-4) is 2,400 ft to the north. Field activities have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. A detailed summary of the site's background and history, results of previous investigations, corrective measures, and current status is presented in the ERP Site-Specific Summaries (USAF, 2005a), which was prepared as a supplement to the 2004 update of the MAP (USAF, 2005b).

LF-002 operated between 1942 and 1965 as a trench-and-fill landfill. The current volume of waste is estimated to be 1,321,700 cy. Two buried pipelines cross LF-002. The 21-inch City of Albuquerque's Tijeras Interceptor sanitary sewer line runs east-west across the northern region of the landfill, approximately 400 ft south of well KAFB-0213. The second buried pipeline is the treated sewage effluent line (ST-051) that carried effluent from the Sewage Lagoons to the Golf Course Main Pond. ST-051 is currently used to pump nitrate-rich water from Production Well No. 7 (KAFB-7) to the Golf Course Main Pond for irrigation. This line was relocated outside of the landfill boundary during construction of the evapotranspiration cover and an access road was constructed.

The LTM Program was initiated at LF-002 in May 1996. As described in the LTM Plan (USAF, 1997), the program consisted of quarterly gauging of six groundwater monitoring wells (KAFB-0213, -0214, -0215, -0216, -0217, and -0218) and semiannual sampling of four of these wells, one upgradient (KAFB-0215) and three downgradient (KAFB-0214, -0216, and -0218). Declining water levels in the regional aquifer have affected two of the wells. KAFB-0216 was abandoned in September 1999 prior to the scheduled sampling event because saturated thickness in the well screen interval was not sufficient for sampling. Since fiscal year 2003, wells at LF-002 have been gauged on a quarterly basis and sampled annually during the fourth quarter. The water level in upgradient well KAFB-0215 has been below the bottom of the screen interval since the September 2005 sampling event and the water level in KAFB-0118 is at the bottom of the screen. The upgradient replacement well KAFB-0219 and downgradient replacement wells KAFB-0220 and -0221 were installed in 2006.

A CMI work plan was submitted to NMED HWB in May 2004 to construct an ET cover system to minimize percolation through the landfill, leachate production, and potential impact to the groundwater (USAF, 2004). The ET cover at LF-002 covers 32 acres and was completed in September 2006. The draft CMI completion report was submitted to NMED in late 2006. The final CMI Report for LF-002 (USAF, 2007b), detailing the installation of the ET cover, was submitted to NMED on February 28, 2007.

Damage to the ET cover system at LF-002 was addressed through erosion repair activities from September 2010 to August 2011. Extensive rilling repairs (concentrated on the south slope) were made and 3,044 lf of 9-inch Excelsior wood fiber rolls were installed.

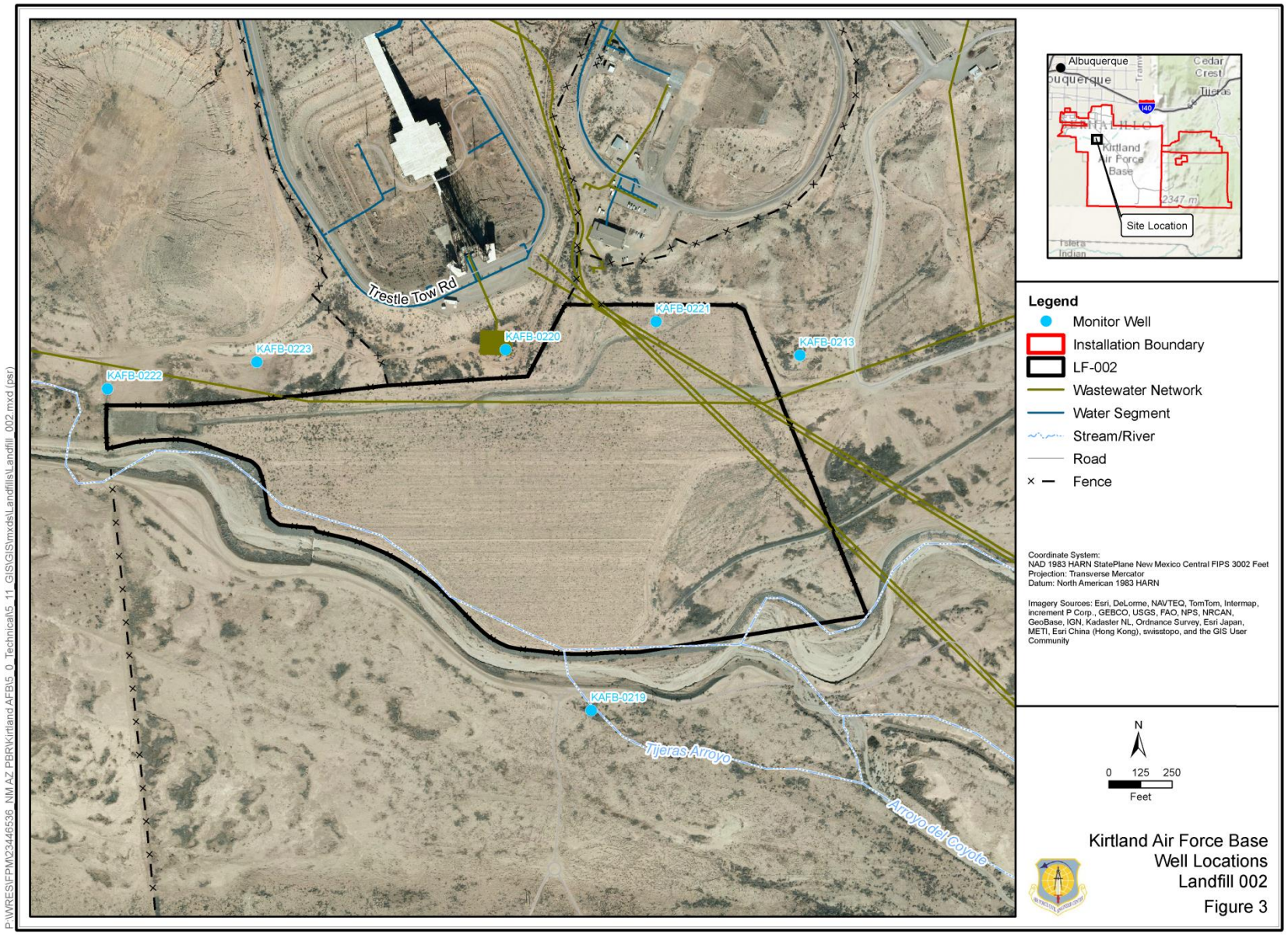

Figure 3. LF-002 Monitoring Well Locations

1.1.3 Landfill Site LF-008

SWMU 6-4, Landfills 4, 5, and 6 (LF-008) is located in the northwestern region of Kirtland AFB and is bounded by the Tijeras Arroyo to the north and the covered slope of the active construction and demolition debris landfill (LF-268) about 150 ft east of Power Line Road to the east (Figure 4). The site is made up of three former contiguous landfills (Landfills 4, 5, and 6). Based on flood plain maps, the site is not located within the 100-year flood plain. Field activities conducted at the site have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. A detailed summary of site's background and history, results of previous investigations, corrective measures, and current status is presented in the ERP Site-Specific Summaries (USAF, 2005a), which was prepared as a supplement to the 2004 update of the MAP (USAF, 2005b).

The City of Albuquerque and Kirtland AFB jointly operated Landfill 4 from 1964 to 1969 as a general refuse landfill. Construction and demolition debris and trees were placed in the northeastern part of Landfill 4 and general refuse was placed in two natural arroyos in the western part of the site. The estimated volume of waste in Landfill 4 is about 600,000 cy buried over an area of approximately 25 acres. Kirtland AFB operated Landfills 5 and 6, located north of Landfill 4, from mid-1960 through 1989. Construction and demolition debris was placed in Landfill 5 and other refuse was disposed in Landfill 6. The estimated volume of waste in Landfills 5 and 6 is about 1,746,000 cy buried over an area of approximately 40 acres.

Monitoring at LF-008 has been conducted under two separate programs—the Groundwater Monitoring System Plan (USAF, 1995) and the LTM Program— to fulfill the requirements of the NMED Solid Waste Bureau for the active portion of the landfill (LF-268) and of the NMED HWB for the inactive portion (LF-008). Each of the programs included gauging and sampling of the 10 monitoring wells at the site, but the results were applied in different ways to determine whether a release from the landfill has occurred. Five wells are sampled to monitor the regional aquifer (KAFB-0307, -0308, -0309, and -0311, and upgradient well KAFB-0312), and five wells are sampled to monitor the perched aquifer (sidegradient well KAFB-0310, upgradient well TJA-2, and KAFB-0313, -0314, and -0315).

An ET cover system was installed at LF-008 to minimize percolation through the landfill, leachate production, and potential impact to the groundwater (USAF, 2001). The ET cover at LF-008 is approximately 67 acres and was completed in June 2005. The final CMI completion report (USAF, 2006a) was submitted to NMED in January 2006 and approved on May 4, 2006.

A *QAPP for Long-Term Monitoring at SWMU 6-1, Landfill 1; SWMU 6-2, Landfill 2; and SWMU 6-4, Landfills 4, 5, and 6 (*covering only groundwater monitoring) was prepared in 2011 (USAF, 2011) to meet the DoD's most recent requirements for planning documents for DoD facilities. This plan is currently in review by the NMED.

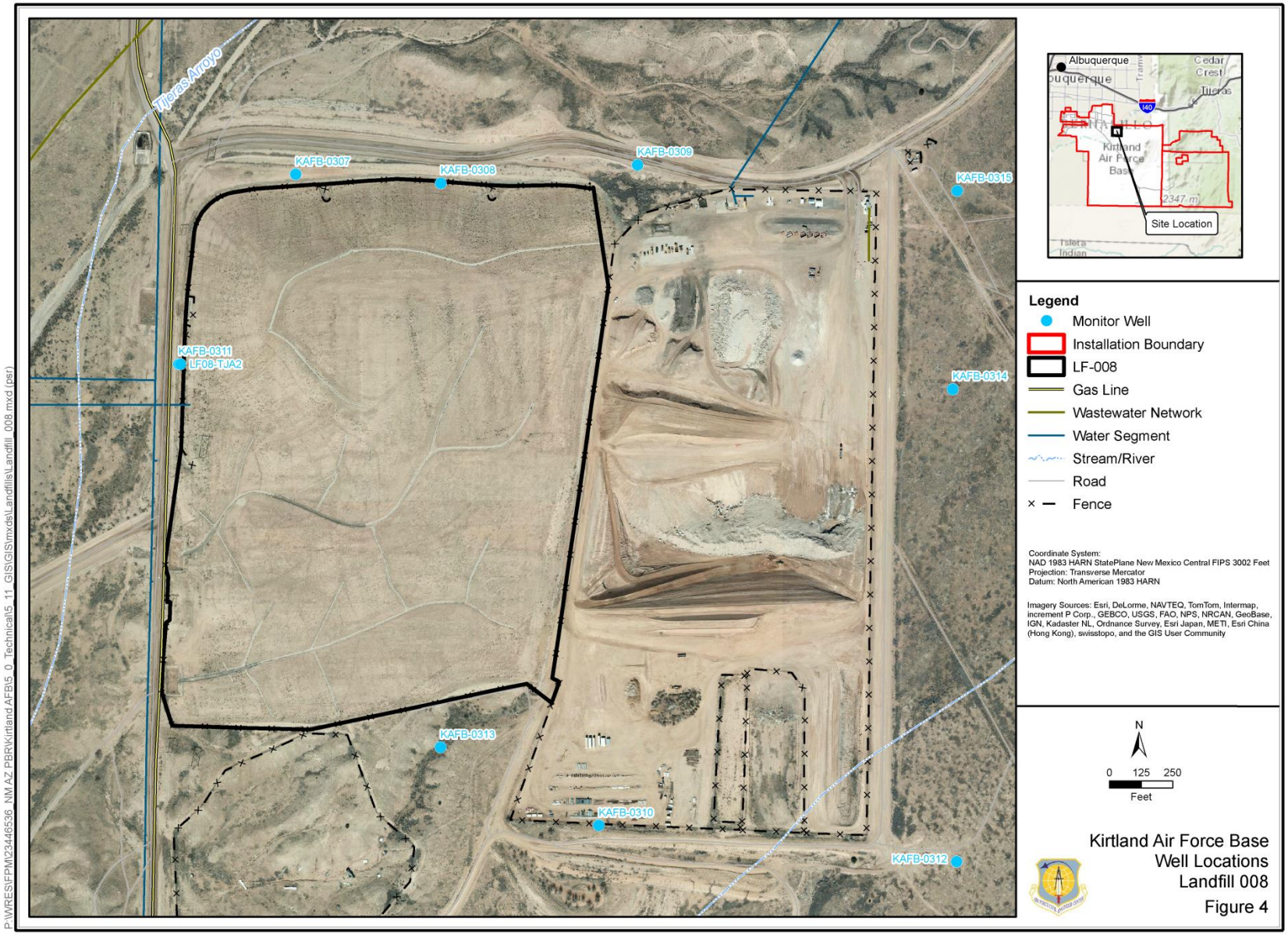

Figure 4. LF-008 Monitoring Well Locations

From September 2006 through April 2007, major erosion repair activities were conducted at LF-008 to repair damage to the ET cover system and reduce future impacts to the site by controlling run-on from offsite sources. Repairs and improvements were also made to existing erosion control features, and areas damaged as a result of the severe storm events that occurred at Kirtland AFB during June through August 2006, were regraded and reconditioned. The repair activities were documented in the *Completion Report for Erosion Repairs at Solid Waste Management Unit (SWMU) 6-1, Landfill 1 (LF-001) and SWMU 6-4, Landfills 4, 5, and 6 (LF-008)* (USAF, 2007). Temporary repairs were performed in September 2006, with permanent repairs and improvements occurring between October 2006 and April 2007. Erosion control channels were extended, run-on aprons were constructed, riprap structures were modified, reinforced, and revegetation of LF-008 was implemented.

Extensive erosion repair activities at LF-008 were performed from April to July 2011 to address damage to the ET cover system and to restore storm water storage capacity. The project involved extensive rilling repairs (concentrated on the north and west slopes), piping repairs, installation of rock check dams in Channel 3, removal of accumulated sediment in channels and basins, and installation of approximately 20,000 lf of 12-inch Excelsior wood fiber rolls.

1.2 SCOPE OF WORK

1.2.1 Groundwater Monitoring Program

The current approach to groundwater monitoring at the landfill sites includes conducting annual groundwater monitoring and quarterly well gauging of four wells at LF-001, six wells at LF-002, and ten wells at LF-008. Samples will be collected and analyzed for volatile organic compounds (VOCs), total and dissolved metals, nitrate-nitrite, anions (chloride, fluoride, and sulfate), alkalinity, total dissolved solids, radium-226/-228, gross alpha/beta, and field parameters. A monitoring report will be prepared on an annual basis to evaluate the results and provide recommendations as to future monitoring requirements.

After monitoring data are collected over a period of four years, the sampling results and sampling frequency will be statistically evaluated to determine whether reducing the frequency of sampling, the number of wells included in sampling activities, and/or the analytes for which the samples are analyzed is merited. Trending analyses can be completed using appropriate statistical analyses software such as the MAROS software or other appropriate tools (i.e., Mann-Kendall). It is anticipated that monitoring and gauging will be reduced to a biennial schedule. Data for individual wells and analytes will be statistically evaluated to determine whether monitoring frequencies can also be adjusted.

Various statistical tests exist to determine whether a significant temporal trend exists in a given data set. For simple linear regression, the statistical test of whether the slope is significantly different from zero is equivalent to testing whether the correlation coefficient is significantly different from zero. To perform the test, the correlation coefficient is first calculated. The correlation coefficient is then used to calculate the t-statistic, which is then compared to a critical value for $t_{1-\alpha/2}$ at a specified significance level (usually 95%) to determine whether there is a significant correlation between the two variables (in this case, an analyte's concentration versus time). Historical and current data sets will be combined to perform the trend analysis taking care to ensure that the data sets are comparable. Any adjustment to monitoring frequency will be documented in an annual monitoring report and require concurrence of the Air Force and NMED.

If the calculated t is greater than the critical value as obtained from a table of statistical t-values, then the null hypothesis is rejected, and it can be concluded that there is no significant positive or negative statistical trend in the data. Conversely, if the calculated t is less than the critical value, then the null

hypothesis is not rejected, and it can be concluded that there is a significant positive or negative statistical trend in the data.

1.2.2 Landfill Cover Inspection, Monitoring, and Maintenance Activities

The ET covers installed at the three landfill sites will be monitored on a monthly basis to document any issues with cover integrity. The *Draft Operations and Maintenance Plan – Landfill Sites LF-001, LF-002, and LF-008* (USAF, 2014b) identifies landfill cover improvements that will be implemented to address areas where erosion has been documented during past inspections. The recommended cover improvements will be implemented and will include revegetation of any disturbed areas.

Landfill inspection frequencies are targeted for reduction from monthly to quarterly, then semi-annually, and annually based on the landfill improvements that will be outlined in the project operations and maintenance plan.

1.3 OVERVIEW OF THE QAPP

The remainder of this QAPP is organized as follows:

- Section 2.0 comprises the 37 UFP-QAPP worksheets.
- Section 3.0 lists the references used to prepare this QAPP.
- Appendix A contains the relevant field standard operating procedures (SOPs) applicable to this project. In addition to these SOPs, the SOPs for Field Investigations provided in Appendix B of the *Kirtland Air Force Base – Base-Wide Plans for the Installation Restoration Program, 2003 Update* (USAF, 2003) provide guidance for the activities prescribed in the Appendix A SOPs, as well as guidance for other activities that may be encountered during the field work.
- Appendix B includes the ESC Lab Sciences (ESC) quality assurance (QA) manual.
- Appendix C includes the TestAmerica, Inc. (TestAmerica) QA manual

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2.0 QAPP WORKSHEETS

2.1 QAPP WORKSHEETS #1 & #2 – TITLE AND APPROVAL PAGE

a. Project Identifying Information

   a. Site name/project name: Kirtland AFB/Performance Based Remediation Site Investigation

   b. Site locations/numbers: LF-001, LF-002, and LF-008

   c. Contract/work assignment number: FA8903-13-C-0008

b. Lead Organization

   a. Lead Organization Project Manager:

   _____ _____

   Brian Renaghan — Date
   Contracting Officer's Representative AFCEC
   Environmental Center of Excellence Restoration
   Execution

   b. Lead Organization Quality Manager:

   _____ _____

   Layi Oyelowo — Date
   AFCEC/Environmental Center of Excellence
   Restoration Execution Contracting Officer Alternate

c. State Regulatory Agency

   _____ _____

   John Keiling, Bureau Chief — Date
   Hazardous Waste Bureau
   New Mexico Environment Department

d. Other Stakeholders

   _____ _____

   Wayne Bitner, Environmental Restoration Manager — Date
   Kirtland Air Force Base

e. Plans and Reports from previous investigations relevant to this project.

- *Long-Term Monitoring and Maintenance Plan for Solid Waste Management Units(SWMU) 6-1, Landfill 1 SWMU 6-2, Landfill 2, and SWMU 6-4 Landfills 4, 5, and 6 (USAF, 2006b)*
- *Annual Monitoring and Maintenance Activities Report for Solid Waste Management Units(SWMU) 6-1, Landfill 1 SWMU 6-2, Landfill 2, and SWMU 6-4 Landfills 4, 5, and 6* (USAF, 2012)

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2.2 QAPP WORKSHEETS #3 & #5 – PROJECT ORGANIZATION AND QAPP DISTRIBUTION

Document Title: **Uniform Federal Policy, Quality Assurance Project Plan for Sites LF-001, LF-002, and LF-008**

AFCEC Contract FA8903-13-C-0008

Table 3-1 provides the project organization and distribution list for the QAPP and Figure 5 provides an overview of the organizational structure.

Table 3-1. Project Organization and QAPP Distribution

Name of QAPP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address
Brian Renaghan	Primary Contracting Officer's Representative	AFCEC	(210) 395-8633	brian.renaghan@us.af.mil
Ludie (Wayne) Bitner	Restoration Chief	Kirtland AFB	(505) 853-3484	ludie.bitner@kirtland.af.mil
Cole Crosgrove	Project Manager	Kirtland AFB	(505) 853-3098	cole.crosgrove@kirtland.af.mil
Michael Skelly	Environmental Restoration Operations	Sandia National Laboratories	505-284-2483	mfskell@sandia.gov
Kamalesh Pinisetti	Program Manager	URS	(602) 861-7434	kamalesh.pinisetti@urs.com
Richard Wells	Project Manager	URS	(602) 861-7409	richard.wells@urs.com
Dale Flores	Operations Manager	URS	(505) 855-7500	dale.flores@urs.com
Patrick Ostrye	Field Team Leader	URS	(505) 855-7500	patrick.ostrye@urs.com
Marianne Burrus	QA Manager and Project Chemist	URS	(602) 861-7473	marianne.burrus@urs.com
Dixie Marlin	Quality Control Manager	ESC	(615) 773-9681	dmarlin@esclabsciences.com
Sarah Nagel	Quality Assurance Manager	TestAmerica	(509) 375-3131	sarah.nagel@testamericainc.com
Dave Cobrain	Permits Program Manager	RCRA Permits Management Program	(505) 476-6055	dave.cobrain@state.nm.us

AFB – air force base
AFCEC – Air Force Civil Engineer Center
ESC – ESC Lab Sciences
NMED – New Mexico Environment Department
QA – quality assurance
TestAmerica – TestAmerica, Inc.
URS – URS Group, Inc.

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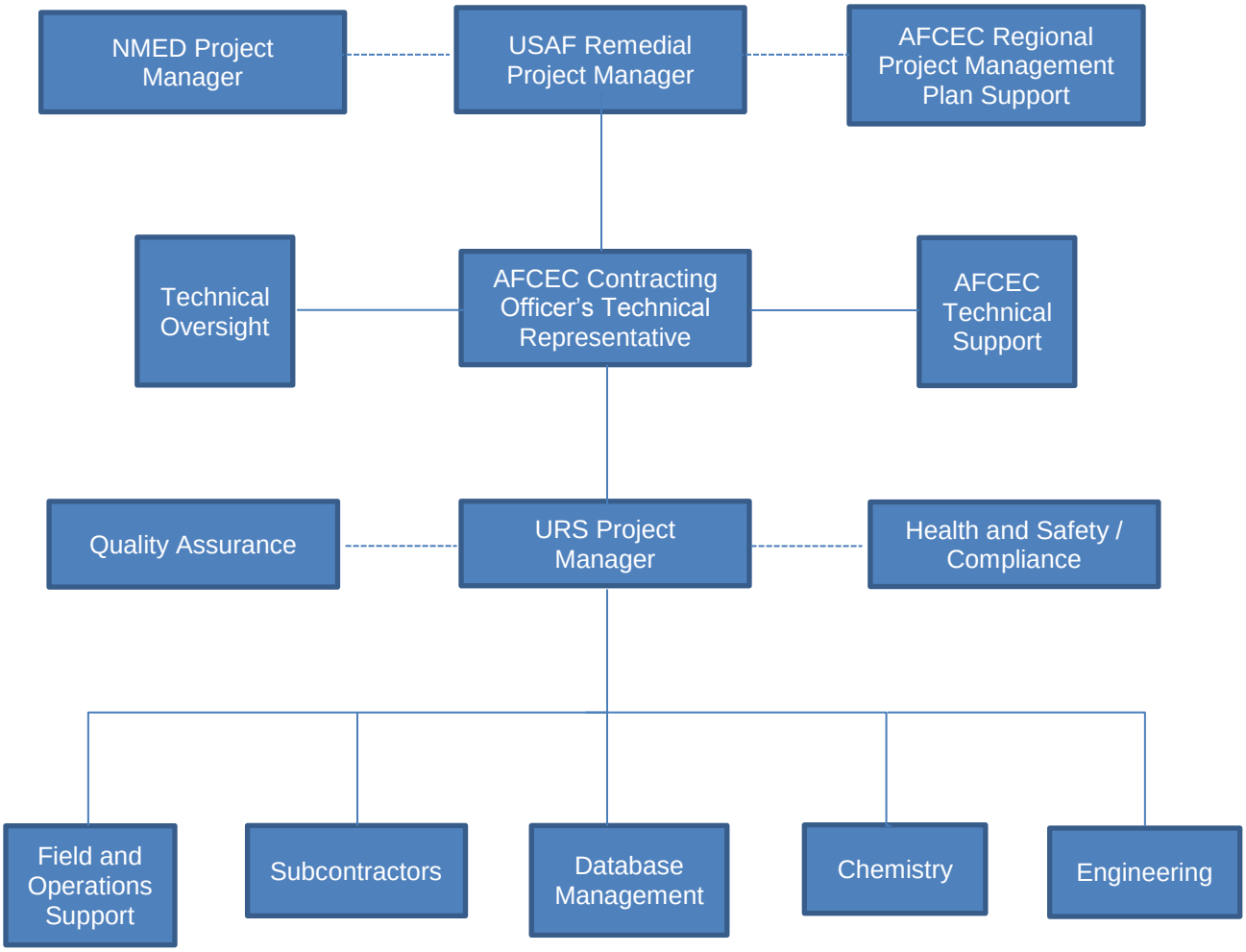

Figure 5. Organization Chart

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2.3 QAPP WORKSHEETS #4, #7 & #8 – PERSONNEL QUALIFICATIONS AND SIGN-OFF SHEET

Table 4-1. Organization: URS

Name	Organization/Title/Role	Education/Experience	Specialized Training/ Certifications	Signature/E-mail Receipt	Date Read
Richard Wells	Project Manager, URS	M.B.A., M.S. Chemistry, B.S. Chemistry, 30 years of experience	40-Hr HAZWOPER, 8-Hr HAZWOPER Refresher, 8-Hr HAZWOPER Supervisor, First Aid, CPR-Certified	richard.wells@urs.com	
Marianne Burrus	Project Chemist and QA Officer, URS	B.S. Geology, 30 years of experience	40-Hr HAZWOPER, 8-Hr HAZWOPER Refresher, First Aid, CPR Certified	marianne.burrus@urs.com	
Skip Wrightson	Field Team Leader and Site Safety Officer	M.S. Geology, B.S. Geology, 30 years of experience	40-Hr HAZWOPER, 8-Hr HAZWOPER Refresher, 8-Hr HAZWOPER Supervisor, 24-Hr MSHA training and refresher, First Aid, CPR Certified	skip.wrightson@urs.com	

B.S. – Bachelor of Science
CPR – cardiopulmonary resuscitation
HAZWOPER – Hazardous Waste Operations and Emergency Response
Hr - hour
M.B.A. – Master of Business Administration
M.S. – Master of Science
MSHA – Mine Safety and Health Administration
QA – quality assurance
URS – URS Group Inc.

All URS site personnel will have met the requirements of 29 Code of Federal Regulation (CFR) 1910.120(e) and the URS Safety Management System:

- Forty hours of initial Occupational Safety and Health Administration health and safety training for Hazardous Waste Operations and Emergency Response (HAZWOPER) or its recognized equivalent
- Eight hours of annual refresher training for all personnel (as required)
- Eight hours of supervisor training for personnel serving as Site Safety Officers
- Three days of work activity under the supervision of a trained and experienced supervisor

- Four hours of a defensive driving course approved by the National Safety Council. All staff driving for company business are required to complete the 4 hour defensive driver training course available at http://www.safetyserve.com/urscorp/.

At least one URS employee on site will hold a current certificate in American Red Cross Standard First Aid. This training provides 6.5 hours of Basic First Aid and Adult CPR.

For details on the site-specific requirements, refer to the Health and Safety Plan.

The laboratories are certified through the National Environmental Laboratory Accreditation Program in accordance with standards promulgated by the National Environmental Laboratory Accreditation Conference Institute.

Table 4-2. Organization: Laboratory

Name	Organization/Title/Role	Education/Experience	Specialized Training/ Certifications	Signature/E-mail Receipt	Date Read
Dixie Marlin	Quality Control Manager, ESC	B.S. Biology, 20 years experience	—	dmarlin@esclabsciences.com	
Sarah Nagel	Quality Manager, TestAmerica	BS Chemistry, MS Chemistry, PhD Chemistry, 10 years experience	Statistical Process Control, American Chemical Society's Laboratory Statistics	sarah.nagel@testamericainc.com	
B.S. – Bachelor of Science ESC – ESC Lab Sciences M.S. – Masters of Science PhD – Doctor of Philosophy TestAmerica – TestAmerica, Inc.					

2.4 QAPP WORKSHEET #6 – COMMUNICATION PATHWAYS

Table 6-1. Communication Pathways

Communication Drivers	Responsible Entity	Name/ Organization	Phone Number	Procedure
Agency Liaison	AFCEC Contracting Officer Representative AFCEC Restoration Chief	Brian Renaghan Ludie (Wayne) Bitner	(210) 395-8633 (505) 853-3484	All communication is initiated through AFCEC. Kirtland AFB provides technical direction; programmatic information will be discussed by Kirtland AFB with NMED.
Project Management	Project Manager	Richard Wells/URS	(602) 861-7409	The project manager will direct and approve all communication to the USAF's Remedial Project Manager (RPM), including notification of field changes or modifications by close-of-business of the following day. The project manager will provide monthly status reports to the RPM.
QA/QC	QA Manager	Marianne Burrus/URS	(602) 861-7473	The QA manager will designate responsible project quality personnel to perform specified QA and QC activities and report to project and program management. Issues and non-conformances and corrective actions will be reported to the USAF RPM (or designee) within 1 day of non-conformance issuance.
Coordination and communication of fieldwork activities related to data and sample collection	Field Team Leader	Skip Wrightson/URS	(505) 855-7500	The field team leader will communicate relevant field information to the Project Manager and project chemist daily during field activities, by phone or e-mail.
Coordination with laboratory for field activities	Project Chemist	Marianne Burrus/URS	(602) 861-7473	The project chemist will contact the laboratory by e-mail to provide necessary sample containers and appropriate shipping to be delivered on site before field sampling begins and throughout the project.
CoC reports and shipping documentation	Field Team Leader	Skip Wrightson/URS	(505) 855-7500	CoCs and shipping records will be submitted via fax or e-mail to the project chemist at the end of each day that samples are collected.

Communication Drivers	Responsible Entity	Name/ Organization	Phone Number	Procedure
Sample shipment coordination with laboratory	Field Team Leader	Skip Wrightson/URS	(505) 855-7500	The field team leader will coordinate with the laboratory on days of sample shipment to inform them of anticipated shipment arrival dates, including number of coolers shipped. The field team leader will also provide laboratory with CoCs, shipment tracking numbers, and any other pertinent information.
Laboratory results	Laboratory Project Manager	Daphne Richards/ ESC Rhonda Wagar/ TestAmerica	(615) 773-9662 (509) 375-3131	Laboratory results will be reported to the project chemist in accordance with the laboratory scope of work.
Reporting laboratory data quality issues	Laboratory Project Manager	Daphne Richards/ ESC Rhonda Wagar/ TestAmerica	(615) 773-9662 (509) 375-3131	The laboratory project manager will report QA/QC issues that potentially affect data usability to the project chemist by e-mail within 1 business day.
Field and analytical corrective actions	QA Manager	Marianne Burrus/URS	(602) 861-7473	The QA program manager will complete documentation of the non-conformance and corrective actions to be taken and will verify that the corrective actions have been implemented.
Release of analytical data	Project Chemist	Marianne Burrus/URS	(602) 861-7473	The project chemist will review faxed/e-mailed data to verify that data quality is met as described in the planning documents before the data are released. Analytical data will be released to the project manager (or designee) after the project chemist has verified that the data are in accordance with the project requirements.
Data validation issues	QA Manager	Marianne Burrus/URS	(602) 861-7473	The data validator will coordinate with the QA manager and analytical laboratory to ensure data packages provided by the lab are complete and allow for full validation. The data validator will immediately notify the QA manager of data that are qualified as rejected, or R-flagged.
QAPP procedure revision during field activities	Project Chemist	Marianne Burrus/URS	(602) 861-7473	The project chemist will prepare a field change request for any changes in sampling procedures that occur as a result of conditions in the field. This request will be submitted to the project manager for approval prior to initiation of the change.

Communication Drivers	Responsible Entity	Name/ Organization	Phone Number	Procedure
Data usability	Project Chemist	Marianne Burrus/URS	(602) 861-7473	The project chemist will notify the project manager of any data usability issues that are identified during data validation immediately. The field manager will notify the project chemist of any field conditions, sample collection techniques, or sample shipping issues that impact data usability at the end of the day of occurrence or earlier as deemed appropriate.
AFB – air force base AFCEC – Air Force Civil Engineer Center CoC – chain-of-custody ESC – ESC Lab Sciences NMED – New Mexico Environment Department QA – quality assurance QA/QC – quality assurance/quality control QAPP – Quality Assurance Project Plan TestAmerica – TestAmerica, Inc. URS – URS Group, Inc. USAF – U.S. Air Force				

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2.5 QAPP WORKSHEET #9 – PROJECT SCOPING SESSION SUMMARY

No additional planning was necessary for the preparation of this QAPP. This plan was written in accordance with contractual requirements and conforms to the QAPP requirements and elements set forth in the UFP-QAPP Manual (DoD, 2005). If any meetings are held with NMED or Kirtland AFB regarding scope and/or elements specifically relating to this UFP-QAPP, this worksheet will be revised accordingly.

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2.6 QAPP WORKSHEET #10 – CONCEPTUAL SITE MODEL

This worksheet describes the environmental problem in terms of the conceptual site model (CSM) for the LF-001, LF-002, and LF-008 sites. The CSM integrates existing information and working assumptions about the physical site conditions, the nature and extent of contamination, fate and transport processes, and potential exposure to human and ecological receptors. The CSM is based on the current understanding of site history and conditions and will be updated as necessary based on the information gained from site soil sampling and groundwater monitoring.

2.6.1 Site Description

Three private airfields predate the Kirtland AFB, formerly named Albuquerque Army Air Base, with military operations becoming the primary focus in 1941. The base was renamed in 1942 honoring Colonel Roy C. Kirtland, a pioneer in Army aviation. Flight crews were trained in the early 1940s at Kirtland's three schools: advanced flying, bombardier training, and multi-engine school. Later that decade, the focus of base operations shifted to developing aircraft modifications for weapons delivery, researching ballistic characteristics, and testing weapons. Manzano Base was named in 1952 and was located on the former Site Able, created under the Armed Forces Special Weapons Command. Sandia Base began operating as the Albuquerque Airport Training Station in 1942 and served historically as a nuclear weapons installation. In 1971, Kirtland, Manzano, and Sandia bases were merged and were managed under one command.

LF-001 is located in the northwestern area of Kirtland AFB, directly south of the main east-west runway for the base and Albuquerque International Sunport (Figure 2). Southgate Avenue forms the northern and western site boundaries, Ammo Road runs parallel to the eastern boundary, and an abandoned railroad grade forms the southern boundary. KAFB-2 is located approximately 150 ft northeast of the landfill, downgradient of former monitoring well KAFB-0111. LF-001 is not located within the Tijeras Arroyo 100-year flood plain.

Although disposal activities date back to 1951, the site was operated primarily between 1960 and 1975 as a trench-and-fill landfill. The landfill contains an estimated 425,000 cy of municipal waste and up to 175,000 cy of construction and demolition debris. Field activities conducted at the site have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. A detailed summary of the site's background and history, results of previous investigations, corrective measures, and current status is presented in the ERP Site-Specific Summaries (USAF, 2005a), which were prepared as a supplement to the 2004 update of the MAP (USAF, 2005b).

SWMU 6-2, Landfill 2 (LF-002) is located between the Trestle Aircraft Testing Facility and Advanced Research Electromagnetic Simulator facilities to the north and the active channel of the Tijeras Arroyo to the south (Figure 3). The eastern and western boundaries are currently defined by security fences. Kirtland AFB Production Well No. 8 is approximately 2,100 ft northeast of the landfill, and Production Well No. 4 (KAFB-4) is 2,400 ft to the north. Field activities have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. A detailed summary of the site's background and history, results of previous investigations, corrective measures, and current status is presented in the ERP Site-Specific Summaries (USAF, 2005a), which was prepared as a supplement to the 2004 update of the MAP (USAF, 2005b).

LF-002 operated between 1942 and 1965 as a trench-and-fill landfill. The current volume of waste is estimated to be 1,321,700 cy. Two buried pipelines cross LF-002. The 21-inch city of Albuquerque's

Tijeras Interceptor sanitary sewer line runs east-west across the northern region of the landfill, approximately 400 ft south of well KAFB-0213. The second buried pipeline is the treated sewage effluent line (ST-051) that carried effluent from the Sewage Lagoons to the Golf Course Main Pond. ST-051 is currently used to pump nitrate-rich water from Production Well No. 7 (KAFB-7) to the Golf Course Main Pond for irrigation. This line was relocated outside of the landfill boundary during construction of the ET cover and an access road was constructed.

SWMU 6-4, Landfills 4, 5, and 6 (LF-008) is located on the northwestern region of Kirtland AFB and is bounded by the Tijeras Arroyo to the north and the covered slope of the active construction and demolition debris landfill (LF-268) about 150 ft east of Power Line Road to the east (Figure 4). The site is made up of three former contiguous landfills (Landfills 4, 5, and 6). Based on flood plain maps, the site is not located within the 100-year flood plain. Field activities conducted at the site have included borehole installation and sampling, soil gas and geophysical surveys, excavation of test pits, geotechnical analyses, and soil and groundwater sampling and analysis. A detailed summary of site's background and history, results of previous investigations, corrective measures, and current status is presented in the ERP Site-Specific Summaries (USAF, 2005a), which was prepared as a supplement to the 2004 update of the MAP (USAF, 2005b).

The City of Albuquerque and Kirtland AFB jointly operated Landfill 4 from 1964 to 1969 as a general refuse landfill. Construction and demolition debris and trees were placed in the northeastern part of Landfill 4 and general refuse was placed in two natural arroyos in the western part of the site. The estimated volume of waste in Landfill 4 is about 600,000 cy buried over an area of approximately 25 acres. Kirtland AFB operated Landfills 5 and 6, located north of Landfill 4, from mid-1960 through 1989. Construction and demolition debris was placed in Landfill 5 and other refuse was disposed in Landfill 6. The estimated volume of waste in Landfills 5 and 6 is about 1,746,000 cy buried over an area of approximately 40 acres.

2.6.2 Conceptual Site Model

Kirtland AFB occupies approximately 51,558 acres in southeastern Albuquerque, New Mexico, nestled between the Sandia and Manzano mountain ranges. The base is located in Bernalillo County, in central New Mexico, southeast of and adjacent to the Albuquerque International Sunport (Figure 1). Kirtland AFB employs more than 23,000 people, including more than 4,200 active duty, 1,000 National Guard, and 3,200 part-time reservists. Kirtland AFB is home to the Air Force Nuclear Weapons Center and its subordinate wings, the 498th Armament Systems Wing and the 377th Air Base Wing. It is also home to the Defense Threat Reduction Agency Albuquerque office, Air Force Safety Center, the Air Force Inspection Agency, the Air Force Operational Test and Evaluation Center, the 58th Special Operations Wing, Space Development and Test Wing, the New Mexico Air National Guard 150th Fighter Wing, the Directed Energy and Space Vehicle Directorates of the Air Force Research Laboratory, the Department of Energy Albuquerque Office, the National Nuclear Security Administration, and Sandia National Laboratories – New Mexico.

2.6.2.1 Regional Geology

The geology of the Kirtland AFB area varies with the regional geology. The eastern portion of Kirtland AFB is mountainous, with elevations reaching 7,900 ft above mean sea level (amsl). These mountains are composed of Precambrian metamorphic and igneous (primarily granite) and Paleozoic sedimentary rock (primarily marine carbonates). The western portion of the base lies within the Albuquerque Basin. Geologic features in this area of the basin include travertine and unconsolidated and semi-consolidated piedmont deposits, as well as eolian, lacustrine, and stream channel deposits.

In general, the near surface geology is characterized by recent deposits (i.e., mixtures of sandy silt and silty sand with minor amounts of clay and gravel); Ortiz gravel (i.e., alluvial piedmont sand and gravel deposits); and the Santa Fe Group (USF) (i.e., a mixture of sand, silt, clay, gravel, cobbles, and boulders). Generally, the northern and western portions of Kirtland AFB are dominated by unconsolidated geologic units; consolidated units predominate in the eastern half of the base.

Kirtland AFB lies within the eastern portion of the Albuquerque structural basin that contains the through-flowing Rio Grande. The basin is approximately 90 miles long and 30 miles wide. The deposits within the Albuquerque Basin consist of interbedded gravel, sand, silt, and clay. The thickness of basin-fill deposits within most of the basin exceeds 3,000 feet, though the thickness varies considerably because of the significant amount of faulting in the basin.

Geologic materials of primary importance within the basin are the USF and piedmont slope deposits. The USF consists of beds of unconsolidated to loosely consolidated sediments and interbedded volcanic rocks. The materials range from boulders to clay and from well sorted stream channel deposits to poorly sorted slope wash deposits. Coalescing alluvial fans of eroded materials from the surrounding mountains were deposited unconformably over the USF, extending westward from the base of the Sandia and Manzano mountains to the eastern edge of the Rio Grande floodplain. The fan sediments range from poorly sorted mud flow material to well sorted stream gravel. The beds consist of channel fill and interchannel deposits. The fan deposits range in thickness from 0 to 200 ft and thicken toward the mountains. The USF is further broken down into two depositional facies called the USF-1 and USF-2 (Hawley et al., 1995). USF-1 is present from ground surface to approximately 86 ft below ground surface (bgs), and then a transition occurs where USF-1 and USF-2 are interfingered to a depth of 144 ft bgs, underneath which USF-2 is present to a depth of greater than 500 ft bgs (CH2M Hill, 2008).

2.6.2.2 Site-Specific Geology

From the *Base-Wide Plan for the Installation Restoration Program* (USAF, 2003), Kirtland AFB lies within the Albuquerque-Belen Basin, also referred to as the Middle Rio Grande Basin. Edges of the basin are marked by normal faults. Groundwater investigations at Kirtland indicate that there is a regional aquifer at a depth of approximately 500-ft below ground surface (bgs). Multiple shallow zones of perched water are also present at between 300 -400 feet bgs.

The apparent groundwater flow direction in the regional aquifer is generally westward, toward the Rio Grande. Groundwater flow direction beneath Kirtland AFB is toward the northwest and north due to drawdown created by water supply wells currently operated by Kirtland AFB and off-base wells operated by the City of Albuquerque (Sandia National Laboratories [SNL], 2010).

The most clearly defined perched zone is located in the north-central portion of Kirtland AFB, situated approximately 100 feet above the regional aquifer. Groundwater flow in the perched aquifer is toward the southeast with a hydraulic gradient ranging between 0.004 and 0.07 ft/ft according to the fall 2011 and spring 2012 groundwater elevation data. At LF-008, the perched system consists of multiple zones of saturation and ranges up to a thickness of 125 ft. Five monitoring wells have been installed in this perched zone.

2.6.2.3 Regional Hydrogeology

The groundwater system at Kirtland AFB and in the Albuquerque area lies within the Albuquerque Basin, also referred to as the Middle Rio Grande Basin. The basin is part of the Rio Grande Rift. As the Rio Grande Rift spread, the Albuquerque Basin filled with sediments several miles in thickness, most of which are referred to as the USF. The unit consists of unconsolidated sediments that thin toward the basin

boundary. Edges of the basin are marked by normal faults. Overlying the USF are the Pliocene Ortiz gravel and Rio Grande fluvial deposits.

Generally, USF-2 contains the most productive portion of the regional aquifer that supplies groundwater to the City of Albuquerque and Kirtland AFB. The unit is characterized by piedmont slope, river, and floodplain deposits. The ancestral Rio Grande formed a large aggradational plain in the central basin, depositing a mix of coarse- to fine-grained sand, silt, and clay with variable bed thickness.

Basin-fill deposits make up the aquifer in the Albuquerque Basin. Hydraulic conductivity values range from 0.25 to 130 ft per day (ft/day) due to large variations in the lithology of the basin-fill deposits. The average hydraulic conductivity is 70 ft/day with flow to the northeast. Clay layers have relatively low hydraulic conductivity, whereas gravel and cobble deposits exhibit relatively high hydraulic conductivity. Deposits of interbedded gravel, sand, silt, and clay have intermediate hydraulic conductivity.

This principal aquifer underlies Kirtland AFB, with the basin fill in this area consisting of unconsolidated and semi-consolidated sand, gravel, silt, and clay of the USF; alluvial fan deposits associated with erosion of upland areas; and valley alluvium associated with stream development. The alluvium varies in thickness from a few feet near the mountains on the east side of the base to greater than 2,100 ft bgs at a location 5 miles southwest of the airfield (USAF, 2003).

The soil at Kirtland AFB ranges from wet to dry. The finer-grained upper soil is generally moist while the coarser-grained deeper soil could be moist or dry. Several minor perched water-bearing zones are present in the vadose zone above the regional water table. Some of these water-bearing zones below 400 ft bgs are likely remnants of the regional aquifer left behind as the water table has dropped.

2.6.2.4 Site-Specific Hydrogeology

Groundwater at the site is present within the overburden and incompetent, weathered granite and is presumably controlled by either flow through the permeable, unconsolidated weathered granite or perhaps by flow through fractures that provide secondary permeability within more competent granite. The interconnectedness of granite fractures is unknown and the degree to which fractures may be infilled due to weathering is unknown. The depth to water at site wells generally ranges from 55 to 65 feet bgs. Water levels have been generally declining over time, dropping by approximately 10 feet from 2001 to 2005, while increasing by approximately 1 foot from 2005 to 2009, and decreasing again by approximately 1 foot from 2009 to 2011. Water levels during the 2012 monitoring period decreased from 2011 levels by approximately 1 foot.

2.6.2.4.1 Regional Aquifer

Groundwater elevations in the regional aquifer near LF-001 in July 2012 ranged from 4,858.55 ft above mean sea level (amsl) in downgradient well KAFB-0119 to 4,860.50 ft amsl in upgradient well KAFB-0120. Depth to the regional water table below the landfill during this same time period ranged from 459.00 to 426.39 ft below the top of the well casing as measured in wells KAFB-0118, -0119, -0120, and -0121.

Groundwater elevations in the regional aquifer near LF-002 in July 2012 ranged from 4,860.52 ft amsl in downgradient well KAFB-0221 to 4,861.47 ft amsl in upgradient well KAFB-0219. Depth to the regional water table below the landfill during this same time period ranged from 381.36 to 418.68 ft below the top of the well casing as measured in wells KAFB-0213, -0219, -0220, -0221, -0222, and -0223.

Groundwater elevations in the regional aquifer near LF-008 in July 2012 ranged from 4,927.08 ft amsl in downgradient well KAFB-0309 to 5,011.10 ft amsl in upgradient well KAFB-0312. Depth to the regional water table below the landfill during this same time period ranged from approximately 418.40 to 482.08 ft below the top of the well casing as measured in wells KAFB-0307, -0308, -0309, -0311, and -0312.

2.6.2.4.2 Perched Aquifer

Groundwater elevations in the perched aquifer near LF-008 in July 2012 ranged from 5,024.66 ft amsl in downgradient well KAFB-0315 to 5,073.65 ft amsl in upgradient well TJA-2. Depth to water in the perched aquifer during this same time period ranged from 276.16 to 438.78 ft below the top of the well casing as measured in wells TJA-2, KAFB-0310, -0313, -0314, and -0315.

2.6.2.5 Source of Contamination

In the regional aquifer, the most recent groundwater monitoring results from monitoring wells located at the landfill sites (April 2012) indicate that few samples taken at the landfill sites have resulted in concentrations of contaminants that exceed NMED Water Quality Control Commission (WQCC) standards or Safe Drinking Water Act Maximum Contaminant Levels (MCLs). These included total chromium, total iron, and nitrate as nitrogen. In the perched aquifer at LF-008, four samples in April 2012 resulted in concentrations that exceeded WQCC standards or MCLs. They included results for total thallium, total dissolved solids, and nitrate as nitrogen. The suspected sources of these contaminants in groundwater are the wastes that were landfilled during the operational periods of LF-001, LF-002 and LF-008.

LF-001 is an inactive trench-and-fill landfill that operated primarily between 1960 and 1975. The landfill encompasses approximately 49 acres with buried materials ranging in depth from 10 to 30 ft bgs. Wastes reportedly disposed of at LF-001 consisted of general refuse, construction and demolition debris, and possibly hazardous waste including chemical drums, oil-soaked insulation, and numerous 55-gal drums and 5-gal cans of unknown content.

LF-002 is an inactive trench-and-fill landfill that operated between 1942 and 1965. The landfill encompasses approximately 32 acres with waste buried between 1 to 20 ft bgs. Wastes reportedly disposed of at LF-002 consisted of general refuse, construction and demolition debris, and potentially hazardous materials such as 55-gal drums with solvents and plastic wastes.

LF-008 includes three former contiguous landfills (LF-004, LF-005, and LF-006) that encompass approximately 80 acres of buried materials. LF-004 was operated from 1964 to 1969 and includes approximately 600,000 cy of construction and demolition debris and general refuse buried over an area of 40 acres.

2.6.2.6 Fate and Transport and Potential Receptors

As discussed in Section 2.6.2.5, recent groundwater monitoring results from monitoring wells located at the landfill sites indicate that few samples have resulted in concentrations of contaminants that exceed WQCC standards or MCLs. There is no active remediation taking place at these sites, only monitoring activities.

The current exposure pathways at the landfills may include direct exposure (dermal contact, ingestion of soil, inhalation of soil particles, and inhalation of soil vapor, should an individual inadvertently come into contact with contaminated soil underlying the evapotranspiration cover) and indirect exposure (ingestion of groundwater). Potential exposure pathways include potential volatilization of VOCs and methane from

soil to indoor and outdoor air, resulting in a complete exposure pathway via inhalation. An exposure pathway could also be created by windblown transport of contaminants as soil particles to receptors via particulate inhalation. Dermal contact with soil and inadvertent ingestion of the soil through site maintenance activities constitute potentially complete exposure pathways for soil. Exposure from intrusive activities associated with the landfill could potentially provide exposure to volatile constituents in subsurface soil. In the future scenario, a complete exposure pathway could potentially occur from direct contact with soil, inadvertent ingestion of soil, and volatilization from soil to indoor or outdoor air.

The regional water table occurs at an approximate depth of 400 ft. Because the regional aquifer is used as a source of drinking water, indirect exposure through ingestion of groundwater is possible. Drinking water at Kirtland AFB is supplied by wells such as groundwater production wells KAFB-15 and KAFB-16. Both of these production wells are located nearest to LF-001, but are greater than one mile from the site. Vertical migration of contaminants has been minimized by construction of the evapotranspiration caps over each of the landfills. Volatilization of chemicals from groundwater to indoor or outdoor air is not considered a likely exposure pathway because the water table is so deep. Groundwater beneath the landfills does not discharge to any surface water features at Kirtland AFB or downgradient of the site outside of Base property, so this is an incomplete exposure scenario.

The apparent groundwater flow direction in the regional aquifer is generally westward, toward the Rio Grande. Groundwater flow direction beneath Kirtland AFB is toward the northwest and north due to drawdown created by water supply wells currently operated by Kirtland AFB and off-base wells operated by the City of Albuquerque (SNL, 2010). The regional aquifer hydraulic gradient near the Sandia fault system ranges from 0.003 to 0.2 foot per foot (ft/ft) to the west. Perched groundwater zones are also present at Kirtland AFB. The best-documented perched zone is located in the north-central portion of Kirtland AFB, lying approximately 100 feet above the regional aquifer. Groundwater flow in the perched aquifer is toward the southeast with a hydraulic gradient ranging between 0.004 and 0.07 ft/ft.

To date, there has not been an effort made to evaluate any significant trends in groundwater constituent concentrations from which an evaluation can be made as to whether the landfill caps have had an impact on potential migration of contaminants from the waste contained in the landfills to the underlying groundwater. Such trend analyses and data evaluation will be a key attribute of the on-going monitoring efforts.

2.7 QAPP WORKSHEET #11 – PROJECT/DATA QUALITY OBJECTIVES

The data quality objective (DQO) process is a series of planning steps based on scientific methods that are designed to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate. The DQO process is intended to:

- Clarify the study objectives
- Define the most appropriate type of data to collect
- Determine the most appropriate conditions for data collection
- Specify accountable levels of decision errors to establish the quantity and quality of data needed to support response decisions

The DQO process specifies project decisions, data quality requirements, specific data types needed, data collection requirements, and analytical techniques to the specified data quality. The process also helps to ensure that the resources required to generate the data are available.

2.7.1 Problem Statement

Low concentrations of VOCs, semi-volatile organic compounds (SVOCs), and metals have been detected in soil beneath LF-001 and LF-002; VOCs and SVOCs were detected in active and passive soil-gas samples. Groundwater quality has not been impacted by these landfill sites. The same analytes, VOCs, SVOCs, and metals, have been detected in soil beneath LF-008. In addition, trichloroethene (TCE), a VOC often used as a solvent, has been detected during the Base's Long-Term Groundwater Monitoring Program in well TJA-2 installed by Sandia National Laboratories in the perched aquifer upgradient of LF-008. TCE is believed to be migrating from an offsite source located west of the landfill. KAFB and Sandia National Laboratories have implemented a joint investigation, known as the Tijeras Arroyo Groundwater Investigation, to characterize both the source and extent of the TCE contamination.

ET covers were installed at all three landfill sites as a result of recommendations contained in a Corrective Measures Implementation work plan. The covers were designed to minimize percolation rates, reduce incidents of erosion and provide proper drainage for the landfill cover. The ET covers must be monitored on a monthly basis to observe and address any future erosion problems.

The approach to groundwater monitoring at these sites is as follows:

- Conduct annual groundwater monitoring and quarterly well gauging (2014-2017), perform trend analysis in 2018, reduce the monitoring frequency to biennial groundwater monitoring, as indicated by trend analyses (2019, 2021, and 2023)
- Prepare and submit annual LTM reports (2014-2023)
- Provide support for Five-Year Reviews in 2015 and 2020.

The dates identified with each item above were established in the project Integrated Master Schedule. Many of these requirements will be performed concurrently.

The first step in the DQO process is to state the problem to be addressed and to put it in programmatic context. The problem statements associated with the DQO process for LF-001, LF-002, and LF-008 are as follows:

- **Problem Statement 1** – Reduce the uncertainty associated with whether constituents currently present in the groundwater underlying the landfills or present in waste contained in the landfills will impact the aquifer such that regulatory quality standards or risk-based concentrations will not be met.

2.7.2 Decisions to be Made

The purpose of DQO Step 2 is to define the principle study questions (PSQs) that need to be resolved to address the problem statements identified in DQO Step 1 and the alternative actions that would result from resolutions of the PSQs. The PSQs and associated alternative actions are combined into decision statements (DSs).

Principal Study Questions

- **PSQ 1 –** Are constituents present in the groundwater underlying the landfills that may indicate the presence of constituents that may cause regulatory groundwater quality standards or risk-based concentrations to be exceeded?
- **PSQ 2 –** If constituents are present in the groundwater underlying the landfills, is a trend apparent that may indicate that regulatory groundwater quality standards or risk-based concentrations may be exceeded at some point in the future?

Decision Statements

- **DS 1** – Determine if there are constituents present in the groundwater underlying the landfills that may indicate the presence of constituents in waste are causing regulatory groundwater quality standards or risk-based concentrations to be exceeded.
- **DS 2** – Determine whether the trend of any constituent present in the groundwater underlying the landfills may indicate that regulatory groundwater quality standards or risk-based concentrations may be exceeded at some point in the future.

2.7.3 Inputs to the Decisions

The purpose of DQO Step 3 is to identify the type of data needed to resolve each of the DSs identified in DQO Step 2. These data may already exist or may be derived from computational or surveying/sampling and analysis methods. The data required to satisfy the two DSs will consist of field measurements and laboratory measures for contaminants of concern. The action level for a particular contaminant is the threshold value that provides the criterion for choosing between alternative actions. The basis for setting the action level for each contaminant is the potential for exceeding human health and/or ecological risk-based concentrations in either the contaminated soil or underlying groundwater.

1. *Target constituent concentrations in the groundwater underlying the Site.*

Collection and laboratory analysis of target constituents of groundwater samples from the four wells located in the vicinity of LF-001, six wells located near LF-002, and ten wells located in the proximity of LF-008 for the full suite of specified analyses will be collected on an annual basis. Constituent concentrations will be compared to applicable regulatory levels or risk-based concentrations to determine

whether any constituents pose an unacceptable risk to human health or the environment. In addition, a statistical trend of constituent concentrations over time will be evaluated to determine whether any constituents may adversely impact the groundwater at some point in the future.

2.7.4 Study Area Boundaries

The primary objective of DQO Step 4 is to identify the population of interest, define the spatial and temporal boundaries that apply to each DS, and identify any practical constraints (hindrances or obstacles) that must be taken into consideration in the sampling design. Implementing this step ensures that the sampling design will result in the collection of data that accurately reflect the true condition of the site under investigation.

The geographic boundary for DSs 1 and 2 includes the groundwater underlying the Site. Based on review of the hydraulic data and groundwater contour maps, the selected wells will allow for evaluation of the potential migration of groundwater constituents.

The temporal boundary refers to both the timeframe in which each DS applies and in which the data should be collected. The sample collection timeframe for DSs 1 and 2 will be on an annual basis for the full suite as specified in Worksheet #15. Temporal boundaries are important when constituent concentration changes over time are significant. Though historical data indicate that constituent concentrations are unaffected by seasonal factors, groundwater monitoring samples will be collected from the landfill wells at approximately the same time of year in an effort to negate any effect that changes in groundwater levels due to snow melt and run-off may have on the data collected.

Practical constraints that could affect the data collection effort include physical barriers and potential background interference during field and laboratory measurements.

2.7.5 Decision Rule

The purpose of DQO Step 5 is initially to define the parameter of interest that will be used for comparison against the action level. The decision rules summarize the attributes the decision-maker needs to know about the sample population and how this knowledge will guide the selection of a course of action to solve the problem. Decision rules define the various conditions that will cause a selection among alternative actions.

1. **If** target constituent concentrations in groundwater exceed applicable water quality standards, **then** evaluation of corrective measures for the target constituent will be warranted, **else** the target constituent will be determined to not pose an unacceptable risk to human health and the environment and no further evaluation will be required.
2. **If** a statistical trend for a constituent indicates that target concentrations will exceed either regulatory standards or risk-based levels at some point in the future, **then** evaluation of corrective measures for the target constituent will be warranted, **else** the target constituent system will be determined to not pose an unacceptable risk to human health and the environment and no further evaluation will be required.

2.7.6 Acceptable Limits on Decision Error

Analysis of collected samples will provide the necessary data to meet Department of Defense Quality Systems Manual Version 4.2 specification for precision, accuracy, representativeness, comparability, completeness, and sensitivity. The laboratory methods proposed in this QAPP provide the lowest

available method detection limits. This will allow for the data to be screened against the project specific objectives. The analytical laboratory data will be definitive data quality while field measurements will be screening level data quality. Worksheet #23 provides the procedures that will be followed by the analytical laboratory to provide definitive quality data. Field measurements associated with screening level data are described in Worksheet #22.

2.7.7 Optimize the Design

Depending on the results of the monitoring, frequency of monitoring and the list of analytes may be decreased as described above. Overall evaluation of the complete data sets of groundwater data will determine future monitoring and sampling requirements necessary to support development of corrective measures if such measures are deemed necessary.

For monitoring data, the frequency of monitoring and the list of analytes may be changed depending on the analytical results obtained. Overall evaluation of the complete data sets will determine future monitoring and sampling requirements necessary to support development of additional corrective measures if such measures are deemed necessary.

Data for individual monitoring points (e.g., wells) will be statistically evaluated to determine whether monitoring frequencies can be adjusted. Various statistical tests exist to determine whether a significant temporal trend exists in a given data set. For simple linear regression, the statistical test of whether the slope is significantly different from zero is equivalent to testing whether the correlation coefficient is significantly different from zero. To perform the test, the correlation coefficient is first calculated. The correlation coefficient is then used to calculate the t-statistic, which is then compared to a critical value for $t_{1-\alpha/2}$ at a specified significance level (usually 95%) to determine whether there is a significant correlation between the two variables (in this case, an analyte's concentration versus time). Historical and current data sets will be combined to perform the trend analysis taking care to ensure that the data sets are comparable. Any adjustment to monitoring frequency will be documented in an annual monitoring report and require concurrence of the USAF and NMED.

If the calculated t is greater than the critical value as obtained from a table of statistical t-values, then the null hypothesis is rejected, and it can be concluded that there is no significant positive or negative statistical trend in the data. Conversely, if the calculated t is less than the critical value, then the null hypothesis is not rejected, and it can be concluded that there is a significant positive or negative statistical trend in the data.

2.8 QAPP WORKSHEET #12 – MEASUREMENT PERFORMANCE CRITERIA

Measurement performance criteria were established for soil and groundwater analytical parameters of the project. Additional information pertaining to measurement performance criteria can be found in the following worksheets:

- Worksheet #15 (Project Action Limits and Laboratory-Specific Detection/Quantitation Limits) for limits of quantitation and limits of detection;
- Worksheet #24 (Analytical Instrument Calibration) and Worksheet #28 (Analytical Quality Control and Corrective Action) for the requirements of laboratory Quality Assurance/Quality Control (QA/QC) activities for both soil and groundwater analytical methods;
- Worksheet #36 (Data Validation Procedures) for data review and validation requirements; and
- Worksheet #37 (Data Usability Assessment) for precision, accuracy, representativeness, comparability, completeness, and sensitivity (commonly referred to as precision, accuracy, representativeness, comparability, completeness, and sensitivity [PARCCS] parameters).

The quality of the data to be collected for this project will be verified using appropriate criteria established for both sampling procedures and analytical methods. The criteria will relate to the data quality indicators. The sampling procedures and the quality of the laboratory results will be evaluated for compliance with the project-specific data quality objectives through a review of overall PARCCS parameters, in accordance with the procedures outlined in Worksheet #37. The results will be summarized in the appropriate report wherein the analytical data are being evaluated.

Table 12-1. Measurement Performance Criteria

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Field Duplicate	All	1 duplicate per 10 field samples	Precision	If one or both results are ≤ 5 times the reporting limit, then the absolute difference between the results should agree within ± 2 times the reporting limit for waters, ± 3 times for soils. If both results are >5 times the reporting limit, then the relative percent difference should be ≤ 30% for waters, ≤ 50% for soils.	S & A
Equipment Blanks	All	1 per 10 field samples	Accuracy/Bias	No target analytes above half the LOQ	S & A
Field Blanks	All	1 per 10 field samples	Accuracy/Bias	No target analytes above half the LOQ	S & A
Trip Blanks	VOCs	1 per sampling cooler	Accuracy/Bias	No target analytes above half the LOQ	S[a] & A

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
MS/MSD	All	1 per 10 field samples	Accuracy/Bias/Precision	Laboratory % Recovery / RPD Control Limits Matrix interference Check Sample within established control limits	S & A
LCS	All	1 per 10 field samples	Accuracy/Bias	Laboratory % Recovery Control Limits	A

[a] Sample Handling Error

% – percent
LCS – laboratory control sample
LOQ – limit of quantitation
MS/MSD – matrix spike/matrix spike duplicate
RPD – relative percent difference
VOCs – volatile organic compounds

2.9 QAPP WORKSHEET #13 – SECONDARY DATA USES AND LIMITATIONS

Secondary data refer to historical data previously collected. The source(s) of the data, date of collection (if known), planned used, and limitations of the secondary data to support the evaluation of the landfill sites are summarized in the following table.

Table 13-1. Secondary Data Uses and Limitations

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
Historical groundwater monitoring data	ERPIMS, USGS, and historical reports; various dates	Oracle database, historical annual reports, and communication/notifications; various dates	Will be used to determine the historical constituent concentrations for Kirtland AFB groundwater and soil sites over time at applicable locations	Older data had a higher laboratory detection level and URS cannot verify that other organizations collected their samples in accordance with USAF procedures.
ERPIMS – Environmental Restoration Program Information Management System USAF – U.S. Air Force USGS – U.S. Geological Survey				

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2.10 QAPP WORKSHEETS #14 & #16 – PROJECT TASKS & SCHEDULE

The following tasks will be completed at Landfill Sites LF-001, LF-002, and LF-008 as follows:

Groundwater Related Tasks

- Annual groundwater sampling shall be performed at the 20 wells for the full suite of analyses
- Quarterly well-gauging will occur at the 20 wells
- Laboratory analysis of the groundwater samples shall be performed within the specified hold times for the analyses and data validation shall be performed within 45 days following completion of sample collection

Landfill Cover Management Related Tasks

- Landfill covers will be inspected on a monthly basis
- An Operations and Maintenance Work Plan for landfill cover improvements will be written to outline proposed design modifications aimed at addressing observed erosion issues
- Accepted design modifications will be implemented and an Operation and Maintenance Report will be prepared to document the results observed after completion of the design modifications

Reporting and Documentation

- A Long-Term Monitoring report will be prepared on an annual basis subsequent to report on completion of all groundwater monitoring tasks for a given year, sample analysis, and data validation; this report will also discuss landfill inspection findings and corresponding cover maintenance activities

2.10.1 Groundwater Sampling

Groundwater samples will be collected by URS field staff on an annual basis from the groundwater monitoring wells installed at the Site. Analytical suites are defined in Worksheet #18. Sample collection will follow SOPs defined in Worksheet #21.

Groundwater monitoring will be performed using conventional sampling methods. A portable submersible pump will be used with the pump intake set at or near the bottom of the screened interval. The maximum purge rate will not exceed 12 liters per minute. The monitoring wells shall be purged a minimum of one borehole volume. Prior to the collection of groundwater samples, purging shall continue beyond one well borehole volume until at least four stable field screening measurements (less than 10 percent (%) variability) are obtained for turbidity, pH, temperature, and specific conductivity. In addition to these parameters, the purge water shall be field screened for dissolved oxygen and redox potential. Stabilization parameters shall be measured at a minimum of 5 minute intervals. If parameters have not stabilized after four purge volumes have been removed from the well, a note shall be made in the field logbook, parameters recorded, and analytical samples collected. If a monitoring well is purged dry prior to meeting the above stability requirements, then sampling shall be conducted once the well has recovered such that the volume of water available in the well is the minimum necessary to collect the required water samples.

2.10.2 Laboratory Analysis

All laboratory analyses shall be performed by an off-Site accredited laboratory. The laboratory is required to hold a current DoD Environmental Laboratory Accreditation Program certification for all required methods. The laboratory analyses will be performed in accordance with the prescribed analytical methods and this QAPP. Analytical data validation will be completed in accordance with the requirements defined in Worksheet #36, complied with the DoD QSM Version 4.2.

2.10.3 Data Management, Review, and Evaluation

2.10.3.1 Data Management

Field activities will be recorded in project logbooks and on the applicable standard field forms. Site maps will be maintained and sample locations will be updated on the maps as necessary. Field and analytical data will be consolidated and maintained within an electronic database system. An SOP describing data management procedures is provided in Appendix A.

2.10.3.2 Data Review

A three-step data review process consisting of verification, validation, and usability assessment will be used to examine the collected data so that only scientifically-sound data of known and documented quality are used in making environmental decisions. Worksheets #34 through #37 describe the process and criteria in detail.

Analytical data obtained during the project will be validated by a qualified URS chemist according to the specifications provided in Worksheet #36. Full documentation of the data validation process and the results will be provided in the reports described above.

Validated data will be uploaded by URS to ERPIMS.

2.10.3.3 Data Evaluation

Field data will be compiled from field logbooks and presented in tables listing the sampling details, field observations, and field parameter measurements. Field data will be used to further refine the understanding of conditions at the site, as appropriate.

The validated data will be used to support statistical analyses, as needed. These statistical analyses will be used to evaluate data trends and determine future monitoring requirements. The results will be provided in the LTM reports.

2.10.4 Reporting Requirements

Key deliverables for this project include the following:

- Annual LTM Reports, which will include groundwater monitoring results and landfill cover inspection and maintenance activities
- Interim Corrective Measures Completion Report, upon completion of all field remediation activities

Draft documents will be prepared for internal review by AFCEC and Kirtland AFB. Final documents will be prepared for review by NMED. The review comments will be addressed and incorporated, where applicable.

This worksheet presents the anticipated schedule for this project, which shows the timeframes for the major activities and deliverables, as well as the individual tasks and their relationships. The schedule has been structured to achieve efficiency during project execution. In some cases, significant changes in the schedule structure may be required if the planning assumptions are inconsistent with actual project requirements.

Table 14-1. Project Schedule

Milestone Tasks	Completion Date
Review Existing Documentation and Develop OES Plan	
Deliver draft OES Plan for USAF review	May 8, 2014
USAF review of draft OES Plan	May 15, 2014
Deliver final OES Plan	May 23, 2014
Operations and Maintenance Work Plan for Landfill Cover Improvements	
Deliver draft O&M Work Plan for USAF review	September 15, 2014
USAF review of draft O&M Work Plan	December 8, 2014
Deliver draft final O&M Work Plan for NMED review	December 23, 2014
NMED review of draft final O&M Work Plan	August 4, 2015
Deliver final O&M Work Plan	September 29, 2015
Landfill Cover Improvements	
Construction Bonding	May 21, 2015
Mobilize for Field Activities	October 6, 2015
Complete Installation of Landfill Cover Improvements	January 8, 2016
Complete Revegetation of Impacted Areas	January 15, 2016
Demobilize from the field activities	January 19, 2016
Operations and Maintenance Report	
Deliver Draft Operations and Maintenance Report for USAF review	February 29, 2016
USAF review of Draft Operations and Maintenance Report	April 4, 2016
Deliver draft final Operations and Maintenance Report for NMED review	April 25, 2016
NMED review of draft final Operations and Maintenance Report	July 5, 2017
Deliver final Operations and Maintenance Report	August 30, 2017
Long-Term Monitoring Plan Including Landfill Inspection Requirements	
Deliver draft Long-Term Monitoring Plan for USAF review	August 27, 2014
USAF review of draft Long-Term Monitoring Plan	December 1, 2014
Deliver draft final Long-Term Monitoring Plan for NMED review	December 15, 2014
NMED review of draft final Long-Term Monitoring Plan	Jun 12, 2015
Deliver final Long-Term Monitoring Plan	August 7, 2015
Landfill Cover Inspections – Fiscal Year (FY) 2014	
Cover Inspection - May 2014	May 16, 2014
Cover Inspection - June 2014	June 20, 2014
Cover Maintenance Activities - 3rd Quarter FY 2014	May 30, 2014
Cover Inspection - July 2014	July 18, 2014

Milestone Tasks	Completion Date
Cover Inspection - August 2014	August 15, 2014
Cover Inspection - September 2014	September 19, 2014
Cover Maintenance Activities - 4th Quarter FY 2014	August 29, 2014
Groundwater Monitoring – FY 2014	
Groundwater Sampling and 3rd Quarter Well Gauging - FY 2014 Note: This was performed by the transition contractor as was the laboratory analyses.	April 21, 2014
Well Gauging - 4th Quarter FY 2014	July 15, 2014
Annual Long-Term Monitoring Report – FY 2014	
Deliver draft FY 2014 Long-Term Monitoring Report for USAF review	November 24, 2014
USAF review of draft FY 2014 Long-Term Monitoring Report	December 8, 2014
Deliver draft final FY 2014 Long-Term Monitoring Report for NMED review	December 29, 2015
NMED Review of draft final FY 2014 Long-Term Monitoring Report	June 15, 2015
Deliver final FY 2014 Long-Term Monitoring Report	August 10, 2015
Landfill Cover Inspections – FY 2015	
Cover Inspection Every Month From October 2014 Through September 2015	Monthly in FY 2015
Cover Maintenance Activities - 1st Quarter FY 2015	November 28, 2014
Cover Maintenance Activities – 2nd Quarter FY 2015	March 6, 2015
Cover Maintenance Activities – 3rd Quarter FY 2015	May 29, 2015
Cover Maintenance Activities – 4th Quarter FY 2015	August 28, 2015
Groundwater Monitoring – FY 2015	
Complete 1st Quarter Well Gauging - FY 2015	October 15, 2014
Complete 2nd Quarter Well Gauging - FY 2015	January 15, 2015
Complete Groundwater Sampling and 3rd Quarter Well Gauging - FY 2015	April 20, 2015
Complete 4th Quarter Well Gauging - FY 2015	July 14, 2015
Annual Long-Term Monitoring Report – FY 2015	
Deliver draft FY 2015 Long-Term Monitoring Report for USAF review	November 11, 2015
USAF review of draft FY 2015 Long-Term Monitoring Report	December 16, 2015
Deliver draft final FY 2015 Long-Term Monitoring Report for NMED review	January 6, 2016
NMED Review of draft final FY 2015 Long-Term Monitoring Report	June 22, 2016
Deliver final FY 2015 Long-Term Monitoring Report	August 17, 2016
Landfill Cover Inspections – FY 2016	
Cover Inspection Every Month From October 2015 Through September 2016	Monthly in FY 2016
Cover Maintenance Activities - 1st Quarter FY 2016	December 4, 2015
Cover Maintenance Activities – 2nd Quarter FY 2016	March 4, 2016
Cover Maintenance Activities – 3rd Quarter FY 2016	June 3, 2016
Cover Maintenance Activities – 4th Quarter FY 2016	August 26, 2016
Groundwater Monitoring – FY 2016	
Complete 1st Quarter Well Gauging - FY 2016	October 13, 2015
Complete 2nd Quarter Well Gauging - FY 2016	January 13, 2016
Complete Groundwater Sampling and 3rd Quarter Well Gauging - FY 2016	April 18, 2016
Complete 4th Quarter Well Gauging - FY 2016	July 12, 2016
Annual Long-Term Monitoring Report – FY 2016	
Deliver draft FY 2016 Long-Term Monitoring Report for USAF review	November 9, 2016
USAF review of draft FY 2016 Long-Term Monitoring Report	December 14, 2016
Deliver draft final FY 2016 Long-Term Monitoring Report for NMED review	January 4, 2017

Milestone Tasks	Completion Date
NMED Review of draft final FY 2016 Long-Term Monitoring Report	June 21, 2017
Deliver final FY 2016 Long-Term Monitoring Report	August 16, 2017
Landfill Cover Inspections – FY 2017	
Cover Inspection Every Month From October 2016 Through September 2017	Monthly in FY 2017
Cover Maintenance Activities - 1st Quarter FY 2017	November 25, 2016
Cover Maintenance Activities – 2nd Quarter FY 2017	March 3, 2017
Cover Maintenance Activities – 3rd Quarter FY 2017	June 2, 2017
Cover Maintenance Activities – 4th Quarter FY 2017	September 1, 2017
Groundwater Monitoring – FY 2017	
Complete 1st Quarter Well Gauging - FY 2017	October 12, 2016
Complete 2nd Quarter Well Gauging - FY 2017	January 12, 2017
Complete Groundwater Sampling and 3rd Quarter Well Gauging - FY 2017	April 17, 2017
Complete 4th Quarter Well Gauging - FY 2017	July 11, 2017
Annual Long-Term Monitoring Report – FY 2017	
Deliver draft FY 2017 Long-Term Monitoring Report for USAF review	November 8, 2017
USAF review of draft FY 2017 Long-Term Monitoring Report	December 13, 2017
Deliver draft final FY 2017 Long-Term Monitoring Report for NMED review	January 3, 2018
NMED review of draft final FY 2017 Long-Term Monitoring Report	June 20, 2018
Deliver final FY 2017 Long-Term Monitoring Report	August 15, 2018
Update Long-Term Monitoring Plan Including Landfill Inspection Requirements	
Deliver draft Updated Long-Term Monitoring Plan for USAF review	February 1, 2017
USAF review of draft Updated Long-Term Monitoring Plan	March 8, 2017
Deliver draft final Updated Long-Term Monitoring Plan for NMED review	March 29, 2017
NMED review of draft final Updated Long-Term Monitoring Plan	October 13, 2017
Deliver final Updated Long-Term Monitoring Plan	December 8, 2017
Landfill Cover Inspections – FY 2018	
Cover Inspections	Quarterly in FY 2018
Cover Maintenance Activities - 1st Quarter FY 2018	December 1, 2017
Cover Maintenance Activities – 2nd Quarter FY 2018	March 2, 2018
Cover Maintenance Activities – 3rd Quarter FY 2018	June 1, 2018
Cover Maintenance Activities – 4th Quarter FY 2018	August 31, 2018
Annual Long-Term Monitoring Report – FY 2018	
Deliver draft FY 2018 Long-Term Monitoring Report for USAF review	November 7, 2018
USAF review of draft FY 2018 Long-Term Monitoring Report	December 12, 2018
Deliver draft final FY 2018 Long-Term Monitoring Report for NMED review	January 2, 2019
NMED Review of draft final FY 2018 Long-Term Monitoring Report	June 19, 2019
Deliver final FY 2018 Long-Term Monitoring Report	August 14, 2019
Landfill Cover Inspections – FY 2019	
Cover Inspections	Quarterly in FY 2019
Cover Maintenance Activities - 1st Quarter FY 2019	November 30, 2018
Cover Maintenance Activities – 2nd Quarter FY 2019	March 1, 2019
Cover Maintenance Activities – 3rd Quarter FY 2019	May 31, 2019
Cover Maintenance Activities – 4th Quarter FY 2019	August 30, 2019
Groundwater Monitoring – FY 2019	
Complete Groundwater Sampling and Well Gauging – FY 2019	April 22, 2019

Milestone Tasks	Completion Date
Annual Long-Term Monitoring Report – FY 2019	
Deliver draft FY 2019 Long-Term Monitoring Report for USAF review	November 11, 2019
USAF review of draft FY 2019 Long-Term Monitoring Report	December 16, 2019
Deliver draft final FY 2019 Long-Term Monitoring Report for NMED review	January 6, 2020
NMED Review of draft final FY 2019 Long-Term Monitoring Report	June 22, 2020
Deliver final FY 2019 Long-Term Monitoring Report	August 17, 2020
Landfill Cover Inspections – FY 2020	
Complete First Semi-Annual Cover Inspection – FY 2020	January 17, 2020
Cover Maintenance Activities – 1st Semi-Annual – FY 2020	January 31, 2020
Complete Second Semi-Annual Cover Inspection – FY 2020	July 10, 2020
Cover Maintenance Activities – 2nd Semi-Annual – FY 2020	July 24, 2020
Annual Long-Term Monitoring Report – FY 2020	
Deliver draft FY 2020 Long-Term Monitoring Report for USAF review	September 10, 2020
USAF review of draft FY 2020 Long-Term Monitoring Report	October 15, 2020
Deliver draft final FY 2020 Long-Term Monitoring Report for NMED review	November 5, 2020
NMED Review of draft final FY 2020 Long-Term Monitoring Report	April 22, 2021
Deliver final FY 2020 Long-Term Monitoring Report	June 17, 2021
Review Implemented Tasks and Develop Final OES Implementation Completion Report	
Submit draft Final OES Implementation Completion Report for USAF review	April 22, 2021
USAF review of draft Final OES Implementation Completion Report	May 27, 2021
Deliver Final OES Implementation Completion Report	June 17, 2021
Landfill Cover Inspections – FY 2021	
Complete First Semi-Annual Cover Inspection – FY 2021	January 15, 2021
Cover Maintenance Activities – 1st Semi-Annual – FY 2021	January 29, 2021
Complete Second Semi-Annual Cover Inspection – FY 2021	July 9, 2021
Cover Maintenance Activities – 2nd Semi-Annual – FY 2022	July 23, 2021
Groundwater Monitoring – FY 2021	
Complete Groundwater Sampling and Well Gauging – FY 2021	April 19, 2021
Annual Long-Term Monitoring Report – FY 2021	
Deliver draft FY 2021 Long-Term Monitoring Report for USAF review	September 15, 2021
USAF review of draft FY 2021 Long-Term Monitoring Report	October 20, 2021
Deliver draft final FY 2021 Long-Term Monitoring Report for NMED review	November 10, 2021
NMED Review of draft final FY 2021 Long-Term Monitoring Report	April 27, 2022
Deliver final FY 2021 Long-Term Monitoring Report	June 22, 2022
Updated Long-Term Monitoring Plan Including Landfill Inspection Requirements	
Deliver draft Updated Long-Term Monitoring Plan for USAF review	March 10, 2021
USAF review of draft Updated Long-Term Monitoring Plan	April 14, 2021
Deliver draft final Updated Long-Term Monitoring Plan for NMED review	May 5, 2021
NMED review of draft final Updated Long-Term Monitoring Plan	November 19, 2021
Deliver final Updated Long-Term Monitoring Plan	January 14, 2022
Landfill Cover Inspections – FY 2022	
Complete Annual Cover Inspection – FY 2022	April 8, 2022
Cover Maintenance Activities – FY 2022	April 22, 2022

Milestone Tasks	Completion Date
Annual Long-Term Monitoring Report – FY 2022	
Deliver draft FY 2022 Long-Term Monitoring Report for USAF review	June 15, 2022
USAF review of draft FY 2022 Long-Term Monitoring Report	July 20, 2022
Deliver draft final FY 2022 Long-Term Monitoring Report for NMED review	August 10, 2022
NMED Review of draft final FY 2022 Long-Term Monitoring Report	January 25, 2023
Deliver final FY 2022 Long-Term Monitoring Report	March 22, 2023
Landfill Cover Inspections – FY 2023	
Complete Annual Cover Inspection – FY 2023	April 7, 2023
Cover Maintenance Activities – FY 2023	April 21, 2023
Groundwater Monitoring – FY 2023	
Complete Groundwater Sampling and Well Gauging – FY 2023	March 20, 2023
Annual Long-Term Monitoring Report – FY 2023	
Deliver draft FY 2023 Long-Term Monitoring Report for USAF review	June 19, 2023
USAF review of draft FY 2023 Long-Term Monitoring Report	July 24, 2023
Review Implemented Tasks and Develop Final OES Effectiveness Report	
Deliver draft Final OES Effectiveness Report for USAF review	June 12, 2023
USAF review of draft Final OES Effectiveness Report	July 17, 2023
Deliver Final OES Effectiveness Report	August 7, 2023

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2.11 QAPP WORKSHEET #15 – PROJECT ACTION LIMITS AND LABORATORY-SPECIFIC DETECTION/QUANTITATION LIMITS

One of the primary goals of the project-specific QAPP is to select appropriate analytical methods to achieve the limits of detection (LODs) and/or limits of quantitation (LOQs) in order to satisfy the overall project DQOs. To determine whether the LOD and LOQ will meet the DQO requirements, the LODs and LOQs were compared to screening criteria as follows:

- **Groundwater:**
    - New Mexico Water Quality Commission Regulations (New Mexico Administrative Code [NMAC] 20.6.2)
    - Applicable federal standards include EPA MCLs as found in 40 CFR 141 and 40 CFR 142
    - New Mexico Ground Water Quality Bureau (GWQB) Voluntary Remediation Program limits for tapwater as found in the Technical Background Document for Development of Soil Screening Levels (NMED, 2006)
    - EPA Regional Screening Levels for Tapwater available online at http://www.epa.gov/reg3hwmd/risk/human/

If the LOQ is below the screening criterion, the LOD and/or the LOQ are sufficient for quantitative use in the risk assessment. The detection limit as defined in Worksheet #28 will be used if a target compound is detected at or above this concentration. The detection limit will be approximately two to three times lower than the LOD. The LOD will be used to evaluate project objectives in the event that the LOQ exceeds the screening criterion. In addition, chemical-specific factors (mobility and toxicity) may be discussed on a more qualitative basis.

Note that sample dilution because of target concentrations or matrix interferences may preclude LOQs from being achieved. All samples will be analyzed undiluted when reasonable. If dilution is required, both the original and diluted result will be reported. Any samples not analyzed undiluted will be reported with accompanying documentation describing why the dilution was not possible. Appropriate cleanup procedures will be followed by the laboratory to minimize matrix effects on the LOQ.

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Table 15-1. Water Reference Limits

Analyte	CAS Number	Project Action Limit (µg/L)	Project Action Limit Reference	Detection Goal (µg/L)	Laboratory Specific	
					LOQ (µg/L)	LOD (µg/L)
Volatile Organic Compounds – SW-846 Method 8260B						
1,1,1-Trichloroethane	71-55-6	60	NMAC	30	1	0.319
1,1,2,2-Tetrachloroethane	79-34-5	10	NMAC	5	1	0.585
1,1,2-Trichloroethane	79-00-5	5	MCL	2.5	1	0.383
1,2-Dichlorobenzene	95-50-1	600	MCL	300	1	0.349
1,3-Dichlorobenzene	541-73-1	—	—		1	0.220
1,4-Dichlorobenzene	106-46-7	75	MCL	37	1	0.274
1,1-Dichloroethane	75-34-3	1,220	GWQB	610	1	0.259
1,1-Dichloroethene	75-35-4	5	NMAC	2.5	1	0.398
1,2-Dichloroethane	107-06-2	5	MCL	2.5	1	0.361
1,2-Dichloropropane	78-87-5	5	MCL	2.5	1	0.306
2-Butanone	78-93-3	7,060	GWQB	3,540	10	3.93
4-Methyl-2-Pentanone	108-10-1	1,990	GWQB	990	10	2.14
Acetone	67-64-1	5,480	GWQB	2,740	50	10
Benzene	71-43-2	5	MCL	2.5	1	0.331
Bromodichloromethane	75-27-4	80	MCL	40	1	0.380
Bromoform	75-25-2	24.4	GWQB	12.2	1	0.469
Bromomethane	74-83-9	8.66	GWQB	4.33	5	0.866
Carbon tetrachloride	56-23-5	5	MCL	2.5	1	0.379
Chlorobenzene	108-90-7	100	MCL	50	1	0.348
Chloroethane	75-00-3	38.1	GWQB	19.0	5	0.453
Chloroform	67-66-3	100	NMAC	50	5	0.324
Chloromethane	74-87-3	14.9	GWQB	7.4	2.5	0.276
cis-1,2-Dichloroethene	156-59-2	70	MCL	35	1	0.260
cis-1,3-Dichloropropene	10061-01-5	—	—		1	0.418
Dibromochloromethane	124-48-1	80	MCL	40	1	0.327
Ethylbenzene	100-41-4	700	MCL	350	1	0.384
Methylene chloride	75-09-2	5	MCL	2.5	5	1
Styrene	100-42-5	100	MCL	50	1	0.307

Analyte	CAS Number	Project Action Limit (µg/L)	Project Action Limit Reference	Detection Goal (µg/L)	Laboratory Specific	
					LOQ (µg/L)	LOD (µg/L)
Tetrachloroethene	127-18-4	5	MCL	2.5	1	0.372
Toluene	108-88-3	750	NMAC	375	5	0.78
trans-1,2-Dichloroethene	156-60-5	100	MCL	50	1	0.396
trans-1,3-Dichloropropene	10061-02-6	—	—	—	1	0.419
Trichloroethene	79-01-6	5	MCL	2.5	1	0.398
Vinyl chloride	75-01-4	1	NMAC	0.5	1	0.259
Xylenes (total)	1330-20-7	620	NMAC	310	3	1.06
Metals – SW-846 Method 6010B						
Aluminum	7429-90-5	200	NSDWR	100	100	35
Antimony	7440-36-0	6	MCL	3	1	0.21
Arsenic	7440-38-2	10	MCL	5	1	0.25
Barium	7440-39-3	1,000	NMAC	500	5	1.7
Beryllium	7440-41-7	4	MCL	2	2	0.7
Boron	7440-42-8	3,100	RSL	1,500	200	12.6
Cadmium	7440-43-9	5	MCL	2.5	5	0.7
Calcium	7440-70-2	—	—	—	500	46.3
Chromium	7440-47-3	50	NMAC	25	10	1.4
Cobalt	7440-48-4	4.7	RSL	2.3	10	2.3
Copper	7440-50-8	1,000	NSDWR	500	20	5.3
Iron	7439-89-6	300	NSDWR	100	100	14.1
Lead	7439-92-1	15	MCL	7.5	5	1.9
Lithium	7439-92-2	—	—	—	15	5.3
Magnesium	7439-95-4	—	—	—	100	11.1
Manganese	7549-96-5	50	NSDWR	25	10	1.2
Nickel	7440-02-0	300	RSL	150	20	4.9
Potassium	7440-09-7	—	—	—	500	102.4
Selenium	7782-49-2	50	MCL	25	20	7.4
Silver	7440-22-4	50	NMAC	25	10	2.8
Sodium	7440-23-5	—	—	—	500	98.5
Thallium	7440-28-0	2	MCL	1	1	0.19
Vanadium	7440-62-2	63	RSL	31	10	2.4

Analyte	CAS Number	Project Action Limit (µg/L)	Project Action Limit Reference	Detection Goal (µg/L)	Laboratory Specific	
					LOQ (µg/L)	LOD (µg/L)
Zinc	7440-66-6	5,000	NSDWR	2,500	30	5.9
Anions – EPA Method 300.0						
Chloride	16887-00-6	250,000	MCL	125,000	1,000	51.9
Fluoride	16984-48-8	1,600	NMAC	800	100	9.9
Nitrate/Nitrite (Method 353.2)		10,000	MCL	5,000	100	23.0
Sulfate	14808-79-8	250,000	NSDWR	125,000	5,000	77.4
Miscellaneous Analyses (Methods Noted Below)						
Alkalinity - EPA SM 2320B	N/A	—	—	—	20,000	2,610
Total Dissolved Solids EPA Method 160.1	N/A	1,000,000	NMAC	500,000	10,000	2,820
Gross alpha (Method 900.0)	12587-46-1				MDA = 1 pCi/g	
Gross beta (Method 900.0)	12587-46-2				MDA = 1 pCi/g	
Radium -226/ -228 (Method 903.1/904.0)	7440-14-4/ 68308-34-9				MDA = 1 pCi/g	

— not established
CAS – Chemical Abstract Service
EPA – U.S. Environmental Protection Agency
GWQB – Ground Water Quality Bureau
LOD – limit of detection
LOQ – limit of quantitation
MCL – maximum contaminant level
NMAC – New Mexico Administrative Code
NMWQCC – New Mexico Water Quality Control Criteria
NSDWR – National Secondary Drinking Water Regulation
N/A – Not applicable
RSL – regional screening level for tapwater
SM – standard method
pCi/g – average picocuries per gram
µg/L – microgram per liter

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2.12 QAPP WORKSHEET #17 – SAMPLING DESIGN AND RATIONALE

This worksheet describes the field investigation activities planned for the groundwater monitoring of wells in the vicinity of the landfill sites. The field activities will be conducted in accordance with the field SOPs provided in Worksheet #21. The number of samples and the analytical parameters planned are summarized in Worksheet #18.

2.12.1 Quarterly Well Gauging

The 20 groundwater monitoring wells located at the three landfill sites, LF-001, LF-002, and LF-008, will be gauged on a quarterly basis to assess the hydraulic gradient and the horizontal groundwater flow across each site. The well gauging log will document the following:

- Date of gauging event
- Project name and location
- Field personnel performing the measurements
- Measuring devices used
- Calibration of measuring devices For each well record:
    - Time of measurement
    - Depth to groundwater
    - Depth to bottom of well
    - Observations (casing condition, well head condition, odor, color, sheen, silting, etc.)
- Activities that may influence water level (groundwater pumping, irrigation, etc.)
- Decontamination procedures

2.12.2 Annual Groundwater Monitoring

Groundwater samples will be collected by URS field staff from each of the 20 groundwater monitoring wells installed in the vicinity of LF-001, LF-002, and LF-008 in April of each year through 2017. (The frequency of monitoring may decrease to biennial in subsequent years.) Analytical suites are defined in Worksheet #18. Sample collection will follow SOPs defined in Worksheet #21.

Groundwater monitoring will be performed using conventional sampling methods. A portable submersible pump will be used with the pump intake set at or near the bottom of the screened interval. The maximum purge rate will not exceed 12 liters per minute. The monitoring wells shall be purged a minimum of one borehole volume. Prior to the collection of groundwater samples, purging shall continue beyond one well borehole volume until at least four stable field screening measurements (less than 10 percent variability) are obtained for turbidity, pH, temperature, and specific conductivity. In addition to these parameters, the purge water shall be field screened for dissolved oxygen and redox potential. Stabilization parameters shall be measured at a minimum of 5 minute intervals. If parameters have not stabilized after four purge volumes have been removed from the well, a note shall be made in the field logbook, parameters recorded, and analytical samples collected. If a monitoring well is purged dry prior to meeting the above stability requirements, then sampling shall be conducted once the well has recovered such that the volume of water available in the well is the minimum necessary to collect the required water samples. Following purging, the groundwater samples shall be collected and analyzed for the parameters defined in Worksheet #18.

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2.13 QAPP WORKSHEET #18 – SAMPLING LOCATIONS AND METHODS

This worksheet lists the sampling locations and methods to be used for collecting the analytical samples in support of groundwater monitoring at LF-001, LF-002, and LF-008. Individual worksheets will be developed prior to each sampling event listing the sampling identification numbers, matrix to be sampled, proposed sampling depth, type of sample, analyses required, and sampling SOP. The purpose of the individual worksheets is to serve as a completeness check for field personnel. They will facilitate verification that all planned samples have been collected, including field QC samples.

Table 18-1. Sampling Locations and Methods

Sampling Location	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	SOP
KAFB-0118 KAFB-0119 KAFB-0120 KAFB-0121 KAFB-0213 KAFB-0219 KAFB-0220 KAFB-0221 KAFB-0222 KAFB-0223 KAFB-0307 KAFB-0308 KAFB-0309 KAFB-0310 KAFB-0311 KAFB-0312 KAFB-0313 KAFB-0314 KAFB-0315 TJA-2	Groundwater	TBD	VOCs Nitrate/ Nitrite Alkalinity (LF-008 only) Metals (Total and Dissolved) Chloride, fluoride and sulfate Total Dissolved Solids Gross alpha and beta Radium -226, -228	1 water sample per well 1 field blank per 10 samples 1 equipment blank per 10 samples 1 field duplicate per 10 samples 1 matrix spike/matrix spike duplicate per 10 samples 1 trip blank per VOC shipping cooler	SOP -15, Groundwater Purging and Sampling
SOP – standard operating procedure TBD – to-be-determined VOC – volatile organic compound ft-bgs – feet below ground surface					

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2.14 QAPP WORKSHEETS #19 & #30 – SAMPLE CONTAINERS, PRESERVATION, AND HOLD TIMES

This worksheet summarizes the analytical methods for each sampling matrix, including the required sample volume, containers, preservation, and holding time requirements.

Table 19-1. Sample Containers, Preservation, and Hold Times

Matrix/ Laboratory	Analysis	Analytical and Preparation Method	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time (preparation/analysis)
Groundwater	VOCs	SW-846 Method 8260B	Three 40 mL Teflon lined septa cap volatile organic analysis vials	3 x 40 mL	HCl to pH<2 Cool to maintain temperature of 4±2°C	14 days
	Metals (total and dissolved)*	SW-846 Method 6010B	One 250-mL polyethylene bottle	125 mL	HNO_3 to pH<2 Cool to maintain temperature of 4±2°C	6 months
	Nitrate/Nitrite	EPA Method 353.2	One 250-mL polyethylene bottle	250 mL	H_2SO_4 to pH<2 Cool to maintain temperature of 4±2°C	28 days
	Alkalinity	EPA SM 2320B	One 500-mL polyethylene bottle	500 mL	Cool to maintain temperature of 4±2°C	14 days
	Chloride, fluoride, & sulfates	EPA Method 300.0	One 125-mL polyethylene bottle	125 mL	Cool to maintain temperature of 4±2°C	28 days
	Total Dissolved Solids	EPA Method 160.1	One 250-mL polyethylene bottle	250 mL	Cool to maintain temperature of 4±2°C	7 days
	Gross alpha/beta	EPA Method 900.0	Two 1-liter polyethylene bottles	2 x 1L	HNO_3 to pH<2	6 months
	Radium-226	EPA Method 903.0	One 1-L polyethylene bottle	1 L	HNO3 to pH<2	6 months
	Radium-228	EPA Method 904.0	One 1-L polyethylene bottle	1 L	HNO3 to pH<2	6 months

Matrix/ Laboratory	Analysis	Analytical and Preparation Method	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time (preparation/analysis)

[1] – Samples analyzed for dissolved metals will be filtered in the field through a 0.45 µm membrane filter.

°C – degrees Celsius
EPA – U.S. Environmental Protection Agency
HCL – hydrochloric acid
HNO_3 – nitric acid
H_sSO_4 – sulfuric acid
L - liter
mL - milliliter
oz - ounce
SM – standard method
VOC – volatile organic compound

2.15 QAPP WORKSHEET #20 – FIELD QUALITY CONTROL SAMPLE SUMMARY

This worksheet summarizes the field QC samples to be collected from the site. The number of field QC samples for each sampling matrix and analytical parameter is provided in Worksheet #18.

2.15.1 Field Duplicate

A field duplicate is an additional sample collected at the same time from the same location as the normal sample. The field duplicate is intended to represent the same population and is taken through all of the steps of the analytical process in an identical manner to the normal sample. It is used to assess precision of the entire data collection activity, including sampling, analysis, and site heterogeneity.

Duplicate samples are collected simultaneously with or in immediate succession to the normal sample, using identical sampling techniques, and are treated in an identical manner during storage, transportation, and analysis. The samples may be either co-located samples or sub samples of a single sample collection. The sample container is assigned a unique identification number in the field. Specific locations will be designated for collection of field duplicate samples prior to sample collection.

2.15.2 Field Blank

A field blank is a clean, analyte-free sample which is carried to the sampling site and then exposed to sampling conditions. The field blank is intended to provide information about contaminants that may be introduced during the sample collection, storage, and transportation of field samples. The sample container is assigned a unique identification number in the field.

2.15.3 Equipment Blank

An equipment blank, sometimes referred to as a rinsate blank, is a sample of analyte-free water poured over or through decontaminated field sampling equipment prior to the collection of environmental samples. It is used to assess the adequacy of the decontamination process in terms of contamination from the total sampling process when decontaminated sampling equipment is used to collect samples. The sample container is assigned a unique identification number in the field.

2.15.4 Trip Blank

A trip blank is a clean sample of a matrix that is taken from the laboratory to the sampling site and transported back to the laboratory without having been exposed to sampling procedures. Typically, a trip blank is required only if samples are being collected for VOC analyses. It is used to assess contamination introduced during shipping and field handling procedures. The sample container is assigned a unique identification number.

2.15.5 Matrix Spike/Matrix Spike Duplicate

A matrix spike/matrix spike duplicate sample is an aliquot of sample spiked with a known mass and concentration of specific analytes. The spiking occurs prior to sample preparation and analysis at the laboratory. To allow the analytical laboratory to run Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses, additional sample volumes will be collected in the field to provide sufficient sample material for the laboratory to perform the additional analyses. The sample container is assigned a unique identification number in the field to denote that the sample is intended for use by the laboratory for the MS/MSD analyses.

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2.16 QAPP WORKSHEET #21 – FIELD STANDARD OPERATING PROCEDURES

The field SOPs associated with the project sampling are listed in the following table. The referenced field SOPs are provided in Appendix A.

Table 21-1. Project Sampling Standard Operating Procedure References

Reference Number	Title	Originating Organization	Equipment Type	Modified for Project Work?
SOP-1	Use and Maintenance of Field Log Books	URS	Not Applicable	No
SOP-13	Static Water Level and Total Depth Measurement	URS	Water Level Indicator	No
SOP-15	Groundwater Purging and Sampling	URS	Variable-rate, submersible pump/hose assembly with control unit; deionized water containers; sample containers and applicable preservative	No
SOP-16	Water Quality Measurements Using a Multiple Parameter Water Quality Meter	URS	Water quality meter	No
SOP-20	Decontamination	URS	All equipment that comes in contact with potentially contaminated media (i.e., surficial soils, vadose zone soils, groundwater)	No
SOP-23	Sample Handling, Shipping and Documentation	URS	Shipping coolers; ice; shipping forms	No
SOP-26	Chain-of-Custody	URS	Chain-of-custody forms	No
SOP-49	Investigation Derived Waste Management	URS	Purge water containers; 55-gallon drums	No
SOP – standard operating procedure URS – URS Group, Inc.				

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2.17 QAPP WORKSHEET #22 – FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

This worksheet lists the field equipment and instruments to be used during the field investigation that require calibration, maintenance, testing, or inspection.

Table 22-1. Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Calibration Activity	Calibration Frequency[a]	Maintenance and Inspection Activity	Testing Activity	Acceptance Criterion	Corrective Action	Responsible Person	SOP Reference
Temperature Meter (YSI 556)	Verification	Daily	Perform maintenance as per the manufacturer's instructions	Measures temperature	± 1 ºC	If the meter fails to calibrate, do not use.	Field Team Leader	SOP-16 (Appendix A)
pH Meter (YSI 556)	Calibration	Daily	Perform maintenance as per the manufacturer's instructions	Measures pH	± 0.2 unit	If the meter fails to calibrate, do not use.	Field Team Leader	SOP-16 (Appendix A)
Conductivity Meter (YSI 556)	Calibration	Daily	Perform maintenance as per the manufacturer's instructions	Measures conductance	± 5% of full scale	If the meter fails to calibrate, do not use.	Field Team Leader	SOP-16 (Appendix A)
ORP Meter (YSI 556)	Calibration	Daily	Perform maintenance as per the manufacturer's instructions	Measures oxidation-reduction potential	± 20 millivolt	If the meter fails to calibrate, do not use.	Field Team Leader	SOP-16 (Appendix A)
Dissolved Oxygen Meter (YSI 556)	Calibration	Daily	Perform maintenance as per the manufacturer's instructions	Measures dissolved oxygen	± 10%	If the meter fails to calibrate, do not use.	Field Team Leader	SOP-16 (Appendix A)
Turbidity Meter	Calibration	Daily	Perform maintenance as per the manufacturer's instructions	Measures turbidity	± 10%	If the meter fails to calibrate, do not use.	Field Team Leader	SOP-16 (Appendix A)
Water Level Indicator	Calibration	Annually	Perform maintenance as per the manufacturer's instructions	Measures depth to liquid and total well depth	± 0.1 ft	If the meter fails to calibrate, do not use.	Field Team Leader	SOP-13 (Appendix A)

[a] If difficult field conditions are present (e.g., heavily silted groundwater or contamination), meters will be re-calibrated more frequently.

°C – degrees Celsius
ft - foot
ORP – oxidation-reduction potential
SOP – standard operating procedure
% - percent

2.18 QAPP WORKSHEET #23 – ANALYTICAL STANDARD OPERATING PROCEDURES

ESC Lab Sciences and TestAmerica, Inc. are contracted to perform sample analysis. The laboratory SOPs have not been modified specifically for this project.Laboratory SOPs are available upon request. Note that the analytical laboratory may change for future sampling events. In the event that the laboratory changes, a QAPP addendum will be submitted that includes all required laboratory-specific information and regulatory agencies will be notified.

Table 23-1. Analytical Standard Operating Procedures

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Yes/No)
Groundwater Samples						
330363	Volatile Organics by GC/MS (SW-846 Method 8260B)	Definitive	Water - VOCs	GC/MS	ESC	No
340319	Determination of Inorganic Anions by Ion Chromatography (EPA Method 300.0)	Definitive	Water – Anions	Ion Chromatography	ESC	No
340333	Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry (EPA Method 353.2)	Definitive	Water – Nitrate/Nitrite	Colorimeter	ESC	No
340386/340390	Inductively Coupled Plasma-Atomic Emission or Mass Spectrometry (EPA Method 6010B/6020)	Definitive	Water – Metals	ICP/AE/MS	ESC	No
RL-GPC-001	Gross Alpha and Gross Beta Radioactivity in Drinking Water (EPA Method 900.0)	Definitive	Water – Gross alpha/beta	Gas-Flow Proportional Counting	TestAmerica	No
RL-RA-001	Radium-226 and Radium-228 Separation in Radiochemical Matrices (EPA Method 903.1 and 904.0)	Definitive	Water – Radium-226 and Radium-228	Gas-Flow Proportional Counting	TestAmerica	No
RL-RA-002	Determination of Total Radium	Definitive	Water – Radium-226 and Radium-228	Gas-Flow Proportional Counting	TestAmerica	No
340301	Carbonate, Bicarbonate, and Total Alkalinity (EPA SM 2320B)	Definitive	Water – Alkalinity	Titration	ESC	No
340347	Total Dissolved Solids (EPA Method 160.1)	Definitive	Water – Total Dissolved Solids	Gravimetric	ESC	No

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Yes/No)
AE – atomic emission EPA – U.S. Environmental Protection Agency ESC – ESC Lab Sciences ICP – inductively-coupled plasma MS – mass spectrometry SM – standard method VOC – volatile organic compound						

2.19 QAPP WORKSHEET #24 – ANALYTICAL INSTRUMENT CALIBRATION

To confirm that the analytical methods and the selected instrumentation meet the project requirements, each analytical instrument will be calibrated according to the procedures outlined in Worksheet #23.

Table 24-1. Analytical Instrument Calibration Requirements

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person	SOP[1]
Hewlett Packard 5890	VOCs by SW-846 Method 8260B	Tune	Tune: Bromofluorobenzene tune shall be performed every 12 hours. Intensities of the characteristic ions shall comply with the method specifications. The relative intensities of the characteristic ions are within 30% of hose ions in the reference spectrum. All ions >10% intensity must be ±20% of standard; ± 0.06 relative response time units of standard relative response times.	Adjust the instrument and/or perform instrument maintenance and re-analyze the calibration standards. Commonly performed maintenance includes baking traps and columns, polishing detector windows, changing injection port liners, changing pump oil, etc. After successful corrective action, reanalyze all samples since the last successful calibration verification.	Laboratory Analyst	330363
		Initial calibration	Initial: <30% RSD for calibration check compounds and <15% RSD for all other compounds; response factors for system performance check compounds = 0.300 (chlorobenzene and 1,1,2,2-tetrachloroethane), = 0.100 (chloromethane and 1,1-dichloroethane), >0.10 (bromoform)			
		Continuing calibration	Continuing: system performance check compounds same as above; calibration check compounds <30% RSD			

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person	SOP[1]
Dionex Models ICS 1500 ICS 2000 ICS 2100 Metrohm Model 850 Professional	Anions by EPA Method 300.0 Anions by SW-846 Method 9056A	Initial calibration Continuing calibration	Initial: Correlation coefficient of ≥ 0.995 Continuing: ±10% for Method 300.0 ± 5% for Method 9056A	If standard curve linearity is not acceptable, check the standard and re-analyze the standards once. If the failure persists, prepare new standards, recheck intermediate dilutions and recalibrate the instrument. If the reference check sample is out of control, the instrument is recalibrated and check sample reanalyzed. If problem persists, the group supervisor or QA department is notified for further action. After successful corrective action, reanalyze all samples since the last successful calibration verification.	Laboratory Analyst	340319
Lachat Models Quickchem 8000 Quickchem 8500	Nitrate/Nitrite by EPA Method 353.2	Initial calibration Continuing calibration	Initial: Correlation coefficient of ≥ 0.995 Continuing: ±10%	If standard curve linearity is not acceptable, check the standard and re-analyze the standards once. If the failure persists, prepare new standards, recheck intermediate dilutions and recalibrate the instrument. If the reference check sample is out of control, the instrument is recalibrated and check sample reanalyzed. If problem persists, the group supervisor or QA department is notified for further action. After successful corrective action, reanalyze all samples since the last successful calibration verification.	Laboratory Analyst	340333
Perkin Elmer 4300 DV ICP Perkin Elmer 5300 DV ICP	Metals by SW-846 Method 6010B/6020	Initial calibration Continuing calibration	Initial: Correlation coefficient of ≥ 0.995 Continuing: ± 10%	Recalibrate the instrument, replace the tubing of the peristaltic pump, examine the standards for degradation, or perform instrument maintenance. After successful corrective action, reanalyze all samples since the last successful calibration verification.	Laboratory Analyst	340386 340390
Fisher Model AB15 Orion Model 410A	Carbonate, Bicarbonate, and Total Alkalinity by EPA Method 160.1	Initial calibration Continuing calibration	Initial: ± 0.05 units Continuing: ± 0.05 units	If calibration check is outside of control limits, the instrument will be recalibrated. After successful corrective action, reanalyze all samples since the last successful calibration verification.	Laboratory Analyst	340301

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person	SOP[1]
Gas-Flow Proportional Counter	Gross Alpha/Gross Beta by EPA Method 900.0	Initial calibration Continuing calibration	Initial: Plateau slope <5% over a range of 100V. A 1-sigma counting uncertainty of ≤1% shall be achieved for all detector efficiency determinations. Verify cross-talk factors meet manufacturer's specifications. Verify the self-absorption curve meets established criteria. Verify that the efficiency calibration verification meets control limits. Continuing: Verify the criteria are within the control chart limits.	Correct the problem and repeat the affected calibration measurements. After successful corrective action, reanalyze all samples since the last successful calibration verification.	Technical Director	RL-CI-001
Gas-Flow Proportional Counter	Radium-226 and Radium-228 by EPA Methods 903.1 and 904.0, respectively	Initial calibration Continuing calibration	Initial: Plateau slope <5% over a range of 100V. A 1-sigma counting uncertainty of ≤1% shall be achieved for all detector efficiency determinations. Verify cross-talk factors meet manufacturer's specifications. Verify the self-absorption curve meets established criteria. Verify that the efficiency calibration verification meets control limits. Continuing: Verify the criteria are within the control chart limits.	Correct the problem and repeat the affected calibration measurements. After successful corrective action, reanalyze all samples since the last successful calibration verification.	Technical Director	RL-CI-001

EPA – U.S. Environmental Protection Agency
RSD – relative standard deviation
SM – standard method
VOC – volatile organic compound

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2.20 QAPP WORKSHEET #25 – ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION

To confirm that the analytical instruments and equipment are available and in working order when needed, all laboratory analytical equipment will be maintained and tested in accordance with procedures described in the laboratory SOPs, available upon request. For laboratory requirements regarding analytical instrumentation maintenance, testing, and inspections refer to the ESC Lab Sciences Quality Assurance Manual provided in Appendix B or the TestAmerica Quality Assurance Manual provided in Appendix C.

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2.21 QAPP WORKSHEETS #26 & #27 – SAMPLE HANDLING, CUSTODY, AND DISPOSAL

To verify sample authenticity and data defensibility, a proper sample handling, custody, and disposal process will be followed from the time of sample collection to final sample disposal.

The Field Team Leader (FTL) or designee will be responsible for the sample collection, sample packing, and coordination of sample shipment. Samples will be delivered to the analytical laboratory within 72 hours of collection. The sample packing and shipping procedures are outlined in SOP-23 provided in Appendix A.

A laboratory representative will acknowledge receipt of the sample shipping containers upon arrival. The laboratory analysts will prepare and analyze the field samples in accordance with the established analytical methods and laboratory SOPs. The field samples will be stored at the laboratory for a minimum of 30 days after a final report has been submitted to URS. The designated individual at the laboratory is responsible for final sample disposal will coordinate disposal activities with the URS Project Chemist.

Table 26-1. Sample Handling, Custody, and Disposal

Sample Collection, Packaging, and Shipment
Sample Collection: URS
Sample Packaging: URS
Coordination of Shipment: URS
Type of Shipment/Carrier: Insulated cooler/United Parcel Service or Federal Express
Sample Receipt And Analysis
Sample Receipt: ESC or TestAmerica
Sample Custody and Storage: ESC or TestAmerica
Sample Preparation: ESC or TestAmerica
Sample Determinative Analysis: ESC or TestAmerica
Sample Archiving
Field Sample Storage: At a minimum 30 days, ESC or TestAmerica
Sample Extract/Digestate Storage: At a minimum 30 days, ESC or TestAmerica
Sample Disposal
Personnel/Organization: ESC or TestAmerica
Number of Days from Analysis: At a minimum 30 days, ESC or TestAmerica

ESC – ESC Lab Sciences
TestAmerica – TestAmerica, Inc.
URS – URS Group, Inc.

2.21.1 Field Sample Custody Procedures

Sample collection information including sample name and time will be recorded in the field logbook and field data sheets, as appropriate. The following subsections provide general guidelines for field documentation, sample containers, sample labeling, handling and custody, and packaging and shipping.

2.21.1.1 Field Documentation

Specific requirements on field documentation procedures are outlined in SOP-01 and SOP-23 provided in Appendix A. The FTL is responsible for ensuring that the field sampling team adheres to proper custody

and documentation procedures. Field logbooks, field forms, and chain-of-custody (CoC) forms will be the primary documentation mechanisms used to record and track information about each sample. Copies of the field logbooks and field forms will be retained in the project files. The field sampling team is responsible for the following field documentation activities:

- Keeping accurate written records of all onsite activities in the field logbooks and/or on the field forms
- Ensuring that all entries are legible, written in waterproof ink, and contain accurate and inclusive documentation of the field activities. This documentation must include field data and observations, any problems encountered, and actions taken to solve the problems
- Recording date and initial daily entries
- Noting errors or changes using a single line to cross out the entry, and dating and initialing the change

Field logbooks and field forms will be available for review during technical audits or at any other time for QC checks. This documentation will provide verification of sampling procedures. When photographs or videos are taken for visual documentation of a site or procedure, they will be numbered to correspond to the field logbook entries. If possible, a reference point such as a building or a sign will be included to assist in verifying the location of the photograph and providing an approximate scale. The date, time, site location, and site description will be documented in the field logbook as photographs are taken. Photography will be coordinated with the installation point of contact to adhere to the installation security requirements.

2.21.1.2 Sample Containers

Sample containers will be purchased pre-cleaned and treated according to the EPA specifications for the analytical methods. Sample containers will not be reused for any reason. Containers will be stored in clean areas to prevent exposure to fuels, solvents, or other contaminants. Amber glass bottles will be used for organic sampling to minimize the effects of ultraviolet light on compounds of interest.

2.21.1.3 Sample Labeling

All samples will be uniquely identified and labeled in the field at the time of collection to meet the following minimum expectations. A sample label will be affixed to each sample collected. Sample labels will identify the sample with the following information:

- Unique identification number
- Sample type
- Analytical method requested
- Sampler’s initials
- Date collected
- Time collected
- Preservation method used

2.21.1.4 Sample Naming Convention

Sample site designations will consist of an alpha-numeric code that identifies the sampling site, medium, location, and a sample date. The media type codes include SO for soil, GW for groundwater, VZ for vadose zone soil, and VA for vapor. The monitoring well name or soil location code (e.g., vadose zone sample depth) will be used for the specific location code. Sampling date will be noted by eight numbers in the DDMMYYYY format.

2.21.1.5 Sample Handling and Custody

Procedures to verify the custody and integrity of the samples will begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. The procedures for sample handling and custody are provided in SOP-23 and SOP-26 provided in Appendix A. Records concerning the custody and condition of the samples will be maintained in field and laboratory records.

The URS field personnel will maintain CoC records for all field and QC samples. A sample is defined as being under a person's custody if (a) it is in their possession, (b) it is in their view, after being in their possession; (c) it was in their possession and they locked it in a secure location; or (d) it is in a designated secure area.

The following sample information will be document on the CoC form:

- Unique sample identification
- Date and time of sample collection
- Source of sample (including name, location, and sample type)
- Designation of MS/MSD
- Preservative used
- Analyses required
- Pertinent field data (such as temperature) if required
- Serial numbers of custody seals and transportation containers (if used)
- Custody transfer signatures and dates and times of sample transfer from the field transporters, and to the laboratory
- Bill of lading or transporter tracking number (if applicable)

2.21.1.6 Sample Packing and Shipping

The procedures for sample packing and shipping are provided in SOP-23 in Appendix A. In order to meet sample holding times, samples collected in the field will be transported to the laboratory as quickly as possible. The samples will be packed on ice or chemical refrigerant to maintain the sample core temperature of 4 ± 2 °C during shipment. A temperature blank (a sample vial filled with tap water) will be included in every cooler requiring temperature control and used to determine the internal temperature in the cooler upon receipt at the laboratory.

2.21.2 Laboratory Sample Custody Procedures

A designated laboratory representative will accept the shipped samples and verify that the received samples match those on the CoC form. The condition, temperature, and appropriate preservation of the samples will be checked and documented on the CoC form or laboratory receiving record. The occurrence of any anomalies in the received samples and their resolution will be documented in the laboratory records. All sample information will be entered into a laboratory tracking system and unique analytical sample identifiers will be assigned in accordance with the documented laboratory procedures. The laboratory will review this information for accuracy.

Sampling holding time tracking begins at the time of sample collection. Holding times for analytical methods required for this project are specified in Worksheet #19. Subcontracted analyses will be documented with the CoC form. Procedures ensuring internal laboratory CoC will also be implemented and documented by the laboratory. Specific instructions concerning the analyses specified for each sample will be communicated to the analysts. Analytical batches will be created, and laboratory QC samples will be introduced into each batch.

Samples will be stored in limited-access, temperature-controlled areas. Refrigerators, coolers, and freezers will be monitored for temperature seven days a week. Acceptance criterion for the temperatures of the refrigerators and coolers is 4 ± 2°C. All of the cold storage areas will be monitored by thermometers that have been calibrated with a National Institute of Standards and Technology traceable thermometer. As indicated by the findings of the calibration, correction factors may be applied to each thermometer. Records regarding acceptance criteria will be maintained.

Samples will be stored after analysis until disposed. The samples will be disposed of in accordance with applicable federal, state, and local regulations. Disposal records will be maintained by the laboratory. The SOPs describing sample control and custody will be maintained by the laboratory.

2.22 QAPP WORKSHEET #28 – ANALYTICAL QUALITY CONTROL AND CORRECTIVE ACTION

This worksheet presents the analytical QC requirements relevant to analysis of environmental samples that will be followed by laboratories producing definitive data. The purpose of the laboratory QC activities is to produce data of known quality that satisfy the project-specific DQOs. Laboratory QC samples will follow method-specific requirements of the DoD QSM version 4.2 (DoD, 2010). Laboratory QC samples must be included in the analytical batch with the field samples. An analytical batch (sample delivery group) is a group of samples (not exceeding 20 environmental samples plus associated laboratory QC samples) similar in composition (matrix) that are extracted or digested at the same time and with the same lot of reagents and analyzed together as a group. The analytical batch also extends to cover samples that do not need separate extraction or digestion. The identity of each analytical batch will be unambiguously reported with the analyses so that a reviewer can identify the laboratory QC samples and the associated environmental samples. The type of laboratory QC samples and the frequency of use of these samples are discussed below and in method-specific laboratory SOPs.

2.22.1 Method Detection Limits

The method detection limit (MDL), as defined by 40 CFR 135 is the minimum concentration of a substance that can be measured and reported with 99 % confidence that the analyte concentration is greater than zero. The MDL will be considered the detection limit for the purposes of this project and reporting in accordance with the DoD QSM Version 4.2 (DoD, 2010). The laboratory will establish MDLs for each method, matrix, and analyte, and provide them to URS at the beginning of the project and upon request. The MDLs may be updated by the laboratory periodically and will be reviewed by the project to ensure that any revision of the MDLs continues to meet the project's needs. The MDL is used along with other measurements of sensitivity, such as the LOQ which is defined as the limit at which the difference between two different values can reasonably be determined.

The laboratories performing work in support of this project will demonstrate the MDLs and LOQs for each instrument, including confirmatory columns, method of analysis, analyte, and matrix in accordance with established EPA protocol as specified in the analytical procedures.

2.22.2 Limit of Detection

The MDL will be used to determine the LOD for each analyte and matrix and for all preparatory and cleanup methods routinely used for the analysis of samples. After each MDL determination, the laboratory will establish the LOD by spiking a quality system matrix at approximately 2 to 3 times the MDL (for a single-analyte standard) or 1 to 4 times the MDL (for a multi-analyte standard). This spike concentration establishes the LOD and is specific to each combination of analyte, matrix, method (including sample preparation), and instrument configuration. The LOD must be verified on an established frequency. The following requirements apply to the initial MDL and LOD determinations and to the periodic LOD verifications:

- The apparent signal-to-noise ratio at the LOD must be at least 3 and the results must meet all method requirements for analyte identification (e.g., ion abundance, second-column confirmation, or pattern recognition). For data systems that do not provide a noise requirement, the signal produced by the verification sample must produce a result that is at least three standard deviations greater than the mean method blank concentrations.
- If a laboratory uses multiple instruments for a given method, the LOD must be verified for each instrument.

- If the LOD verification fails, the laboratory must repeat the MDL determination and LOD verification at a higher concentration, or perform and pass two consecutive LOD verifications at a higher concentration and set the LOD at the higher concentration.
- The laboratory will maintain documentation for all MDL determinations and LOD verifications.

2.22.3 Limits of Quantitation

The laboratory will compare the results of the LOD demonstrations to the LOQs for each method and analyte. The LOD may not be more than one-half the corresponding LOQ. The laboratory will also verify LOQs by including a standard equal to or below the LOQ at the lowest point on the calibration curve.

If no detected concentration is determined to be above the LOD, the result will be reported to the LOQ concentration (with the added variables of sample dilution, final volume, and sample mass included), reported as a non-detect result, and flagged "U." If a result is greater than the LOD and less than the LOQ, the result will be reported as a detected concentration and flagged "J." A detected result greater than or equal to the LOQ will be reported without a qualifying flag unless a specific QA/QC failure is associated with the data as identified during the method data validation process.

The laboratory procedure for establishing the LOQ must empirically demonstrate precision and bias at the LOQ. The LOQ and associated precision and bias must meet project-specific requirements and must be reported. If the method is modified, precision and bias at the new LOQ must be demonstrated and reported.

Estimated LOQs are provided in Worksheet #15. The LODs will be specified by the laboratory at the time of reporting; LODs are expected to be 2 to 3 times greater than the MDL and below the LOQ. The MDLs, LODs, and reporting limit were compared to the project-specific screening criteria to determine whether they meet the analytical DQOs. If the LOD is below the screening criterion, the LOQ is sufficient for project decision making. Otherwise, other analyte-specific factors (e.g., potential use at the site, mobility, or toxicity) may be discussed in the Project Quality Objectives on a more qualitative basis.

Sample dilution because of target or non-target compound concentrations or matrix interferences could prevent LOQs from being achieved. Samples must be initially analyzed while undiluted when reasonable. If dilution is necessary, both the original and diluted results must be reported. Any samples that are not analyzed undiluted must have the express approval of URS within the extraction and analysis holding time and be supported by matrix interference documentation, such as sample viscosity, color, odor, or results from other analyses of the same sample, to show that undiluted analysis is not feasible. Appropriate cleanup procedures must be followed to minimize matrix effects on LOQs.

2.22.4 Calibration

All analytes reported must be present in the initial and continuing calibrations. These calibrations must meet the acceptance criteria specified in the tables provided in the analytical procedure. All results reported must be within the calibration range. Samples will be diluted, if necessary, to bring analyte responses within the calibration range. Records of standard preparation and instrument calibration will be maintained. Records must unambiguously trace the standards and their use in calibration and quantitation of sample results.

Instrument calibration will be performed by, beginning with the simplest approach first, the linear model through the origin, and then progressing through other options until the acceptance criteria are met. In cases where an analyte has more than one acceptable calibration model, results from the simplest

calibration model will be reported. If more than the minimum number of standards is analyzed for the initial calibration, all of the standards analyzed will be included. The only exception to this rule is that a standard at either end of the calibration curve can be excluded from the calibration, providing that the requirement for the minimum number of standards is met and the low point of the calibration curve is at or below the reporting limit for each analyte.

Calibrations must use the simplest calibration model first. Non-linear calibration will be considered only when a linear approach cannot be applied. It is not acceptable to use an alternate calibration procedure when a compound fails to perform as expected. When this occurs, it is indicative of instrument issues or operator error.

The continuing calibration verification cannot be used as the laboratory control sample (LCS), except for methods that do not involve sample preparation. A continuing calibration verification will be performed daily prior to sample analysis (unless an initial calibration and second-source standard verification is performed immediately prior to sample analysis) and is required by the applicable method. In accordance with National Environmental Laboratory Accreditation Program requirements, the laboratory will analyze the continuing calibration verification concentration to vary throughout the calibration range. The lowest standard used must be at or below the reporting limit for each analyte in the method.

2.22.5 Laboratory Control Samples

A LCS is a sample of known composition that is spiked with all target analytes. The LCS is used with each analytical batch to determine whether the method is in control. Each analyte in the LCS will be spiked at a level less than or equal to the midpoint of the calibration curve, which is defined as the median point of the curve instead of the middle of the range. The LCS will be carried through the complete sample preparation and analysis procedure. Except for VOC analysis, the LCS cannot be used as the continuing calibration verification.

At least one LCS will be included in every analytical batch. If more than one LCS is analyzed in an analytical batch, results from all LCSs will be reported. Failure of an analyte in any LCS will necessitate appropriate corrective action, including qualification of the failed analyte in all of the samples, as required.

2.22.5.1 Laboratory Control Sample Limits

The LCS limits specified in Worksheet 11 will be used unless the laboratory determines that the limit cannot be met, in which case laboratory historical control limits will be used. The LCS limits are based on those specified in the DoD QSM Version 4.2 (DoD, 2010) limits of Section D or the laboratory control limit. If a target compound does not have a defined limit, the laboratory limit will be used. If the laboratory cannot meet the DoD lower control limit, the laboratory limit will be used.

The performance of the LCS is evaluated against the QC acceptance limits. When an analyte in the LCS is outside the acceptance limit, corrective action will be required. If an analyte in the LCS exceeds the upper or lower control limit and no corrective action is performed, or the corrective action is ineffective, an appropriate flag will be applied to all affected results.

2.22.5.2 Marginal Exceedance

The laboratory may not use marginal exceedances as part of their data review practice but are encouraged to contact the URS Project Chemist to discuss compound-specific failures as needed.

2.22.6 Matrix Spike and Matrix Spike Duplicate Samples

A MS or MSD is an aliquot of a sample collected in the field and spiked with known masses and concentrations of all target analytes reported. The spiking will occur prior to sample preparation and analysis. Each analyte in the MS and MSD must be spiked at a level less than or equal to the midpoint of the calibration curve for that analyte. The MS/MSD is used to document potential matrix effects associated with a site and will not be used to control the analytical process. The MS/MSD results and flags will not be associated with or related to samples that are collected from the same site where the MS/MSD set were collected. The FTL will select the samples for the MS/MSDs, and the laboratory will use those samples to prepare the appropriate MS/MSDs.

The performance of the MS and MSD will be evaluated against the QC acceptance limits outlined in Worksheet 11. If either the MS or the MSD is outside the QC acceptance limits, the data will be evaluated to determine whether there is a matrix effect or analytical error, and the analytes in the parent sample and associated field duplicate (if applicable) will be qualified according to the data flagging criteria.

If the sample concentration exceeds the spike concentration by a factor of four or more, the data will be reported unflagged. The laboratory should communicate potential matrix difficulties to the URS Project Chemist so an evaluation can be made with respect to the project-specific DQOs.

2.22.7 Surrogates

Surrogates are compounds similar to the target analytes in chemical composition and behavior in the analytical process, but not normally found in environmental samples. Surrogates are used to evaluate accuracy, method performance, and extraction efficiency. Surrogates will be added to environmental samples, controls, and blanks, in accordance with the method requirements.

If a surrogate recovery is outside the acceptance limit, corrective action must be performed. After the system problems have been resolved and system control has been re-established, the sample will be re-prepared and re-analyzed. If corrective actions are not performed or are ineffective, an appropriate flag will be applied to the affected sample results.

2.22.8 Internal Standards

Internal standards are known amounts of standards that are added to a portion of a sample or sample extract and carried through the entire determination procedure. They are used as a reference for calibration and for controlling the precision and bias of the analytical method. Internal standards will be added to the environmental samples, controls, and blanks, in accordance with the method requirements.

If the results of the internal standard are outside the acceptance limits, corrective actions will be performed. After the system problems have been resolved and system control has been re-established, all samples analyzed while the system was malfunctioning will be re-analyzed. If corrective actions are not performed or are ineffective, an appropriate flag will be applied to the affected sample results.

2.22.9 Retention Time Windows

Retention time windows are used in gas chromatographic and ion chromatographic analysis for qualitative identification of analytes. They are calculated from replicate analyses of a standard on multiple days. The procedure and calculation method are provided in SW-846 Method 8000B. The center of the window is established for each analyte and surrogate using the retention time of the midpoint standard of

the initial calibration. For non-mass spectrometric methods, these are updated daily using the absolute retention time in the initial calibration verification.

If the retention time is outside of the acceptance limits, corrective action will be performed. This applies to all continuing calibration verification subsequent to the initial calibration verification and to the LCSs. If corrective actions are not performed or are ineffective, an appropriate flag will be applied to the affected sample results.

2.22.10 Method Blank

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is carried through the complete sample preparation and analytical procedure and is used to assess potential contamination resulting from the analytical process.

A method blank will be included in every analytical batch. The presence of analytes in a method blank at concentrations greater than the LOD indicates the need for further assessment of the data. The source of contamination will be investigated and measures will be taken to correct, minimize, or eliminate the problem if the concentration exceeds one-half the LOQ. For common laboratory contaminants (i.e., methylene chloride, acetone, or phthalates), the method blank must not exceed the LOQ. No analytical data will be corrected for the presence of analytes in method blanks.

If an analyte is detected in the method blank and in the associated samples and corrective actions are not performed or are ineffective, an appropriate flag may be applied to the sample results depending on the magnitude of the analyte concentration in the method blank as compared to the analyte concentrations in the individual samples.

2.22.11 Quality Control Checks

Quality control checks will include reviewing compliance to holding time requirements, evaluation of laboratory control charts, review of standard reference materials used by the laboratory, and review of the supplies and consumables used by the laboratory.

2.22.11.1 Holding Time Compliance

All sample preparation and analyses will be performed within the method-required holding times. Some methods have more than one holding time requirement (i.e., SW-846 Method 8270C specifies a holding time for extraction and a second holding time for analysis of the extract). For methods not requiring sample preparation, holding time is calculated from the data and time of sample collection to the time of completion of all analytical runs. For methods requiring sample preparation prior to analysis, holding time is calculated from the date and time of sample collection to the time of completion of all analytical runs.

Holding times are determined on the basis of days, hours, and minutes. If the time of sample collection is not provided, the most conservative time of day will be assumed. If holding times are exceeded and the analyses are performed, the results must be flagged and identified in the data-package case narrative.

2.22.11.2 Control Charts

Control charts are used to track laboratory performance over time. It is recommended that all analytes spiked into the LCS be tracked via control charts. These charts are useful for identifying trends and problems in an analytical method, and the laboratory will use these charts to establish in-house LCS control limits. The control charts will be updated as needed. At a minimum, the charts will be updated annually and reviewed each time a data point is generated so that corrective action can be taken in a timely manner. These charts can also be used to benchmark a laboratory's performance against QAPP requirements to determine possible areas of improvement.

2.22.11.3 Standard Reference Materials

Standard reference materials (including second source materials) used in calibration and sample preparation must be traceable to National Institute of Standards and Testing, EPA, American Association of Laboratory Accreditation, or other equivalent approved source, if available. If such a standard reference material is not available, the standard reference material proposed for use must be approved by the URS Project Chemist prior to use.

The standard reference materials must be current, and the following expiration policy must be followed.

- Expiration dates for ampulated solutions should not exceed the manufacturer's expiration date or one year from the date of receipt, whichever comes first.
- Expiration dates for laboratory-prepared stock and diluted standards must be no later than the expiration date of the stock solution or material or the date calculated from the holding time allowed by the applicable analytical method, whichever comes first.
- Expiration dates for pure chemicals will be established by the laboratory and be based on chemical stability, possibility of contamination, and environmental and storage conditions.

Expired standard reference materials will be either re-validated prior to use or discarded. Re-validation may be performed through assigned of a true value and error window statistically derived from replicate analyses of the material as compared to an unexpired standard. The laboratory will label standard reference and QC materials with expiration dates.

A second source standard will be used to independently confirm the initial calibration. A second source standard is a standard purchased from a vendor different from that supplying the material used in the initial calibration or traceable to a different source than the primary standard. The second source material can be used for the continuing calibration standards and/or for the LCS. Two difference lot numbers from the same vendor may not constitute a second source and must be reviewed to ensure traceability to a different source. When a project requires analyses for which there is not a separate vendor source available, the use of different lot numbers from the same vendor will be acceptable to verify calibration.

2.22.11.4 Supplies and Consumables

The laboratory will inspect supplies and consumables prior to their use in analyses. The materials description in the methods of analysis will be used as a guideline for establishing the acceptance criteria for these materials. Purity of reagents will be monitored and documented. An inventory and storage system for these materials will assure use prior to the manufacturer's expiration dates and storage under safe and chemically compatible conditions.

2.23 QAPP WORKSHEET #29 – PROJECT DOCUMENTS AND RECORDS

The required data package deliverables during every aspect of the project are identified in this worksheet. These include, but are not limited to: (1) sample collection and field measurement records, (2) analytical records, and (3) data assessment records.

2.23.1 Sample Collection and Field Measurement Records

Sample collection and field measurement records generally include field logbooks, photographic documentation, equipment decontamination records, sampling instrument calibration records, soil sampling logsheets, chain-of-custody forms, and air bills.

2.23.2 Analytical Records

Analytical records are comprised of hardcopy analytical data deliverables and electronic data deliverables (EDDs).

2.23.2.1 Hardcopy Analytical Data Deliverables

Hardcopy deliverables must be provided with a summary format forms package, equivalent to those provided in the most recent versions of the EPA Contract Laboratory Program Statements of Work for Organic and Inorganic Analyses of Contract-Laboratory Program as long as the format provides summarized, form-oriented reporting and are fully validatable. Other reporting formats require approval from the URS Project Chemist.

All hardcopy deliverables will be Level II deliverables. Level IV data packages will be delivered electronically. The Level IV data package will be delivered in a Portable Document Format (PDF) version. The laboratory data report must be organized in a format that facilitates identification and retrieval of data.

2.23.2.2 Electronic Data Deliverable

The EDD from the laboratory will contain all final laboratory data complete with laboratory-applied flags. Prior to upload to the ERPIMS, the EDD will be amended to include flags resulting from the data validation process. ERPIMS is the data management system designed to accommodate many types of data collected. The EDD will be compatible with the ERPIMS format to facilitate download of the data into ERPIMS and to ensure the quality of the data loaded into the ERPIMS. URS has developed specific codes and laboratory data forms to allow for the consistent and efficient input of information into the ERPIMS. The information transferred into ERPIMS shall include all required technical data such as site information; well characteristics; and hydrogeologic, geologic, physical, and chemical analytical results. Electronic data reporting formats and requirements are provided in the most current version of the *ERPIMS Data Loading Handbook* and ERPIMS X loading tools.

2.23.3 Data Assessment Records

Data assessment records include, but are not limited to, data validation reports. Data assessment records may also include evaluation of field logbooks and calibration records, as well as laboratory and field audit reports.

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2.24 QAPP WORKSHEETS #31, #32 & #33 – ASSESSMENTS AND CORRECTIVE ACTION

Table 31-1. Planned Project Assessments

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Action	Person(s) Responsible for Monitoring Effectiveness of Corrective Action
Field Procedure Assessment and Work Plan Compliance	Monthly	Internal	URS	Project QA Manager	Project Manager	Project Manager	Project QA Manager
Field Documentation Reviews	Quarterly	Internal	URS	Project Database Manager	Project Manager	Project Manager	Project QA Manager
Safety and Health Audit	As needed	Internal	URS	Project QA Manager	Project Manager/ Field Team Leader	Field Team Leader	Project QA Manager
Field Instrument Calibration	Monthly	Internal	URS	Field Team Leader	Project Manager	Project Manager	Project QA Manager
Chain-of-Custody and Shipping	After receiving coolers at the laboratory	Internal and External	URS Laboratory QA Officer	Project Chemist Laboratory QA Officer	Project Manager Laboratory QA Officer	Project Manager	Project QA Manager
Data Validation	After receiving data from the laboratory	Internal and External	URS Laboratory QA Officer	Project Chemist Laboratory QA Officer	Project Manager Laboratory QA Officer	Project Manager	Project QA Manager
Internal Project Reporting Reviews	Once per report and/or per report revision	Internal	URS	Varies dependent upon the expertise required	Project Manager	Varies dependent upon the expertise required	Project Manager
External Project Reporting Reviews	Once per report	External	AFCEC or Kirtland AFB	AFCEC or Kirtland AFB	Project Manager	Project Manager	AFCEC or Kirtland AFB

AFB – Air Force Base
AFCEC – Air Force Civil Engineer Center
QA – quality assurance
URS – URS Group, Inc.

2.24.1 Assessment Findings and Corrective Action Responses

Corrective actions will be required if the audits (see Worksheet #31) identify noncompliance problems with the laboratory, field procedures, or the data. Specifically, corrective actions for field nonconformance issues will require addressing the audit findings as described in Worksheet #31. Depending on the severity of the finding, a follow-up audit may be performed to verify that the corrective action has successfully been implemented.

Corrective actions for laboratory issues identified as a result of performance audits will require the following actions:

- Document the nonconformance issues on a laboratory nonconformance form.
- Record the cause of the nonconformance.
- Document the corrective actions taken.
- Verify the corrective actions taken were sufficient to address the concern.

Corrective actions for database issues identified as a result of data performance audits will require the database manager to consult with the project chemist, project manager, data validator, or laboratory to develop corrective actions. If the issues identified are laboratory based, the laboratory will be contacted in writing by the project chemist, database manager, or data validator of the required corrective actions to be taken (typically, a resubmittal of the pertinent data package).

Table 31-2. Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Field Procedure Assessment and Work Plan Compliance	Internal Memo	Field Team Leader	24 hours after audit	Internal e-mail	Project Manager	24 hours after notification
Field Documentation Reviews	Internal Memo	Field Team Leader	24 hours after audit	Internal e-mail	Project Manager	3-5 business days
Chain-of-Custody	Internal Memo	Field Team Leader	24 hours after audit	Internal e-mail	Project Manager	24 hours after notification
Safety and Health Audit	Written Audit Report	Project Manager	7 days after audit	Internal Memo	Project Health and Safety Officer	7 days after notification

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Data Validation	Laboratory resubmissions	Laboratory QA Officer	After receiving data from the laboratory and during data validation	Corrective action reports, updated case narratives, and corrected data submissions	Project Chemist	7 business days
Internal and external project reporting reviews	Report comments	Project Manager	7-10 business days	Responses to comments and report revision	Project Manager	7-10 business days
QA – quality assurance						

2.24.2 Quality Assurance Management Reports

In order to meet the project quality objectives, periodic QA Management Reports will be prepared so that the project stakeholders are updated on project status and results of all QA assessments. This will ensure that corrective actions can be implemented in a timely and effective manner. The frequency and type of planned QA Management Reports, the delivery date, the personnel responsible for report preparation, and the report recipients are identified in the table below.

Table 31-3. Quality Assurance Management Reports

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Data Validation Reports	Once, after data are reviewed	30 days after receipt of data	Project Chemist	Project Manager
Final Report	Once, after all field work is completed and data have been validated	180 days after completion of field activities	Project Manager	Air Force, NMED
Field Audit Report	Annually	7 days after audit completion	QA Manager	Project Manager,
Field QC Reports	Daily	Daily	Field Team Leader	Project Chemist
NMED – New Mexico Environment Department QA – quality assurance QC – quality control				

The QA reports will address the following issues:

- Summary of project QA/QC programs.
- Conformance of project activities to approved UFP-QAPP requirements and procedures.
- Deviations from the approved QAPP and approved amendments to the QAPP.
- Results of data review activities in terms of amount of usable data generated.
- Required corrective actions and effectiveness of corrective action implementation.
- Data usability assessments in terms of PARCCS.
- Limitations on the use of measurement data generated. When data is unusable for its intended purpose the appropriate regulatory agencies will be notified.

2.25 QAPP WORKSHEET #34 – DATA VERIFICATION AND VALIDATION INPUTS

To confirm that scientifically-sound data of known and documented quality are used in making project decisions, the following three step review will be performed:

- Verification and validation Checks will confirm that all sampling and analytical requirements have been met.
- Data verification will assess whether the sampling and analytical processes comply with the contract-specific and the QAPP-specific requirements.
- Usability Assessment will determine whether the resulting data are suitable as a basis for the decision being made.

Worksheets #34, #35, and #36 describe the processes to be followed for the above three steps, respectively. This worksheet establishes the procedures that will be followed to verify project data including, but not limited to, sampling documents and analytical data package requirements.

Table 34-1. Verification and Validation Checks

Item	Description	Verification (Completeness)	Validation (Conformance to specifications)
Planning Documents and Records			
1	Approved Quality Assurance Project Plan	X	
2	Approved Long-Term Monitoring Plan	X	
3	Approved Laboratory Contract	X	
4	Field Standard Operating Procedures	X	
5	Laboratory Standard Operating Procedures	X	
Field Records			
6	Field Logbooks	X	X
7	Equipment Calibration Records	X	X
8	Chain-of-Custody Forms	X	X
9	Sampling Surveys	X	X
10	Drilling logs	X	X
11	Relevant Correspondence	X	X
12	Change Orders/Deviations	X	X
13	Field Audit Reports	X	X
14	Field Corrective Action Reports	X	X
Analytical Data Packages			
15	Cover Sheet (Laboratory Identifying Information)	X	X
16	Case Narrative	X	X
17	Internal Laboratory Chain-of-Custody	X	X
18	Sample Receipt Records	X	X
19	Sample Chronology (i.e., dates and times of receipt, preparation, analysis)	X	X
20	Communication Records	X	X
21	Limit of Quantitation/Limit of Detection Established and Verified	X	X
22	Standards Traceable	X	X
23	Instrument Calibration Records	X	X

Item	Description	Verification (Completeness)	Validation (Conformance to specifications)
24	Definition of Laboratory Qualifiers	X	X
25	Results Reporting Forms	X	X
26	Quality Control Sample Results	X	X
27	Corrective Action Forms	X	X
28	Raw Data	X	X
29	Electronic Data Deliverable	X	X

2.26 QAPP WORKSHEET #35 – DATA VERIFICATION PROCEDURES

Table 35-1. Data Verification Procedures

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Field Logbook	QAPP, Field SOPs	Verify that records are present and complete for each data of field activities. Verify that all planned samples, including field QC samples, were collected and that sample collection locations are documented. Verify that meteorological data were provided for each data of field activities. Verify that changes/exceptions are documented and were reported in accordance with requirements. Verify that any required field monitoring was performed and results are documented.	Daily – Field Team Leader At conclusion of field activities – Project QA Manager
Chain-of-Custody Forms	QAPP, Field SOPs	Verify the completeness of chain-of-custody records. Examine entries for consistency with the field logbook. Check that appropriate methods and sample preservation have been recorded. Verify that the required volume of sample has been collected and that sufficient sample volume is available for QC samples (e.g., MS/MSD). Verify that all required signatures and dates are present. Check for transcription errors.	Daily – Field Team Leader At conclusion of field activities – Project Chemist
Laboratory Deliverable	QAPP	Verify that the laboratory deliverable contains all records specified in the QAPP. Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported accordance to plan. Compare the data package with the chain-of-custody forms to verify that results were provided for all collected samples. Review the case narrative to ensure that all QC exceptions are described. Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. Verify that necessary signatures and dates are present	Before release – Laboratory Quality Assurance Manager Upon receipt – Project Chemist
Audit Reports, Corrective Action Reports	QAPP	Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan	Project QA Manager

MS/MSD – matrix spike/matrix spike duplicate
QA – quality assurance
QAPP – Quality Assurance Project Plan
QC – quality control
SOP – standard operating procedure

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2.27 QAPP WORKSHEET #36 – DATA VALIDATION PROCEDURES

The objective of data validation is to assess the performance associated with the analysis in order to determine the quality of the data. This will be accomplished by evaluating whether the collected data comply with the pre-defined project requirements (including method, procedural, and contractual requirements) and by comparing the collected data with criteria established based on the project DQOs. All types of data, including screening data and definitive data, are relevant to the usability assessment. The following requirements are applicable to definitive data only obtained from laboratory analyses of the field samples.

Table 36-1. Data Validation Summary

Matrix	Analytical Group	Validation Procedures	Data Validator
Groundwater	VOCs Anions Nitrate/Nitrite Metals Alkalinity Gross alpha/beta Radium -226, -228	• Department of Defense Quality Systems Manual Version 4.2 (DoD, 2010) [a] • EPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review (EPA, 2010) • EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (EPA, 2008)	Project Chemist, QA Manager

a. Upon accreditation, the laboratory will comply with version 5.0 (DoD, 2013) of the Quality Systems Manual and validation procedures will be in accordance with the applicable standards.

DoD – Department of Defense
EPA – U.S. Environmental Protection Agency
QA – quality assurance
VOC – volatile organic compound

All laboratory analytical data shall undergo Stage 2A Verification and Validation Checks as defined in the *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA, 2009). Stage 2A expands beyond the data verification requirements outlined in Worksheet #35 to address the verification and validation checks for the compliance of sample-related QC, including method blanks, surrogate recoveries, deuterated monitoring compound recoveries, laboratory control sample recoveries, duplicate analyses, matrix spike and matrix spike duplicate recoveries, serial dilutions, post-digestion spikes, and standard reference material traceability. In addition, sample holding times are evaluated and the frequency of QC samples is checked for appropriateness.

Ten percent of laboratory analytical data shall undergo Stage 2B/3 Verification and Validation Checks as defined in the EPA guidance (EPA, 2009). Stage 2B builds upon Stage 2A to address compliance of instrument-related QC, including initial calibration data, continuing calibration

data, method specific instrument performance checks, and frequency of instrument QC samples. Stage 3 includes the final step of recalculation of instrument and sample results from the laboratory instrument responses, and comparison of recalculated results to laboratory reported results.

The following data qualifiers will be applied during data validation. Potential impacts on project-specific data quality objectives will be discussed in the data validation report.

U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."

NJ The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

2.28 QAPP WORKSHEET #37 – DATA USABILITY ASSESSMENT

The data usability assessment is an evaluation based on the results of data verification and validation in the context of the overall project decisions or objectives. The assessment is used to determine whether the project execution and resulting data meet the project DQOs. Both the sampling and analytical activities must be considered, with the ultimate goal of assessing whether the final, qualified results support the decisions to be made using the data.

The following sections summarize the processes to determine whether the collected data are of the right type, quality, and quantity to support the environmental decision-making process for the project, and describe how data quality issues will be addressed including limitations of the use of the data.

Data gaps may be present if a sample is not collected, a sample is not analyzed for the requested parameters, or the data are determined to be unusable because of data verification/validation issues. The need for further investigation will be determined on a case-by-case basis, depending on whether data can be extrapolated from existing data and whether the data are needed based on the both historic and current data collected.

The project chemist and the laboratory will confirm that the collected data meet the required detection limits and laboratory QC limits specified herein. During the data validation assessment, non-conformances will be documented, and the data will be qualified accordingly. The project chemist will determine whether the data are usable based on the specified requirements.

All data as qualified by the project chemist are considered usable, with the exception of rejected data. Estimated and/or biased results are considered usable. Outlier, if present, can be addressed on a case-by-case basis. Potential outliers will be evaluated using appropriate statistical methods in an appropriate and defensible manner.

Overall measurement error is normally associated with both sampling design and quality and quantitative measures performed both in the field and the laboratory. In-depth assessment will be performed during the data validation process to assess conformance with established laboratory criteria. Qualifiers will be used to indicate overall usability of the data. The project chemist will be responsible for ensuring compliance with data validation criteria.

All the results will be tabulated and statistically evaluated for an overall quality assessment, which will be provided as an appendix to the associated reports. This assessment will address precision and accuracy with respect to the laboratory performance for the related samples, as well as comparability of field and laboratory duplicates. The assessment will include a discussion of the PARCCS parameters.

2.28.1 Precision

Precision will be evaluated by measuring the agreement among individual measurements of the same property under similar conditions. Field precision is measured through the collection and analysis of field duplicate samples. Laboratory precision is measured through the analysis of laboratory duplicate control samples, MSDs, or sample duplicates. Total precision is a measurement of the variability associated with the entire sampling and analytical process.

Typically, one of four common calculations will be used to assess various measurements for precision. The relative percent difference (RPD) or relative standard deviation (RSD) is calculated for every contaminant for which field or laboratory duplicates exist. The precision of the absolute range (PAR) can be used when the absolute variation between two measurements is more appropriate. The mean difference

is a standard statistical method of assessing the difference between two radioactivity measurements and determining the significance of that difference.

The RPD is used for two observed values (e.g., field collocated duplicates, laboratory duplicates, and laboratory matrix spike or matrix spike duplicates). The RPD for duplicate samples is calculated as shown in Equation 1.

$$\text{RPD} = \frac{|C_1 - C_2|}{(C_1 + C_2)x\left(\frac{1}{2}\right)} x(100\%) \qquad (1)$$

Where:

RPD	=	relative percent difference
C_1	=	larger of the two observed values
C_2	=	smaller of the two observed values

The RSD is used for more than two observed values and is calculated as shown in Equation 2.

$$\text{RSD} = \left(\frac{s}{\overline{X}}\right) x\ (100\%) \qquad (2)$$

Where:

RSD	=	relative standard deviation
s	=	standard deviation
$\overline{X}$	=	mean of observations

The standard deviation is calculated as shown in Equation 3.

$$s = \sqrt{\frac{\sum(x_i - \overline{X})^2}{n-1}} \qquad (3)$$

Where:

s	=	standard deviation
x_i	=	measured value of the observation
$\overline{X}$	=	mean of observations
n	=	number of observations

For measurements (such as pH) where absolute variation is more appropriate, the PAR of a duplicate measurement calculation can be used in lieu of the standard deviation. The PAR is calculated as shown in Equation 4.

$$D = |m_1 - m_2| \qquad (4)$$

Where:

D	=	absolute range
m_1	=	first measurement
m_2	=	second measurement

Precision of radionuclide measurements is determined using the mean difference calculation shown in Equation 5.

$$MD = \frac{|S-D|}{\sqrt{(\sigma_S^2 + \sigma_D^2)}} \qquad (5)$$

Where:

MD	=	statistical difference of the duplicate results
S	=	sample result (as pCi/g or pCi/L)
D	=	duplicate result (as pCi/g or pCi/L)
σ_D	=	associated total propagated one-sigma uncertainty of the duplicate result
σ_S	=	associated total propagated one-sigma uncertainty of the sample result

2.28.2 Accuracy

Accuracy reflects the total error associated with a measurement. A measurement is considered accurate when the reported value agrees with the true value or known concentration of the spike or standard within acceptable limits. Analytical accuracy is measured by comparing the percent recovery of analytes spikes into a laboratory control sample to a control limit. For many methods of organic compound analysis, the surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed.

Both accuracy and precision are calculated for each analytical batch, and the associated sample results are interpreted by considering these specific measurements. Accuracy requirements are listed for each method, matrix, and analyte in Worksheet 15. Two calculations are used to assess laboratory accuracy. For measurements where matrix spikes are used, the percent recovery of the matrix spike is calculated as shown in Equation 6.

$$\%R = \frac{C_i - C_0}{C_t} \text{ x } (100\%) \qquad (6)$$

Where:

%R	=	percent recovery
C_i	=	measured concentration of the spiked aliquot
C_0	=	measured concentration of the unspiked aliquot
C_t	=	concentration of spike added

The percent recovery of a known or blind laboratory control sample or a standard reference material is calculated as shown in Equation 7.

$$\%R = \frac{C_m}{C_a} \text{ x } (100\%) \qquad (7)$$

Where:

%R	=	percent recovery
C_m	=	measured concentration of SRM or LCS
C_a	=	actual or certified amount of analyte in the sample

For determining the accuracy of radionuclide measurements as compared to a known value, the mean difference calculation is used as shown in Equation 8.

$$MD = \frac{|S-K|}{\sqrt{(\sigma_S^2 + \sigma_K^2)}} \qquad (8)$$

Where:

MD	=	statistical difference of the sample result and the known value
S	=	performance evaluation sample result (as pCi/g or pCi/L)
K	=	certified activity for the known sample
σ_K	=	associated total propagated one-sigma uncertainty for the known sample
σ_S	=	associated total propagated one-sigma uncertainty for the sample result

2.28.3 Representativeness

Representativeness is a qualitative term that refers to the degree in which data accurately and precisely depicts the characteristics of a population, whether referring to the distribution of a contaminant within a sample, a sample within a matrix, or the distribution of a contaminant at a site. Representativeness is determined by employing an appropriate sampling design with consideration of elements such as sampling locations, sample collection methods, and temporal influences. Assessment of representativeness will be achieved through the use of standard field sampling and analytical procedures. Decisions regarding sampling locations, the number of samples, and the sampling design are document in Worksheets #10, #11, and #17.

2.28.4 Comparability

Comparability is a qualitative indicator of the confidence with which one data set can be compared to another data set. The objective for this QA/QC program is to produce data with the greatest possible degree of comparability. The number of matrices that are sampled and the range of field conditions encountered are considered in determining comparability. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, normalizing results to standard conditions, and using standard and comprehensive reporting formats. Complete field documentation using standardized data collection forms supports the assessment of comparability. Historical comparability can be achieved through consistent use of methods and documentation procedures throughout the project. Assessment of comparability is considered subjective and the results should be interpreted by experienced environmental professionals with knowledge of the sampling objectives and project decisions.

2.28.5 Completeness

Completeness is a measure of the amount of valid data obtained compared with the amount that was expected to be obtained under correct, normal conditions. It is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples as set out in the specific project quality objectives. Valid data are data which are usable in the context of the project goals. Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not rejected during the validation process. Completeness should not be determined only on the basis of laboratory data qualifiers. The goal for completeness is 95 % for aqueous samples and 90 % for soil samples. Completeness is calculated as shown in Equation 9.

$$\%C = \frac{S_a}{S_t} \text{ x } (100\%) \qquad (9)$$

Where:

%C	=	percent completeness
S_a	=	number of samples for which acceptable data are generated
S_t	=	total number of samples planned for a particular sampling event

2.28.6 Sensitivity

Sensitivity is the ability of an analytical method or instrument to discriminate between measurement responses representing different concentrations. This capability is established during the planning phase to meet project-specific objectives. It is important to be able to detect the target analytes at the levels of interest. Sensitivity requirements include the establishment of various limits such as calibration requirements, instrument LODs, and instrument LOQs. The project QA/QC control on method requirements has been established to be compliant with DOD QSM Version 4.2. Project-specific LODs and LOQs are provided in Worksheet 15 based on project-specific action level objectives. Upon laboratory accreditation to Version 5.0 of the QSM, the laboratory will comply with the QA/QC method requirements delineated therein. To note, matrix effects and laboratory limitations may raise LOQs from the LOQ goals in this QAPP. An evaluation of the LOQs will be performed and their potential implications will be assessed for the individual sampling events.

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APPENDIX A

Standard Operating Procedures

SOP-1	Use and Maintenance of Field Log Books
SOP-13	Static Water Level and Total Depth Measurement
SOP-15	Groundwater Purging and Sampling
SOP-16	Water Quality Measurements Using a Multiple Parameter Water Quality Meter
SOP-20	Decontamination
SOP-23	Sample Handling, Shipping, and Documentation
SOP-26	Chain-of-Custody
SOP-49	IDW Management

Note: In addition to these SOPs, the SOPs for Field Investigations provided in Appendix B of the *Kirtland Air Force Base – Base-Wide Plans for the Installation Restoration Program, 2003 Update* (USAF, 2003) provide guidance for the activities prescribed herein, as well as guidance for other activities that may be encountered during the field work.

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1.0 PURPOSE AND SCOPE

The purpose of this standard operating procedure (SOP) is to describe the methods for use and maintenance of field log books. This procedure outlines methods, lists examples for proper data entry into a field log book, and provides the standardized URS format. In addition, this SOP documents procedures employed in recording site activities photographically or using a video camera.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring the procedures are followed by all personnel.

This SOP applies to all personnel who record information in field logbooks, or employ photographic or video techniques to document site activities. Field personnel are responsible for performing the applicable tasks in accordance with this SOP when conducting work related to environmental projects. Daily logs will be kept during field activities by a Field Team Member to provide daily records of events, observations and measurements taken in the field.

The Project Leader or an approved designee is responsible for checking work performance and verifying that the applicable tasks required by this SOP have been performed. This will be accomplished by reviewing documents and data produced during work performance.

Personnel using this procedure are required to have the appropriate health and safety training as described in either the project-specific Health and Safety Plan or the Safe Work Plan, as applicable. In addition, all personnel are required to understand the procedures described within this SOP and receive specific training, if necessary.

3.0 RELATED STANDARD OPERATING PROCEDURES

This procedure is intended to be used with the SOPs that involve field work.

4.0 EQUIPMENT

- Site-specific Field Log Book
- Indelible black or blue pen
- Field forms, as applicable

5.0 PROCEDURE

5.1 General

An essential part of the sampling/analytical portion of any environmental project is assuring that proper documentation of field activities is accomplished. The primary document used to record site data is the field log book. Tasks where analytical data or conclusions based upon analytical data may be used in litigation demand that accountability of the history of a sample be available to demonstrate that the data are a true representation of the environment. The field log book may be used as evidence in legal proceedings to defend procedures and techniques employed during site investigations. Therefore, it is important that field log book documentation be factual, complete, accurate, and consistent.

Likewise, when photographic or videographic techniques are used to document site activities, the goal of the records is a true representation of field activities that accurately portrays site conditions or procedures.

5.2 Procedures

5.2.1 Preparation

New field log books will be obtained as needed from the Field Manager/Task Leader. The individual using the field logbook will be responsible for its care and maintenance throughout the field task.

Field log books will be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the log book. The following information will be recorded on the cover, binding, or inside the front cover of the logbook:

- Company name;
- Project number;
- Site name;
- Field Log Book number;
- Phone number; and
- Site contact (for example, URS Project Manager).

5.2.2 Operation

The following requirements must be followed when using a logbook:

- The date must be recorded at the top of each page;
- If data collection forms are specified by an activity-specific plan or procedure, the information need not be duplicated in the logbook;

- All changes must be made with a single line through the deletion. Changes must be initialed and dated;
- A diagonal line must be drawn through space left at the bottom of each page;
- The bottom of each page will be signed by the author; and
- Do not remove any pages from the logbook.

Entries into the log book may contain a variety of information. At a minimum, log book entries must include the following information at the beginning of each day:

- Start time;
- Weather;
- All field personnel present and directly involved;
- Level of personal protective equipment being used on the site;
- Equipment used and procedures followed;
- Any field calculations, and
- End time.

Entries into the field log book will be preceded with the time using military notation (i.e., HHMM) of the observation. The time should be recorded frequently and at the point of events or measurements that are pertinent to the activity being logged.

At each station where a sample is collected or an observation made, a description of the location is required. If a map is not already available that shows the sample location, a sketch of the location is required. The sketch or diagram should be detailed enough for other individuals to locate the points at future times. A direction indicator or compass direction should be located on the sketch along with three permanent landmarks, if available. It is preferred that maps and sketches be oriented so that north is towards the top of each page. The location information may be augmented by GPS measurements, if applicable.

Events and observations that should be recorded include, but are not limited to:

- Changes in weather that may impact field activities;
- Observations about site and samples;
- Deviations from procedures outlined in applicable documents. Also record the reason for any noted deviation;
- Problems, downtime, or delays;
- Upgrade or downgrade of personal protective equipment;
- All task members, client representatives, and any public involvement, visitors, or press interest;

- Results generated by health and safety monitoring equipment;
- Identification of equipment used, including model numbers and/or serial identification numbers, including time and date of calibration;
- Background levels of each instrument and possible background interferences;
- Instrument readings for the borehole, cuttings, or samples in the breathing zone and from the specified depth of the borehole, etc.;
- Field parameters (pH, specific conductivity, etc.), if not documented on other field forms;
- Unusual observances, irregularities or problems noted on site or with instrumentation used; and
- Decontamination times and methods.

When samples are collected, the following information should be recorded:

- Sample location;
- Sample number;
- Sample methodology;
- Sample description;
- Name of sampler;
- Sample depth;
- Sample type;
- Sample analyses requested;
- Sample preservation;
- Quality control (QC) sample numbers and types, and;
- Information about any activities that may affect the integrity of the samples.

5.2.3 Visual Recordings

When visual recordings (photographs or video recordings) are made, they will be documented in the associated field log book. At the start of the day, the weather conditions should be recorded; the weather should also be noted if site conditions change (e.g., weather goes from clear to overcast) throughout the day. For each photograph, the following information must be recorded:

- Location;
- Date and time;
- Photographer;
- Description of subject of photograph;

- Direction of photograph (e.g., "taken facing northwest");
- Identification of individuals in the photograph and their affiliation;
- Photograph number;
- Mechanical difficulties (if encountered) and corrective actions taken (and results).

A figure, map, or sketch of the site indicating the locations where photographs were taken is useful, especially if before and after photographs are to be taken at different times (potentially by different photographers, although using the same photographer is recommended).

For video recordings, the same information should be noted, along with the start and stop times on the recording. If the camera is capable of captioning with date, time, and text information to the recorded image, this is recommended. Such a captioning capability aids in later labeling and identifying the photographs or video recordings.

Photographs and/or video recordings should be taken with a camera-lens system having a perspective similar to that afforded by the naked eye. Telephoto or wide-angle shots are to be avoided unless previously approved by the client.

Most video cameras offer the cameraperson, or an accompanying field technician, audio recording capability that can be used to provide a running commentary on the activities recorded. This information is <u>not</u> a substitute for hard-copy documentation in a log book (wind blowing across the microphone or technical difficulties may render the sound inaudible). Commentary should be pertinent and succinct.

5.2.4 Post-Operation

At the conclusion of a task or when a log book has been completed, it will be submitted to the Project Leader or an approved designee for filing in the Project File.

The Project Leader or an approved designee will check field log books and field forms for completeness and accuracy on an appropriate site specific schedule determined by the Project Leader. Discrepancies in these documents will be noted and returned to the originator for correction. The reviewer will acknowledge that these review comments have been incorporated by signing and dating the applicable reviewed documents.

Cameras will be returned to the location designated by the field task leader (the camera must be kept in a temperature and humidity controlled environment when not in use; camera batteries may need to be recharged overnight). Video recordings must be protected from magnetic fields. The video cartridge must be labeled.

6.0 RECORDS

Documentation will follow guidelines contained in this SOP.

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1.0 PURPOSE AND SCOPE

The purpose and scope of this Standard Operating Procedure (SOP) is to describe the equipment and methods used to accurately determine static water level and total depth in a groundwater monitoring well, pumping well, or piezometer.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

Personnel using this procedure are required to have the appropriate health and safety training as described in either the project-specific Health and Safety Plan or the Safe Work Plan, as applicable. In addition, all personnel are required to understand the procedures described within this SOP and receive specific training, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

This procedure is intended to be used with the following SOPs:

- SOP-1 – Use and Maintenance of Field Log Books
- SOP-20 – Decontamination

4.0 EQUIPMENT

The equipment and supplies that may be necessary to measure water levels include:

- Water level indicator with an audible alarm and a cable marked in 0.01-foot increments. The point on the probe that triggers the alarm corresponds to the zero point.
- If free-phase product is present, an interface probe capable of distinguishing between product and water.
- Decontamination supplies.
- Field logbook or field data sheets.

5.0 PROCEDURES

This procedure requires the use of an electronic water level device that employs a battery-powered probe assembly attached to a cable marked in 0.01-foot increments. When the probe makes contact with the water surface, a circuit is closed and energy is transmitted through the cable to sound an audible alarm. This equipment will have a sensitivity adjustment switch that enables the operator to distinguish between actual and false readings. The manufacturer's operating manual should be consulted for instructions on use of the sensitivity adjustment.

If there is the potential for free-phase product to be present on the surface of the water table in a well, then an oil-water interface probe will be used to collect water level measurements. Interface probes are used in the same manner as a water level indicator. The difference is that the interface probes have two different audible signals to differentiate between water and oil. If a layer of free-phase product is present, the probe will emit a different signal than for water. Most probes emit an intermittent beep when product is encountered, as opposed to a constant tone for water. The alarm codes for individual probes are marked on the reel casing.

The measurements must be taken at an established reference point, generally from the top of the well casing at the surveyor's mark. The mark should be permanent, such as a notch or mark on the top of the casing. If the surveyor's point is not marked at the time of water level measurement, the north side of the casing should be used and marked.

5.1 Calibration

The water level indicator or interface probe should be calibrated in accordance with the manufacturer's procedure prior to use.

1. Place the end of the probe in a bucket of water to ensure that the audible alarm is in working condition and responds when the electrical contacts encounter water.
2. Verify the marked length units on the probe line for accuracy by comparing to a standard steel tape measure. If there is any noted discrepancy between the water level indicator and the measuring tape, the difference in length will be noted on the field log and identified on the water level indicator. All subsequent water level measurements will be corrected as necessary.

5.2 Static Water Level Measurement

The static water level will be measured each time a well is sampled. This is typically done before any fluids are withdrawn and before any purging or sampling equipment enters the well.

1. Before mobilization, obtain previous water level data, a description of the measuring point for water level measurements, and the appropriate well keys (if the wells are locked).
2. Test the water level probe to ensure that it is working properly by pushing the circuit test button or as specified in the instrument manufacturer's instructions.
3. Decontaminate the water level indicator probe according to SOP-20, Decontamination, between wells and after measuring the water level in the last well.
4. Unlock and open the well. Follow the health and safety procedures specified in the project Health and Safety Plan or Safe Work Plan, as applicable. If necessary, let the well vent any gases that may be present in the well casing. Also, this allows the water to equilibrate to barometric changes.

5. After opening the well cover, locate the water level measuring point. If a measuring point is not marked, the measurement should be taken from the north side of the well casing, if possible.
6. With the water level indicator switched on, slowly lower the probe until it contacts the water surface as indicated by the audible alarm.
7. Raise the probe out of the water until the alarm turns off. Three or more measurements will be taken at each well until two measurements agree to within +/- 0.01 feet.
8. Record the reading on the cable at the established reference point to the nearest 0.01 foot in the field logbook and/or on a field data sheet. In addition, document the measuring point location. Compare the most recent measurement with past measurements to verify that the new measurement is reasonable before leaving the well. If the measurement does not seem reasonable, repeat the water level measurement.
9. If the water level indicator fails to activate and is operating properly, lower the water level probe to the bottom of the well to ensure that the well is dry. Document that the well is dry, measure the total depth in accordance with the following method.

5.3 Total Depth Measurement

Depending on the type of instrument used, the total depth measurement may need to be adjusted for the offset between the bottom of the probe and the water level sensor. Some instruments have the sensor at the bottom of the probe so the depth reading is accurate without an adjustment. However, the water indicator sensor on some probes is not located at the bottom of the probe. To get a true total depth reading, the distance from the water indicator sensor to the bottom of the probe housing must be added to the depth reading.

1. Slowly lower the water level indicator, with weight attached if necessary, until the cable goes slack.
2. Raise and lower the probe until the depth to bottom is determined.
3. Account for the length of the probe tip in determining the total depth.
4. Record the reading on the cable at the established reference point to the nearest 0.01 foot.

If it is not possible to measure the depth of a well in which pumping equipment is installed, then the as-built well construction diagram will provide the total depth.

5.4 Interface Probe Measurement

1. Before mobilization, obtain previous water level data, a description of the measuring point for water level measurements, and the appropriate well keys (if the wells are locked).
2. Test the interface probe to ensure that it is working properly by pushing the circuit test button or as specified in the instrument manufacturer’s instructions.

3. Decontaminate the interface probe according to SOP-20, Decontamination, between wells and after measuring the water level in the last well.
4. Unlock and open the well. Follow the health and safety procedures specified in the project Health and Safety Plan or Safe Work Plan, as applicable. If necessary, let the well vent any gases that may be present in the well casing. Also, this allows the water to equilibrate to barometric changes.
5. After opening the well cover, locate the water level measuring point. If a measuring point is not marked, the measurement should be taken from the north side of the well casing, if possible.
6. With the interface probe indicator switched on, slowly lower the probe until it contacts the liquid surface as indicated by the audible alarm.
7. If product is encountered, continue to raise and lower the probe until a precise level (within 0.01 foot) is determined.
8. Record the measurement in the field logbook and/or on the field data sheet to the nearest 0.01 foot and identify it as a product measurement.
9. Lower the interface probe until the water interface is encountered. Repeat the level measurement process a minimum of three or more measurements until two measurements agree to within +/- 0.01 feet.

NOTE: CARE SHOULD BE TAKEN DURING THE MEASUREMENT PROCESS TO MINIMIZE DISTURBANCE OF THE PRODUCT/WATER INTERFACE.

10. Record the measurement in the field logbook and/or on the field data sheet to the nearest 0.01 foot and identify it as the water level measurement. In addition, document the measuring point location. Compare the most recent measurements with past measurements to verify that the new measurements are reasonable before leaving the well. If the product and/or water level measurements do not seem reasonable, repeat both measurements.

6.0 RECORDS

All field notes for water level, product level (if applicable), and well depth measurements will be recorded in the field logbook and/or the field data sheets in accordance with SOP-1, Use and Maintenance of Field Log Books. Entries shall be legible, signed or initialed, and dated. Documented information shall include, as appropriate:

- Personnel who performed the measurement,
- Date of measurement,
- Time of measurement,

- Well number,
- Depth to water from the measuring point,
- Description of the measuring point location for the well,
- Water-level or interface probe manufacturer and serial/identification number,
- Calculations performed (if any), and
- Other observations (i.e., well condition, evidence of tampering, artesian conditions).

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1.0 PURPOSE AND SCOPE

The purpose and scope of this Standard Operating Procedure (SOP) is to describe the equipment and methods used for collecting groundwater samples in the field using the low-flow purge, the conventional purge, and the passive diffusion sampler methods.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

Personnel using this procedure are required to have the appropriate health and safety training as described in either the project-specific Health and Safety Plan or the Safe Work Plan, as applicable. In addition, all personnel are required to understand the procedures described within this SOP and receive specific training, if necessary.

Project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

This procedure is intended to be used with the following SOPs:

- SOP-1 – Use and Maintenance of Field Log Books
- SOP-13 – Static Water Level and Total Depth Measurement
- SOP-16 – Water Quality Measurements Using a Multiple Parameter Water Quality Meter
- SOP-20 – Decontamination
- SOP-26 – Chain-of-Custody
- SOP-33 – Organic Vapor Measurements
- SOP-49 – Investigation-Derived Waste Management

4.0 EQUIPMENT

The equipment and supplies that may be necessary to collect groundwater samples include:

- Variable-rate, submersible pump and hose assembly with control limit, electrical generator and extension cord, and air compressor or other air supply,
- Teflon® or Teflon®-lined polyethylene tubing,
- Plastic sheeting,
- Drums or other large container for capturing and storing purge water,
- Weighted tape measure,

- Drum liners,
- Trash bags,
- Decontamination tub,
- Low-phosphate detergent (e.g., Liquinox),
- Gloves (nitrile),
- Graduated five-gallon buckets and/or graduated cylinder for measuring flow rate and volumes,
- Paper towels,
- Calculator,
- Digital watch with stopwatch function,
- Well logs, written description of wells including identification numbers, maps, well locations, elevations, well construction details, and (if available) records of previous development and/or purging and sampling,
- Well keys,
- Sample containers,
- Passive Diffusion Bags and related equipment (if required for VOC samples),
- Chain-of-custody forms,
- Sample labels,
- Field data forms,
- Cooler with ice for sample preservation,
- Ziploc® bags,
- Field logbook, and
- Ball-point pen and waterproof permanent marker.

In addition, the following is monitoring equipment that may facilitate sampling.

- Electronic water level indicator and, when necessary, oil/water interface probe,
- Water quality sampling field instrumentation (e.g., pH, temperature, specific conductance, turbidity, dissolved oxygen, oxidation/reduction potential probes), and
- Photoionization detector or flame ionization detector if sampling wells with volatile organic contamination at concentrations that may pose a hazard to worker safety.

Health and safety items may include the following.

- First aid kit and emergency eye-wash kit,
- Fire extinguisher,
- Material Safety Data Sheets,
- Emergency information packet, including map to hospital and phone contacts,
- Field radio or cell phone, and
- Personal protective equipment as specified in the project-specific Health and Safety Plan or Safe Work Plan, as applicable.

5.0 PROCEDURES

5.1 Decontamination

Before purging or sampling, pumps and hoses, water level measurement devices, and other sampling equipment that may come in contact with the sample will be decontaminated in accordance with SOP-20, Decontamination, with the exception of equipment still in the original packaging (for example, disposable bailers). While decontamination of the pump/hose assembly may generally be performed at a central decontamination area, mobile decontamination supplies will be available so that accessory equipment (e.g., electronic water level indicators) can be decontaminated in the field.

Each piece of purging or sampling equipment will be decontaminated prior to and in between sampling operations and wells. Depending on site conditions, the decontamination solutions may be replaced with clean solutions between wells. Decontamination solutions will be handled and disposed of in accordance with SOP-49, Investigation-Derived Waste Management. Typically, sampling should progress from the less contaminated locations to those locations that have, or are more likely to have, degraded groundwater quality.

5.2 Well Monitoring

Equipment used during purging and sampling may include a photoionization detector, flame ionization detector, multi-gas meter, water level indicator, oil/water interface probe, and water quality measurement devices for temperature, pH, conductivity, turbidity, dissolved oxygen, and oxidation/reduction potential. Before going into the field, the Field Team Leader, or designee, will verify that the instruments are operating properly. The instruments will be calibrated in accordance with manufacturer’s specifications.

5.3 Well Purging

The purpose of well purging is to remove stagnant water from the well and obtain a representative sample from the geologic formation being sampled while minimizing disturbance of the water column during sample collection.

5.3.1 Low-Flow Purge Methodology

1. Inspect the well and surrounding area for security, damage, and evidence of tampering.
2. Establish the exclusion zone around the work area, using traffic cones and caution tape where necessary.
3. Don personal protective equipment as specified in the project-specific Health and Safety Plan or Safe Work Plan, as applicable.
4. Locate the well survey reference point. This is usually an indelible mark or V-notch cut in the top of the well casing. If this point is missing, make one on the north side of the well casing.
5. Measure the static water level in the well in accordance with SOP-13, *Static Water Level and Total Depth Measurement.*
6. Containerize wastewater until analytical data are available to determine the proper disposal process in accordance with SOP-49, Investigation-Derived Waste Management.
7. Install the pump to the depth prescribed in the sampling documentation. This depth should correspond to approximately the middle of the screened interval, five feet below the water table or in the instance where the well screen is submerged, 5 feet below the top of the screen.
8. Reinsert the water level to monitor water levels during purging.
9. Start the pump at a low flow rate until surface discharge occurs. Check the water level, if no drawdown occurs, gradually increase the pump rate until the flow is optimized with minimal drawdown. The maximum allowable drawdown is 0.3 feet.
10. Connect the pump discharge tubing directly to the flow-through-cell of the multi-parameter meter.
11. Using a stopwatch and appropriate volume measuring device (e.g., graduated cylinder), monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging.
12. During well purging, monitor selected indicator field parameters (e.g., turbidity, temperature, specific conductance, pH, oxidation-reduction potential, dissolved oxygen) every three to five minutes in accordance with SOP-16, Water Quality Measurements Using a Multiple Parameter Water Quality Meter.
13. When the field parameters have stabilized, disconnect the flow cell from the water path before collecting samples. Water samples for laboratory analyses must be collected before the water has passed through the cell to prevent cross-contamination or chemistry changes. Stabilization is achieved when three consecutive readings show the following:
    - Temperature – ± 1 degree Celsius
    - pH – ± 0.1 pH unit
    - Turbidity – ≤ 10 NTU or ± 10%
    - Conductivity – ± 5%

- Dissolved Oxygen – ± 10%
- Oxidation-Reduction Potential – ± 10 millivolts

If parameters do not stabilize, then a minimum of three casing volumes will be purged before sample collection.

5.3.2 Total Well Volume Purge Methodology

If water level drawdown greater than 0.3 feet occurs at a purge rate of 0.1 L/min or less, or if it is deemed necessary, the total well volume purge methodology will be used.

1. Inspect the well and surrounding area for security, damage, and evidence of tampering.
2. Establish the exclusion zone around the work area, using traffic cones and caution tape where necessary.
3. Don personal protective equipment as specified in the project-specific Health and Safety Plan or Safe Work Plan, as applicable.
4. Locate the well survey reference point. This is usually an indelible mark or V-notch cut in the top of the well casing. If this point is missing, make one on the north side of the well casing.
5. Measure the static water level in the well in accordance with SOP-13, Static Water Level and Total Depth Measurement.
6. Containerize wastewater until analytical data are available to determine the proper disposal process in accordance with SOP-49, Investigation-Derived Waste Management.
7. Install the pump to the depth prescribed in the sampling documentation. This depth should correspond to the middle of the screened interval, five feet below the water table or in instance where the well screen is submerged, 5 feet below the top of the screen.
8. Reinsert the water level (or oil/water interface probe, as appropriate) to monitor water levels during purging.
9. Start the pump at a low flow rate until water discharges at surface. Check the water level, if no drawdown occurs, gradually increase the pump rate until the flow is optimized with minimal drawdown. The pumping rate should never exceed 2 liters per minute (L/min).
10. Connect the pump discharge tubing directly to the flow-through-cell of the multi-parameter meter.
11. Using a stopwatch and appropriate volume measuring device (e.g., graduated cylinder), monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging.
12. During well purging, monitor selected indicator field parameters (e.g., turbidity, temperature, specific conductance, pH, oxidation-reduction potential, dissolved oxygen) every three to five minutes in accordance with SOP-16, Water Quality Measurements Using a Multiple Parameter Water Quality Meter.

13. At a minimum, three total volumes must be purged for this method if the well is not purged dry with a pumping rate less than 2 L/min. If the well is purged dry with a pumping rate less than 2 L/min, then the sample will be collected after a sufficient volume of water has recharged the well regardless of total volume purges and field parameter stabilization. When purging by this methodology, if parameters have not stabilized after three well casing volumes, then purging will cease and samples collected.

    The well volume can be calculated in gallons using the following equation:

    Well Volume V (in gallons) = H x F

    Where:

    V = one well volume

    H = the difference between the depth of the well and depth of water in feet

    F = factor for volume of one foot section of casing as below:

Diameter of Casing (inches)	F Factor (gallons per foot)
1.5	0.09
2.0	0.16
3.0	0.37
4.0	0.65
6.0	1.47

14. When the field parameters have stabilized, disconnect the flow cell from the water path before collecting samples. Water samples for laboratory analyses must be collected before the water has passed through the cell to prevent cross-contamination or chemistry changes. Stabilization is achieved when three consecutive readings show the following:

    - Temperature – ± 1 degree Celsius
    - pH – ± 0.1 pH unit
    - Turbidity – ≤ 10 NTU or ± 10%
    - Conductivity – ± 5%
    - Dissolved Oxygen – ± 10%
    - Oxidation-Reduction Potential – ± 10 millivolts

    If parameters do not stabilize, then a minimum of three casing volumes will be purged before sample collection.

5.4 Sample Collection

Regardless of the purging methodology, samples for laboratory analyses will be collected immediately following purging. For wells that were purged dry, samples will be collected as soon as possible after a sufficient volume of groundwater is available in the well. The following sampling procedure will be used at each well.

1. Immediately following purging, the pump will be used to collect the groundwater sample. The pump should not be removed between purging and sampling unless a peristaltic pump is used.
2. Fill out identification labels for samples bottles for each well.
3. If the order of sample collection is not provided in a work plan, then the individual sample bottles should be filled in the order given below:
   - Volatile organic compounds,
   - Semi-volatile organic compounds,
   - Other organic parameters,
   - Metals (inorganics),
   - Anions,
   - Other parameters, and
   - Field test parameters (e.g., pH, conductivity, and temperature).
4. The VOC vials should be completely filled so the water forms a convex meniscus, or dome, at the top, then capped so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles in the vial. If air bubbles exist, remove cap, carefully top-off vial again with sample to create a dome and gently recap.
5. For all other laboratory samples, fill containers until almost full. Samples will be preserved and managed as detailed in SOP-24 and SOP-23.
6. Record the sampling information in the field logbook and/or the field data sheets.
7. After samples have been collected, immediately place the samples in a cooler with ice for transport to the analytical laboratory in accordance with SOP-23, Sample Handling, Shipping and Documentation.
8. Complete all chain-of-custody information in accordance with SOP-26, Chain-of-Custody.
9. Remove the pump and equipment from the well, replace the well cap, and secure the lock.

5.5 Passive Diffusion Bags

Sampling for VOCs may be accomplished through the use of passive diffusion bags. A passive diffusion bag is made of low-density polyethylene lay-flat tubing that is closed at both ends. Tubes can be 18 to 24 inches long and from 1 to 1.5 inches in diameter.

1. Prior to deployment to the field, fill the passive diffusion bags with laboratory-grade deionized water using a funnel. Fill the sampler until water rises and stands at least two inches up the funnel to expand the sampler to its maximum capacity. Gently squeeze and add more water to expand the membrane and remove air pockets. Repeat as needed until completely full.

2. Insert the plug provided with the sampler firmly into the sampler until the rim of the plug is as close to the nozzle as possible.
3. Inspect the well and surrounding area for security, damage, and evidence of tampering.
4. Establish the exclusion zone around the work area, using traffic cones and caution tape where necessary.
5. Don personal protective equipment as specified in the project-specific Health and Safety Plan or Safe Work Plan, as applicable.
6. Locate the well survey reference point. This is usually an indelible mark or V-notch cut in the top of the well casing. If this point is missing, make one on the north side of the well casing.
7. Measure the static water level in the well in accordance with SOP-13, Static Water Level and Total Depth Measurement.
8. Attach a weight to the bottom of the tether line. For shallow wells (less than 150 ft depth), use an 8-ounce stainless steel weight. For deeper wells, or if deploying multiple samplers in a single well, use a 20-ounce stainless steel weight.
9. Attach the sampler to the tether line.
10. Lower the tether with the sampler(s) attached into the well. Locate the sampler(s) below the water surface at the prescribed depth(s) in the screened interval of the well.
11. Attach the top of the tether line to the well cap or other secure location at the top of the well.
12. Leave the sampler in the well for a sufficient period of time to allow for contaminant concentrations in the sampler to equilibrate with the contaminant concentrations in the groundwater (a three-week deployment is recommended).
13. Retrieve the sampler from the well.
14. Upon retrieval, discharge the sample immediately into the sample containers to avoid loss of VOCs. Select a point on the sampler near the handle/bottom of the sampler. Press one end of the provided discharge tube firmly into the polyethylene membrane at a downward angle until it pierces the membrane. Discharge a small amount to waste to purge the discharge tube prior to filling the sample vials.
15. The VOC vials should be completely filled so the water forms a convex meniscus, or dome, at the top, then capped so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles in the vial. If air bubbles exist, remove cap, carefully top-off vial again with sample to create a dome and gently recap.
16. Record the sampling information in the field logbook and/or the field data sheets.
17. After samples have been collected, immediately place the sample containers in a cooler with ice for transport to the analytical laboratory in accordance with SOP-23, Sample Handling, Shipping and Documentation.

18. Complete all chain-of-custody information in accordance with SOP-26, Chain-of-Custody.
19. Remove any remaining equipment from the well, replace the well cap, and secure the lock.

6.0 RECORDS

All field notes for groundwater purging and sampling will be recorded in the field logbook and/or the field data sheets in accordance with SOP-1, Use and Maintenance of Field Log Books. Entries shall be legible, signed or initialed, and dated.

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1.0 PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure (SOP) is to establish guidelines for the use of a multiple parameter water quality meter such as the Horiba, U-22, or equivalent. Multiple parameter meters measure water quality parameters including pH, temperature, salinity, turbidity, dissolved oxygen (DO), oxidation reduction potential (ORP), and specific conductance in water during well purging, well development, and surface water sampling.

This SOP applies to all personnel who measure water quality parameters using a multiple parameter water quality meter.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

Personnel using this procedure are required to have the appropriate health and safety training as described in either the project-specific Health and Safety Plan or the Safe Work Plan, as applicable. In addition, all personnel are required to understand the procedures described within this SOP and receive specific training, if necessary.

Project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

This procedure is intended to be used with the following SOPs:

- SOP-1 – Use and Maintenance of Field Log Books
- SOP-1 – Groundwater Purging and Sampling
- SOP-20 – Decontamination

4.0 PROCEDURE

Water quality parameters such as pH, temperature, turbidity, DO, conductivity, ORP, and salinity are collected to determine conditions in surface or groundwater at a given location. A series of such determinations can be used to evaluate a variety of situations, from the performance of a groundwater treatment system to the spread of a contaminant plume in groundwater. A multiple parameter water quality meter measures each of these parameters digitally. The pH is a primary parameter measured in the field to determine hydrogen-ion activity. It is measured using a glass electrode in combination with a reference potential. Temperature is measured because many water quality parameters vary with temperature. The solubility of oxygen is temperature dependent as are all electrochemically determined water quality parameters (pH, conductivity).

Turbidity serves as a measure of suspended solids in a water sample. Since these suspended solids might result in elevated apparent concentrations of some contaminants (especially metals), the measurement of turbidity is a critical measurement

DO is an indicator of the oxygen-consuming and oxygen-providing process taking place. It is an indicator of the biochemical processes occurring in the water and is related to the ORP. The most common membrane electrode (ME) meters for determining the DO in water are dependent upon electrochemical reactions. Under steady-state conditions, the current or potential can be correlated with DO concentration. Dynamics at the ME/sample interface are a factor in probe response and a significant degree of interfacial turbulence is necessary to avoid a “stagnant layer” at the interface and resulting biased determinations. For acceptable precision to be obtained, flow over the DO membrane should be constant, as in the case of a flow-through cell used for groundwater sampling or a flowing stream for stream sampling.

Specific conductance is the capacity of a solution to conduct an electrical current as compared to the same volume of pure water. Chemically pure water has a very low electrical conductance, indicating that it is a good insulator. However, total dissolved solids in water increase the electrical conductance of water. In dilute solutions, the specific conductance varies almost directly with the content of total dissolved solids. Salinity of the sample is computed from conductivity data.

4.1 Materials and Equipment

Equipment that will be used to collect water quality measurements using a multiple parameter water quality meter includes, but is not limited to, the following items:

- Multiple parameter water quality meter with power supply;
- Calibration solutions, as specified by the manufacturer;
- Calibration log form and field log book for recording calibration;
- Clean sample containers (glass, plastic);
- Distilled or deionized water in wash bottle; and
- Operating manual for the multiple parameter water quality meter.

4.2 Calibration

The multiple parameter water quality meter may be calibrated in the field by using calibration solutions supplied by a commercial laboratory supply house. The specific calibration procedures in the owner’s manual for the multiple parameter water quality meter should be followed. Generally, the calibration procedure involves measuring the value of a specific parameter in a standard calibration solution of a known value. The meter is typically calibrated to read the known value to within the acceptance criteria. The instrument should be calibrated at the beginning of each workday. The initial instrument response and the final (calibrated) response

will be recorded on the calibration log, along with the date and time of calibration. Calibration will be performed in accordance with the manufacturers' instructions.

4.3 Taking Measurements

After the unit is calibrated, it is ready for use. To take measurements, turn the unit on and carefully place the probe in the water sample. Typically, a select button can be pressed to toggle between the different parameters, if they are not all displayed on screen simultaneously.

Care should be exercised when handling the probes. The water quality meter should be allowed to stabilize before collecting water quality parameter data. When conducting groundwater sampling, a flow-through cell should be used whenever possible to minimize wear and tear on the probes, eliminate the need for stabilization (since the electrode is constantly immersed in groundwater), and improve the consistency of the readings. Multiple determinations as an indication of field precision should be conducted at a ten percent frequency for quality control (QC) purposes. However, measurements more frequently than every tenth reading should be taken if precision problems are apparent.

4.4 Storage

After using the water quality meter, thoroughly wash all probes with analyte free water. The turbidity sensor tube should be periodically washed out with a test tube brush and analyte free water, or according to the manufacturer's instructions. The conductivity guard should be periodically removed to brush away any dirt from the sensor unit. If storing the unit for a week or less, fill the calibration cup with tap water (*not distilled or deionized water, which can damage the probes*) and fit the cap over it. For long-term storage, follow the manufacturer's instructions.

4.5 Additional Considerations

Operators of field equipment should refer to the manufacturer's instructions for step-by-step calibration and usage guidelines. Additional considerations of a general nature include:

- The water quality meter must be checked for mechanical and electrical failures, weak batteries, and cracked or fouled electrodes before field activities.
- Perform calibration using the appropriate solutions as described in the manufacturer's instructions.
- Clean and rinse probes thoroughly using distilled or deionized water in a wash bottle between all samples and at the end of the day. Each time the electrodes are cleaned, they should be examined for damage.
- Some electrodes (e.g., pH and DO electrodes) must NOT be allowed to dry completely, as this may permanently alter the physical or electrochemical properties of the electrode surface.

- Note that oily samples are likely to result in fouling of the electrodes and more aggressive cleaning procedures (such as mild acid washing) will be required, as described in the manufacturer's instruction manual. After such cleaning, a calibration check must be performed; typically such cleaning will necessitate recalibration.

5.0 RECORDS

Documentation, including field survey measurements and QC measurements, will be recorded in the field log book in accordance with SOP-1. Personnel collecting field measurements are responsible for documenting sampling activities in the field log book. The observations and data will be recorded with waterproof ink in a permanently bound weatherproof field log book with consecutively numbered pages.

1.0 PURPOSE AND SCOPE

The purpose and scope of this Standard Operating Procedure (SOP) is to provide procedures for field decontamination of equipment. Decontamination of equipment and personal protective equipment (PPE) is designed to ensure that the introduction and transfer of contamination is minimized. This SOP applies to all personnel collecting environmental samples or operating in environments in which hazardous or contaminating substances are expected to be present. This SOP will be used in conjunction with the project-specific Sampling and Analysis Plan and Health and Safety Plan.

The overall objective of environmental sampling programs is to obtain samples that are representative of conditions within the sampled medium at the sample location. Extraneous contaminant materials can be introduced into the sample medium of interest during the sampling program. Trace quantities of contaminants can thus be captured in a sample and lead to false positive analytical results and, ultimately, to an incorrect assessment of the contaminant conditions. Decontamination of personnel, sampling equipment (e.g., pumps, tubing, and soil/sediment sampling equipment), and field support equipment (e.g., drill rigs and vehicles) is therefore required to minimize the possibility of sampling cross-contamination, exposure to personnel, and transport of contaminated material to clean areas.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring the procedures are followed by all personnel.

All personnel performing this procedure are required to have the appropriate health and safety training as described in either the project-specific Health and Safety Plan or the Safe Work Plan, as applicable. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training to these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

This procedure is intended to be used with nearly all other SOPs.

4.0 EQUIPMENT

The equipment and supplies that may be necessary to perform decontamination activities include:

- Laboratory wash bottles
- Brushes
- Wash tubs (plastic)

- Buckets (plastic)
- Thin window Geiger-Müller detector (if radiological contamination is suspected)
- Scrapers
- Bristle brushes
- High-pressure, hot water washer
- Paper towels
- Alconox™ detergent (or equivalent)
- Potable water
- Deionized or distilled water
- 10% nitric acid solution
- Reagent grade methanol solution
- Water sprayers
- Disposable latex gloves
- Anti-bacterial wipes
- Clean plastic sheeting and/or trash bags.

Health and Safety Items

- First aid kit and emergency eye-wash kit
- Fire extinguisher
- Material Safety Data Sheets
- Emergency information packet, including route map to hospital and phone contacts
- Field radio or cell phone
- Personal protective equipment as specified in the project-specific Health and Safety Plan or Safe Work Plan, as applicable.

5.0 DECONTAMINATION PROCEDURES

Decontamination will be performed during field investigation activities to decontaminate personnel, sample containers, sampling equipment, and heavy equipment. Specific areas where these activities will occur, the methods to be used, and other requirements are described in the following sections.

5.1 Personnel Decontamination

Decontamination procedures for field personnel shall take place prior to individuals leaving the contamination reduction corridor and entering the support zone, and as needed based on field conditions and events. Personnel decontamination will be performed in the designated area established during field mobilization. The decontamination process will include:

1. Remove hard hat and other safety equipment (e.g., protective eyewear), wash with detergent solution, and rinse.
2. Remove PPE coveralls and boot covers (if used) and dispose of them in the specified PPE container.

Note: Ensure that all sprayers are labeled to comply with the hazard communication program and avoid use of the wrong solutions in the decontamination process. Decontamination fluids and solid IDW shall be managed as described in the project SAP.

3. Wash boots or boot covers with detergent solution and rinsing.
4. Perform radiological screening (frisking) of personnel (see the site Health and Safety Plan for procedures), if required.
5. Remove latex gloves and disposed of them in the specified PPE container.
6. Wash hands, face, and forearms with soap and water or anti-bacterial wipes.

5.2 Sampling Containers and Equipment

Procedures for decontamination of sampling equipment apply to:

- Reusable equipment that will and has come in contact with a sample medium
- Wash and rinse tubs/buckets
- Water levels probes
- Sample bottles and coolers.

Disposal items such as disposable filters and tubing that are certified clean by the manufacturer are not subject to decontamination requirements. Decontamination of sampling equipment will in general be performed at individual sample locations. However, any pre-rinsing or decontamination of reusable equipment prior to sampling can be performed at other specified locations suitably established for such activities.

1. Don appropriate PPE as specified in the project-specific HASP. To note, new latex gloves shall be worn when performing equipment decontamination.
2. Scrape off gross contamination from equipment at the sampling site and place in containers specified for investigation-derived waste (IDW).
3. Place the equipment in a wash tub containing detergent solution or spray the equipment with a detergent solution contained within a water sprayer. Scrub the equipment with a bristle brush or similar utensil (if possible).
4. Triple rinse the equipment with deionized or distilled water from a water sprayer or wash bottles catching the rinsate in a second wash tub or bucket.

Note: If decontaminating a well pump, use a 1% nitric acid rinse solution rather than a 10% to avoid corroding the pump. The rinse solutions shall be pumped into a container for IDW water using the pump.

5. In a third wash tub or bucket, rinse equipment with a 10% nitric acid solution or reagent grade methanol, as applicable. A nitric acid rinse will be used when samples are collected for metals analysis with a methanol rinse used for collecting semi-volatile organic compounds.
6. Re-rinse the equipment with deionized or distilled water (note that if time allows for air drying after performing a methanol rinse, this step shall be omitted.
7. Allow equipment to gravity drain or air dry.
8. Perform radiological screening (frisking) of the equipment (see the site Health and Safety Plan for procedures), if required. If elevated readings are encountered (i.e., 100 counts per minute above background), additional decontamination is required.
9. Decontaminate sample containers, as necessary, and perform radiological screening to support shipping requirements in accordance with SOP-23, *Sample Handling, Shipping, and Documentation*.

5.3 Heavy Equipment

Decontamination of heavy equipment, such as drilling equipment (augers, drill rigs) and field vehicles, shall take place at a designated decontamination area. A lined, bermed decontamination pad will be constructed such that decontamination fluids will be contained.

1. Personnel shall don appropriate PPE as specified in the project HASP.
2. Scrape off gross contamination or drill cuttings that are caked on with a flat-bladed scraper or shovel at the sampling or borehole location prior to moving the equipment to the decontamination pad. Containerize the solid waste and handle it in accordance with SOP-49, *IDW Management.*
3. Once moved to the decontamination pad, the heavy equipment will be sprayed with a detergent solution then rinsed with potable water. Care shall be taken to adequately clean the inside surfaces of hollow-stem augers. A high-pressure, hot water washer will be used to decontaminate the heavy equipment.
4. Allow equipment to gravity drain or air dry.
5. Perform radiological screening (frisking) of the equipment (see the site Health and Safety Plan for procedures), if required. If elevated readings are encountered (i.e., 100 counts per minute above background), additional decontamination is required.

6. Following decontamination, drilling equipment shall be placed on the clean drill rig. If the equipment is not used immediately, it shall be stored in an area where it will remain clean. If necessary, equipment storage racks on drill rigs will be cleaned or covered with clean plastic sheeting to assure that decontaminated equipment is not placed in dirty areas for storage.
7. To preclude contamination of clean equipment from blowing dust in a contamination control area, cover equipment with clean plastic sheeting.

6.0 RECORDS

All field notes for decontamination will be recorded in the field logbook in accordance with SOP-1, *Use and Maintenance of Field Log Books*. Entries shall be legible, signed or initialed, and dated. Documented information shall include, as appropriate:

- Personnel who performed the decontamination
- Date and times of decontamination
- Equipment identification numbers
- Decontamination solutions used
- Decontamination observations and procedures
- Photo documentation, if applicable.

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1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used to handle, ship and document samples collected during the Remedial Investigation/ Feasibility Study (RI/FS) at a Client Site.

This SOP is intended to accommodate shipping samples to privately contracted laboratories. If samples are collected for shipment to laboratories procured through the Environmental Protection Agency (EPA) Contract Labs Program (CLP), then see EPA document EPA/540/R-96/032 *Sampler's Guide to the Contract Laboratory Program* for additional handling and shipping information.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP and will be responsible for assigning staff and for ensuring that the procedures are followed by personnel.

Personnel performing these procedures are required to have the appropriate health and safety training. U.S. Department of Transportation and International Air Transport Association regulations require that employees involved with transporting hazardous materials complete specific training requirements. Site personnel will be trained regarding hazardous materials transportation prior to shipment of any hazardous materials. In addition, personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

Project staff will be responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

Related SOPs cross-referenced by this SOP include:

- SOP-10 – Decontamination
- SOP-26 – Chain-of-Custody

4.0 EQUIPMENT

The following equipment will be used for sample labeling, packing, documentation, and Chain-of-Custody procedures:

- Personal protective equipment (PPE) as outlined in the Health and Safety Plan (HSP)
- Radiological monitoring equipment (Ludlum Model 19 Micro R Meter or equivalent)
- Decontamination equipment and supplies (see SOP No. 10 Decontamination)
- Clean sample containers (e.g., glass polyethylene, etc.) with preservatives, if required, as specified in the Quality Assurance Project Plan (QAPP), Section 2.4

- Shipping coolers
- Ziplock® or equivalent plastic bags
- Self-adhesive sample labels
- Shipping forms (provided by shipping courier)
- Shipping labels (e.g., Fragile, This Side Up, etc.)
- Sample labels
- Chain-of-Custody forms
- Custody seals
- Bubble wrap or equivalent packing material
- Tape (clear tape and packing tape)
- Ice
- Paper towels
- Large trash bags

5.0 PROCEDURES

5.1 Sample Identification

Samples collected during site activities will have unique sample identification (ID) numbers. These numbers are necessary to identify and track each sample collected for analysis during the project. In addition, the sample ID numbers will be used in the database to identify and retrieve the analytical results received from the laboratory. The sample ID plan is presented in Section 3 of the Sampling and Analysis Plan (SAP).

5.2 Sample Labeling

Sample labels will be filled out partially before field sampling activities begin. The date, time, sample depth, and sampler's initials or signature should not be completed until the time of sample collection. Sample labels will be filled out using waterproof ink. At a minimum, each label will contain the following information:

- Site location
- Sample ID number
- Sample type
- Date and time of sample collection
- Analyses required
- Method of preservation (if any)

- Sample matrix
- Sampler initials

After the label is completed and attached to the sample container, clear plastic tape will be placed over the label to protect and secure it to the container. Care must be taken during labeling and taping to preclude the possibility of sample contact with label or tape adhesive.

5.3 Sample Handling

This section discusses proper sample containers, preservatives, and handling and shipping procedures. Table 1 summarizes sample analyses, containers, and preservation.

5.3.1 Sample Containers

As available, certified, commercially clean sample containers will be obtained from a subcontracted analytical laboratory or vendor. Required preservatives may be prepared and placed in the bottles at the laboratory before shipment to the site. Alternatively, sample preservatives will be added at the site prior to shipment of samples to the laboratories. Appropriate sample containers are discussed in the QAPP and summarized in Table 1 of this SOP.

5.3.2 Sample Preservation

Samples requiring refrigeration as a means of preservation will be stored on ice in an insulated cooler to maintain a temperature of 4°C immediately following sample collection. As noted above, sample containers for aqueous samples will either be obtained from the laboratory containing the appropriate preservatives or the appropriate preservatives will be added to the bottles at the site.

5.3.3 Radiological Screening

Each sample container must be decontaminated per the requirements of SOP No. 10 Decontamination, prior to transport of samples to support zones or off-site.

Following decontamination, each sample container will be frisked using a thin window Geiger-Muller detector, or equivalent, on the surface of the sample container. If elevated readings (i.e., 1000 or more disintegrations per minute above background) are detected, the container will be decontaminated again. If elevated readings are not indicated, and no other hazardous characteristics are identified, no additional container decontamination is required and the material may be shipped per the requirements of Section 5.3.4 of this SOP.

If elevated readings are detected from the sample container after it has been decontaminated again, the container will be placed in a Ziploc™ bag, labeled “radioactive”, and the highest radiation reading placed on the bag in waterproof ink. After the cooler is packed, meter readings

must be taken across all external surfaces of the closed sample cooler. If the readings do not exceed 0.5 millirem per hour, include the following statement on a regular airbill:

> "Radioactive material, excepted package – limited quantity of material"

Additionally, the following notice must be placed in the cooler:

> "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, exempted package – limited quantity of material – UN2910"

The package is exempted from additional requirements and the samples may now be shipped per the requirements of Section 5.3.4 of this SOP.

If readings greater than 0.5 millirem per hour are detected on any external surface of the cooler, attempt to separate or shield samples so that readings of less than 0.5 millirem per hour may be achieved. When packaging the samples, be sure to eliminate the potential for shifting during transport which could result in readings outside the package exceeding 0.5 millirem per hour. If readings of less than 0.5 millirem per hour cannot be achieved, the samples must be shipped per the requirements of section 5.3.4.1.

5.3.4 Sample Packaging and Shipping

Samples and sample containers will be packaged properly to prevent breakage of containers and leakage of contents. Samples that pass the radiological screening (i.e., frisking) criteria described in Section 5.3.3 will follow the packaging and shipping procedure presented below. Samples that do not pass the radiological screening criteria will follow procedures presented in Section 5.3.4.1.

- If the sample container is glass, wrap individual sample containers with bubble wrap.
- For Marinelli beakers used to collect samples for radon analysis, the lids shall be sealed to the containers using electrical tape. Specifically, place electrical tape around the area where the lid meets the container by winding around the circumference three to four times.
- Place sample containers in recloseable plastic bags.
- Place sufficient amounts of bubble wrap in the bottom and sides of the shipping cooler to prevent movement of contents.
- Line the inside of the cooler with a plastic trash bag, add enough ice (in double bags) to the cooler to maintain the required temperature of 4°C. Line the bottom, sides, and top of cooler to ensure proper shipment temperature. Using at least 3-4 one gallon bags of ice per 48-quart cooler is recommended. Samples for radiological analysis do not require ice. These samples will be placed in a plastic bag inside a cooler. Vermiculite will be added to fill the space surrounding the radiological sample containers to absorb any liquids within the cooler. The sample teams will avoid breathing the dust generated by handling the vermiculite.

- A bottle containing tap water and identified as a temperature blank will be included with each cooler containing samples cooled to 4°C. Upon receipt of the samples at the laboratory, the temperature blank will be used to determine the cooler temperature. The temperature blank will not be assigned a sample identification number and will not appear as a line item on the chain-of-custody form.
- Place samples and temperature blank inside the bag in an upright position. Tie shut the trash bag holding the samples and ice.
- Fill excess space in the cooler with packing material (e.g., bubble wrap) to prevent movement of sample containers.
- Place the original and yellow copy of the chain-of-custody (COC) form inside a plastic bag, and tape the bag inside the cooler lid.
- Close the cooler lid, and seal the cooler and the cooler spout with appropriate packaging tape.
- Place two custody seals (tampering seals) on the cooler in separate areas over (across) the seal between the lid and the cooler base. Tape the custody seals to the cooler to ensure that custody seal is adequately affixed.

A shipping bill should be completed for the shipper and taped to the top of the cooler using the envelope provided by the shipper. The following markings will also be placed on the top of the cooler:

- This End Up
- Fragile
- Laboratory delivery address
- Sender's return address

The pink copy of the shipping bill will be retained by the Sample Manager for attachment to the corresponding COC form. Samples will be hand delivered or shipped by express courier for delivery to the analytical laboratory. The Sample Manager is responsible for verifying that samples collected by the field team have been properly packed in coolers and for verifying the accuracy and completeness of sample labels and COC forms.

The following is a summary of steps to be followed to check that sample management and paperwork is complete:

- Verify sample labels.
- Check or complete the COC form.
- Pack samples in cooler and verify COC form accuracy.
- Verify that labels and forms meet shipping requirements.

- Photocopy the COC form and retain two copies for the project files.
- Send original and yellow copy of the COC form to the laboratory.
- Obtain pink copy of the shipping bill and staple it to the corresponding COC copy.

No samples will be shipped for Sunday delivery. Saturday delivery to the laboratory will require laboratory approval before shipment.

5.3.4.1 Shipping Samples Above Radiological Screening Criteria

Refer to the classification, identification, packing, labeling, documentation and shipping requirements specified in the current versions of the International Air Transport Association "Dangerous Goods Regulations" and U.S. Department of Transportation "Hazardous Materials Regulations" as applicable.

Copies of these regulations will be available in the on-site project file; additional guidance can be obtained by contacting the Project Health and Safety Officer.

5.3.5 Sample Container Tampering

If, at any time after samples have been secured, custody seals on the cooler are identified as having been tampered with, the following procedures will be conducted:

- Check with personnel having access to sample coolers to evaluate whether inadvertent tampering can be documented.
- Document findings of the incident in a logbook.

If it cannot be documented that inadvertent breaking of the custody seal that did not affect the integrity of samples has occurred, the samples will be re-collected and the Project Manager and QA Officer will be notified.

5.3.6 Holding Times and Analyses

The holding time is specified as the maximum allowable time between sample collection and analysis or extraction, based on the analyte of interest, stability factors, and preservative (if any) used. The sample analyses and corresponding holding times are summarized in QAPP Section B.

6.0 RECORDS

This section describes documentation required in the field notes and sample COC requirements.

6.1 Field Notes

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded on field sampling data sheets, and, in a permanently bound

weatherproof field notebook with consecutively numbered pages. The information on field sampling data sheets or in the field notebook will include the following as a minimum. Additional information is included in the specific SOPs regarding the appropriate data sheets.

- Project name
- Location of sample
- Sampler's signature
- Date and time of sample collection
- Sample identification numbers and sample depth (if applicable)
- Description of samples (matrix sampled), composite or grab sample
- Analysis to be performed
- Number and volume of samples
- Description of QA/QC samples (if collected)
- Sample methods or reference to the appropriate SOP
- Sample handling, including filtration and preservation, as appropriate for samples
- Field observations
- Results of any field measurements, such as depth to water, pH, temperature, and conductivity
- Decontamination information
- Calibration information
- Personnel present

Changes or deletions in the field notebook should be lined out with a single strike mark, initialed and dated by person making change, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the collector's memory.

Each page of the field notebook will be signed by the person making the entry. Anyone making entries in another person's field book will sign and date those entries.

6.2 Chain-of-Custody Procedures

The custody of all samples shall be documented on the COC forms. The COC forms document possession of the sample from collection through laboratory receipt. A sample COC form is shown in Appendix C of the QAPP.

Follow appropriate sample custody and documentation procedures precisely to preserve sample integrity and to ensure the validity of field and laboratory data. As a result, sample data will be

traceable from the time and location of sample collection through chemical analyses and to the time when data are used. Information on the custody, transfer, handling, and shipping of samples will be recorded on a COC form.

The following minimum information will be recorded on the COC form:

- Sample ID
- Sampling date and time
- Required analysis
- Number of containers
- Sampler signature

The objective of the custody identification and control system for the samples is to ensure, to the extent practicable, that the following occur:

- All samples scheduled for collection are uniquely identified.
- The correct samples are analyzed and are traceable to their records.
- Important sample characteristics are preserved.
- Samples are protected from loss or damage.
- Any alteration of samples (e.g., filtration, preservation, and dilution) is documented.
- A record of sample integrity is established.
- Legally traceable custody and possession records are maintained.

For this project, a sample is defined as being in an individual's custody if the following conditions occur:

- The sample is in that individual's actual physical possession.
- The sample is in that individual's view after being in their physical possession.
- The sample is in that individual's physical possession and then locked or otherwise sealed so that tampering would be evident.
- The sample is maintained in a secure area that is restricted to authorized personnel only.

General field custody procedures include the following:

- As few people as possible should handle samples.
- The field sampler is personally responsible for the care and custody of the samples collected until they are properly transferred.

- When transferring the samples, the individuals relinquishing and receiving the samples will document the transfer by signing, dating, and writing the time of transfer on the COC form.
- The person responsible for delivering the samples to the laboratory or to the shipping carrier will sign the COC form, retain the third copy of the form, document the method of shipment, and send the original and the second copy of the form with the samples.
- Custody seals shall be attached so that it is necessary to break the seal to open the shipping container. The person affixing the custody seal will sign and date the seal.

Observe general documentation rules, including the use of black ink. Make any changes to the COC form by drawing a single line through the incorrect material and initialing the markout. Put a line through and initial blank lines on the COC form.

Upon receiving the samples, the laboratory's representative shall do the following:

- Sign and keep copies of shipping documents.
- Sign the COC form and return the second copy to the Project Manager (may be included with the analysis results)
- Measure and document the temperature of the samples using temperature blank.
- Document the condition of the custody seals and of the samples.
- Notify the project manager if any breakage or improper preservation has occurred or if there is a discrepancy between the COC form, sample labels, and requested analyses.
- Provide copies of the above documentation to the project manager with the final laboratory data package.
- At the laboratory, custody of all samples will be in accordance with the laboratory QAP and SOP (QAPP, Appendix E) from sample receipt through sample residual disposal.

6.3 Photographs

When photographs, slides, or movies are taken for visual documentation of a site or procedure, they are numbered to correspond to the field logbook entries. If possible, a reference point (building, sign, etc.) is included in the photograph to assist in verifying the location of the photograph and provide an approximate scale. The name of the photographer, date, time, site location, direction viewed, and site description is entered sequentially in the logbook as photos are taken.

Table 1

SAMPLE ANALYSES, CONTAINERS AND PRESERVATION

Analytical Parameter (a)	Sample Matrix	Preservation	Number/Minimum Volume of Container(s)
Total Metals	Groundwater	pH < 2 with HNO_3	1 1-liter poly (b)
Dissolved Metals	Groundwater	Filtration through a 0.45 micron filter followed by pH < 2 with HNO_3	1 1-liter poly (b)
Anions, TSS, TDS, Alkalinity, Total Phosphorus, Phosphate	Groundwater	Cool to 4 °C	1 1-liter poly (b)
Ammonia, COD	Groundwater	pH < 2 with H_2SO_4 and cool to 4 °C	1 1-liter poly (b)
U234, U235, U238	Groundwater	pH < 2 with HNO_3	1 1-liter poly (c)
Rn222	Groundwater	pH < 2 with HNO_3	1 1-liter marinelli (d)
Total Metals	Surface Water	pH < 2 with HNO_3	1 1-liter poly (b)
Dissolved Metals	Surface Water	Filtration through a 0.45 µm filter followed by pH < 2 with HNO_3	1 1-liter poly (b)
Anions, TSS, TDS, Alkalinity, Total Phosphorus, Phosphate	Surface Water	Cool to 4 °C	1 1-liter poly (b)
Ammonia, COD	Surface Water	pH < 2 with H_2SO_4 and cool to 4 °C	1 1-liter poly (b)
U234, U235, U238	Surface Water	pH < 2 with HNO_3	1 1-liter poly (c)
U234, U235, U238, Th227, Th228, Th230, Th232, Ra226, Ra228, gross alpha, gross beta	Surface Water	pH < 2 with HNO_3	2 1-gallon poly (c)
Rn222	Surface Water	pH < 2 with HNO_3	1 1-liter marinelli (d)
Pb210	Surface Water	pH < 2 with HNO_3	1 1-liter poly (b)
Po210	Surface Water	pH < 2 with HNO_3	1 1-liter poly (b)
Metals, Mercury, Anions, Ammonia, Total Phosphorus, Orthophosphate, Carbonate, Bicarbonate, pH, TOC	Sediment (e)	Cool to 4 °C	2 8-oz glass or poly (b)
Particle Size Distribution	Sediment (e)	None	1 8-oz glass or poly (c)
U234, U235, U238, Th227, Th228, Th230, Th232, Ra226, Ra228, Pa231	Sediment (e)	None	1 1-liter poly (c)
Pb210, Po210	Sediment (e)	None	1 4-oz poly (d)
Cation Exchange Capacity (CEC) including exchangeable bases, Soluble Exchangeable Metals (SEM)/Phosphorus, Gravimetric Clay Content plus Particle Size Distribution	Sediment (e)	Cool to 4 ºC (necessary for CEC and SEM)	1 8-oz glass or poly (b)

Analytical Parameter (a)	Sample Matrix	Preservation	Number/Minimum Volume of Container(s)
Metals, Mercury, Anions, Ammonia, Total Phosphorus, Orthophosphate, Carbonate, Bicarbonate, pH, TOC	Surface Material (e)	Cool to 4 °C	2 8-oz glass or poly (b)
Particle Size Distribution	Surface Material (e)	None	1 8-oz glass or poly (c)
U234, U235, U238, Th227, Th228, Th230, Th232, Ra226, Ra228, Pa231	Surface Material (e)	None	1 1-liter poly (c)
Pb210, Po210	Surface Material (e)	None	1 4-oz poly (d)
Radon Emanation Fraction	Surface Material (e)	None	1 16-oz glass or poly
pH, TOC, % Moisture, Metals (f)	Subsurface Material (e)	Cool to 4 ºC	1 8-oz glass or poly (b)
U234, U235, U238, Th227, Th228, Th230, Th232, Ra226, Ra228, Pa231 (f)	Subsurface Material (e)	None	1 1-liter poly (c)
Cation Exchange Capacity (CEC) including exchangeable bases, Soluble Exchangeable Metals (SEM)/Phosphorus, Gravimetric Clay Content Plus Particle Size Distribution	Subsurface Material (e)	Cool to 4ºC (necessary for CEC and SEM)	1 8-oz glass or poly (b)

Table 1 Footnotes:

(a) All definitive methods and some screening methods will be conducted at an analytical laboratory. The following screening methods will be performed in the field at the time of sampling: pH (water only), temperature, specific conductance, Eh, turbidity, dissolved oxygen and ferrous iron.

(b) One in twenty samples require triple volume for laboratory QC. Field QC to be collected at the QAPP-specified frequency.

(c) One in ten samples require double volume for laboratory QC. Field QC to be collected at the QAPP-specified frequency.

(d) One in twenty samples require double volume for laboratory QC. Field QC to be collected at the QAPP-specified frequency.

(e) All sediment, surface material, and subsurface material will be sieved through a No. 10 mesh prior to collecting the sample in the specified container. Completely fill specified containers.

(f) Metals and radiological analysis on subsurface material will not be performed initially. Rather, these samples will be held by the laboratory (for potential future metals analysis excluding mercury) until an evaluation of the surface material sample data is completed.

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1.0 PURPOSE AND SCOPE

The purpose and scope of this Standard Operating Procedure (SOP) is to define protocols for maintenance of the chain-of-custody. This SOP applies to all personnel responsible for collecting, shipping, and analyzing environmental samples.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring the procedures are followed by all personnel.

All personnel performing this procedure are required to have the appropriate health and safety training as described in either the project-specific Health and Safety Plan or the Safe Work Plan, as applicable. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training to these procedures, if necessary.

All project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

This procedure is intended to be used with the following SOPs:

- SOP-1 – Use and Maintenance of Field Log Books
- SOP-23 – Sample Handling, Shipping and Documentation

4.0 EQUIPMENT

The equipment and supplies that may be necessary for maintaining chain-of-custody include:

- Chain-of-custody forms
- Sample labels
- Field data forms
- Custody seals
- Field logbook
- Pens and waterproof permanent marker

5.0 PROCEDURES

Chain-of-custody is the process whereby traceability of samples is maintained from the moment of sample collection until laboratory analysis is completed and the sample is disposed. Chain-of-custody forms are used to legally track samples from the time of collection through completion of laboratory analysis and ultimately final disposal of the sample.

5.1 Chain-of-Custody Forms

1. Ensure the following information is written on the chain-of-custody form:

    - Project name
    - Name and address of laboratory
    - Analysis type and method
    - Site name
    - Name of receiving laboratory
    - Sample identification numbers for all samples
    - Sample matrix or matrix code (e.g., SO for soil)
    - Sample type (environmental, trip blank, equipment blank, etc.), which is encrypted in the sample identification code
    - Number of containers
    - Quality control (QC) required (e.g., matrix spike, matrix spike duplicate analyses)
    - Date of collection (mm/dd/yyyy)
    - Time of collection (military format – hh:mm)
    - Signature of individual preparing the chain-of-custody form
    - Cooler identification
    - Carrier service and airbill number
    - Signature of individual relinquishing samples along with the date and time the samples were relinquished.

2. Upon completion of the form, retain two copies and affix the original and one copy to the inside of the sample cooler (in a Ziploc® bag to preclude moisture).

3. Affix a completed custody seal to the bag.

4. Ensure that both electronic copies and hard copies of the chain-of-custody forms are submitted for inclusion in the project file.

5. Upon receipt, the laboratory shall inspect the shipping cooler and note whether the custody seals

5.2 Custody Maintenance

Custody shall be maintained at all times either visually or through the use of chain-of-custody forms and custody seals.

1. After samples are placed in a shipping cooler and the chain-of-custody form is completed and copies placed inside the cooler, the cooler shall be closed.
2. Fill out the required information on two custody seals and affix one custody seal to the front of the cooler and a second custody seal to the side ensuring that the seals cross between the cooler lid and the main body of the cooler. Place clear packing tape over the top of each custody seal to ensure that the seals remain intact and to protect the written information on the custody seals.
3. Upon receipt, the laboratory shall inspect the shipping cooler and note whether the custody seals are intact.
4. The laboratory shall open the shipping cooler and inspect the contents for comparison to the enclosed chain-of-custody form(s) to ensure that the samples indicated on the form(s) are present.
5. The laboratory shall note any discrepancies found and sign the chain-of-custody form acknowledging receipt.
6. The laboratory shall retain custody of all samples in accordance with established laboratory procedures.
7. Following completion of all required analyses and approval of the project, the laboratory will dispose of any unused sample material in accordance with established laboratory procedures, note the final disposition on the chain-of-custody form(s), and sign the forms accordingly.
8. The laboratory shall return the original chain-of-custody form to the project for inclusion in the project file.

6.0 RECORDS

The chain-of-custody record will be distributed as follows:

- Original and one copy – sealed in plastic bag with a custody seal (initialed and dated) and taped inside the lid of the shipping container
- One copy – file in the Project File
- One copy – submit to the project database manager for inclusion in the Project Electronic File.

1.0 PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure (SOP) is to ensure that Investigation-Derived Waste (IDW) generated as the result of environmental investigations is managed as follows:

- In a manner consistent with the federal and state applicable or relevant and appropriate requirements;
- To ensure that the potential of further contamination to the site from IDW is eliminated;
- To ensure the quantity of generated IDW is minimized;
- To provide labeling, tracking, and inventory of IDW; and
- To reduce health and safety concerns by reducing the potential for exposure.

This SOP applies to contractor personnel and subcontractors generating, transporting, and handling IDW during environmental investigations and monitoring programs. This SOP describes the minimum acceptable practices. Do not sign any hazardous waste manifests or in any other way imply URS is responsible for the waste.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager has the overall responsibility for implementing this SOP. The Project Manager will be responsible for assigning staff to implement this SOP and for ensuring that the procedures are followed by all personnel.

All personnel performing this procedure are required to have the appropriate health and safety training as described in either the project-specific Health and Safety Plan or the Safe Work Plan, as applicable. In addition, personnel are required to understand the procedures described within this SOP and receive specific training to these procedures, if necessary. Project staff are responsible for reporting deviations from this SOP to the Project Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

This procedure is intended for use with the following SOPs:

SOP-1	Use and Maintenance of Field Log Books
SOP-2	Aquifer Testing
SOP-5	Borehole Logging (includes soil and rock)
SOP-6	Boring-Monitoring Well-Piezometer Installation
SOP-8	Drilling and Sampling of Subsurface Materials
SOP-10	Geotechnical Investigation
SOP-11	Soil Boring / Well Installation

SOP-12 Monitoring Well Development

SOP-15 Groundwater Purging and Sampling

SOP-20 Decontamination

SOP-23 Sample Handling, Shipping and Documentation

SOP-25 Field Sample Management

SOP-28 Sediment Sampling

SOP-29 Soil and Waste Sampling

SOP-30 Soil Sampling

SOP-32 Soil Sampling for Analyses of Radionuclides

SOP-35 Collection of Composite Soil Samples for Compliance Purposes

SOP-36 Collection of Soil Samples for Metals Analysis

SOP-37 Collection of Soil Samples for VOCs

SOP-38 Sampling (low level Hg, XRF, radiological, etc.)

SOP-40 Surface Material Sampling

SOP-42 Surface Water Sampling

4.0 EQUIPMENT

Equipment that may be used to comply with this SOP is as follows:

Major Equipment Items

- 20-yard (or similar capacity) roll-off bins with tarps to cover;
- 250-gallon truck tank(s);
- Submersible pump(s), hoses, and clamps;
- Boom truck;
- Flat-bed truck; and
- Drums, drum forks, and clamps;

Equipment Support and Sampling Items

- Drum labels and liners;
- Field supplies such as pallets, plastic sheeting, rope, drum liners, paint pens, tape, and hand tools;

- Sampling and shipping supplies such as bottles, coolers, plastic bags, vermiculite, self-closing plastic bags, labels, tapes, and bubble wrap;
- Field forms, logbooks, and materials necessary for the documentation of the IDW management:
- Soil sampling equipment such as hand auger, trowels, bowls, sieves, drum thieves, disposable bailers, funnels, and bottles;
- Personal protective equipment (PPE), first aid supplies from sites and vehicles, and eye wash stations;
- First aid kit and emergency eye-wash kit;
- Fire extinguisher;
- Material Safety Data Sheets;
- Emergency information packet, including route map to hospital and phone contacts;
- Field radio or cell phone;
- Health and safety equipment and monitoring equipment; and
- Spill kit that contains absorbent booms or pads, vermiculite, hand tools, spill-related PPE.

5.0 PROCEDURES

IDW consist of wastes generated during environmental site investigations and sampling activities including soil cuttings and other soil wastes; fluids from well drilling, aquifer testing, well purging, sampling, and decontamination; and disposable sampling and personal protection equipment.

5.1 Solid Investigation-Derived Waste

Solid waste that is generated, stored, processed, transported or disposed of must be classified according to the provisions of Arizona Administrative Code, Title 18, Chapter 13.

Non-indigenous solid IDW such as disposable sampling equipment or tools will be disposed of at a licensed landfill. Used PPE such as Tyvek® or Saranac® suits; latex, nitrile, or rubber gloves or booties; and spent respirator filters will be disposed as hazardous, non-hazardous, or radioactive waste in an appropriate designated drum/container/dumpster based on its generation. PPE generated from coming into contact with listed or characteristic hazardous waste, will be disposed in a separate drum/container/dumpster designated for hazardous waste and shipped to a licensed facility. However, PPE generated during the investigation from non-hazardous waste areas will be placed in a separate container and will be managed as non-hazardous waste.

Grossly contaminated PPE will be put into a ring-top 55-gallon drum with plastic bag drum liner. When the drum is full, the liner bag will be sealed, the lid closed, and the drum will be numbered, labeled, and moved to the secured site drum holding area.

Indigenous solid IDW Solids generated during an investigation will be collected and placed in appropriate designated containers and manifested off-site for disposal based on the characteristics as hazardous waste, non-hazardous waste, or radioactive waste. For solids where the nature of contamination is not known, the contractor must first determine whether the waste is hazardous or non-hazardous using either historical information or data from sampling. Waste, such as drill cuttings or other solid media that may be generated, will be stored at the sampling location or a designated location. As the IDW is generated, it will be placed into ring-top 55-gallon drums or roll-off bins. Containers storing hazardous waste must be marked using a yellow "Hazardous Waste" label with the name, address, city, state, zip code, EPA ID number, EPA waste number, accumulation start date, manifest document number and DOT shipping name.

5.1.2 Solid Waste Sampling and Characterization

Generators who classify waste using analytical methods must follow all state requirements. Where required by the disposal facilities, additional samples from each drum/container may be required. For each container, the analytical data will be evaluated to determine if the IDW is hazardous waste. To determine the characteristic of the IDW, the analytical results will be compared to the Toxicity Characteristic Leaching Procedure (TCLP) regulatory limit (40 CFR 261.24).

The field sampler will document field-screening data and the IDW at each site will be contained, managed, and sampled as a single waste stream. Grossly contaminated non-indigenous IDW will be characterized as special or hazardous waste. The drums will be labeled, manifested, transported, and disposed of at a licensed RCRA hazardous/special waste landfill.

Indigenous solid IDW will be classified after analytical data are available. If soil is determined to be suitably free of contamination and can be classified as a Class 3 waste, it may be used as clean fill on site or taken out of the drums and put onto the ground at the location it was generated. If the IDW is found to be either a special waste or a hazardous waste, then the container will be labeled, manifested, transported, and disposed of at an appropriate licensed landfill. The landfill will be certified according to 40 CFR 300.440.

5.1.3 Analytical Methods

The hazardous waste characteristics are defined in 40 CFR 261 Subpart C. Those characteristics include ignitability, corrosivity, reactivity, and TCLP levels. In the TCLP procedure, samples are analyzed for TCLP metals, TCLP volatile and semivolatile organic compounds. All waste streams shipped off-site for disposal will be analyzed for RCRA characteristics in accordance with 40 CFR 261 Subpart C. For purposes of determining accurate waste classification, SW-846 analytical method, using internally derived quality control limits, is adequate for off-site disposal. Typically, the laboratory will be associated with the disposal company and will provide relevant information such as bottle sizes, holding times and sample preparation. All samples analyzed for IDW characterization will be collected in compliance with the project-specific plans.

5.2 Liquid Investigation-Derived Waste

It is expected that during sampling activities liquids will be generated. The liquid IDW generated at each location, such as groundwater from the purging and development of monitoring wells and wastewaters from the decontamination of equipment will be characterized to determine types of contaminants present and the management process required to handle the waste. Liquid IDW may, at the Project Manager and client direction, be combined from several sites if the IDW is determined to be non-hazardous. Historic results may be used to make this determination. The disposal options for liquids may include disposal by evaporation provided there is no potential to violate air permit requirements or discharge into the sanitary sewer if allowed. Any liquids that cannot be eliminated by evaporation or discharged into the sanitary sewers will be contained and disposed of properly.

5.2.1 Liquid Waste Characterization

If the IDW is found to be a special or hazardous waste as defined in 40 CFR 261, Subpart D, then the container will be labeled, manifested, and stored in a secured area with temporary berms, until it can transported for disposal to a licensed RCRA hazardous/special waste disposal facility. Empty drums will be decontaminated and if structurally sound, will be reused. If the drum is not structurally sound, the drum will be decontaminated, crushed, and recycled as scrap.

5.2.2 Sampling and Analysis of Liquid IDW

Representative composite samples will be collected and analyzed to characterize the liquid IDW. The samples will be labeled, sealed, recorded on the chain of custody, packaged, and shipped to the laboratory for analysis. The hazardous waste characteristics are defined in 40 CFR 261 Subpart C. Those characteristics include: toxicity, ignitability, corrosivity, reactivity, and TCLP levels for metals, volatile, and semi-volatile organic compounds. For purposes of determining accurate waste classification, any commercial laboratory capable of performing SW-846 analytical method, using internally derived quality control limits, meet the requirement for waste classification. Typically, the laboratory will be associated with the disposal company and will provide relevant information such as bottle sizes, holding times and sample preparation.

5.3 IDW Management Procedures

5.3.1 Drum Specifications

The drums to be used for the collection of wastes will be in new or reconditioned condition. Drums should be selected for their ability to hold hazardous, radioactive, and non-hazardous liquids and solids without damage to drum integrity. Special care should be taken in the selection of drums in areas where wastes will be collected and that are known to be reactive, corrosive, or contain organic solvents. The drums will be marked with weather proof indelible ink identifying the sampling locations associated with the waste. These markings will be located on the top and side of the drum. Each drum will be stored in a manner so that the drum and attached labels can be inspected without moving the drum or surrounding drums.

5.3.2 Waste Tracking Labels and Transport

Container labels will be placed on the side and top of each container and will include the following information at a minimum: generator; contents; the estimated depth collected (if applicable); date the waste was first put in the container; date the container was closed; estimated quantity; the name, address, and phone number of an emergency Point of Contact for additional information concerning the container, and the words “Waste Solids” or “Waste Liquids”. The drums will comply with DOT regulations outlined in 40 CFR.

Where site conditions dictate, drums will be placed on a flat bed truck or trailer using a forklift or Bobcat and transported to the designated central IDW staging area. Roll-off bins will be transported on a flatbed trailer to the central IDW staging area when 2/3^{rds} full or after the roll-off bin is no longer needed. Straps will be used to secure the drums when they are placed on the flat bed and transported to the IDW staging area. Do not sign any hazardous waste manifests or in any other way imply URS is responsible for the waste.

5.3.3 Drum Inspections

The drums will be stored at the sampling location or designated location. The drums will rest directly on a gravel/soil substrate with a secondary containment. Any spills will be reported immediately to the Field Manager and the Project Manager. If drum integrity is compromised, it will be immediately corrected. All drums will remain closed at all times except during accumulation or when waste is being sampled or removed.

Drums will be inspected periodically by the Field Manager or designee who will document in the field logbook or on a checklist the condition of each drum. Initiation of any necessary corrective actions will be the responsibility of Field Manager and coordinated with the client. Any corrective actions will be discussed with the Air Force and it contractor’s project management personnel.

5.3.4 Storage Time Limitations

Potential RCRA hazardous IDW generated will be temporarily stored for no longer than 90 days from beginning date of collection. According to 40 CFR 262.34(a), a generator may accumulate hazardous waste on-site for 90 days or less without a permit or without having interim status provided that the requirements in 40 CFR 262.34(a) are met. The storage unit will conform to 40 CFR 262.34(a), having a secondary containment system lined with 10-mil plastic.

6.0 RECORDS

The following records will be maintained by the Project Manager and retained as project documents.

- Field log books;
- Water treatment logs, sample collection data sheets, and discharge records; and
- Analytical results from IDW sampling.

7.0 REFERENCES

- 40 Code of Federal Regulations (CFR) 261, Subpart D
- Arizona Department of Environmental Quality Investigation Derived-Wastes Policy, Document No. 4013.001 August 2005.

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APPENDIX B

ESC Lab Sciences Quality Assurance Manual (provided electronically)

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Quality Assurance Manual

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Version 12.0 4/15/14

COMPREHENSIVE QUALITY ASSURANCE MANUAL

for

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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.

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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 National Environmental Laboratory Accreditation Conference (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 (International Organization for Standardization) 17025, NELAC, Department of Defense Quality Systems Manual (DOD QSM), and the American Industrial Hygiene Association (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
- aquatic toxicity analysis

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/IEC 17025, The TNI Standard, DOD QSM. The effectiveness of the quality system is measured by accreditation maintenance, internal and external audits, management reviews, proficiency sample testing, and an active preventive/corrective action system.

2.1.3 Analytical Capabilities:

Where mandated, only approved 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.*
	40 CFR part 136
	Methods for Chemical Analysis of Water and Wastes (March 1983)
	Standard Methods for the Examination of Water and Wastewater (20th through 22nd 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 (20th through 22nd 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 1622: *Cryptosporidium in Water by Filtration/IMS/FA, December 2005.*
	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)*

Routine Methodology and Programs	
PROGRAM	***METHOD SOURCE***
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.
	OSHA Sampling and Analytical Methods (online)
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
MOLD	*American Industrial Hygiene Association*
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 operating 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 and the 2009 TNI Standard (EL-V1M2-ISO-2009, Section 3.0).

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 item, process, or service defined in requirement documents.
Accreditation Body	The territorial, state or federal agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation.
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 each group of 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 prepared and/or analyzed together with the same process and personnel using the same lot(s) of reagents.
Bias	The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).
Blank	See FIELD, TRIP, METHOD, EQUIPMENT, INSTRUMENT, REAGENT

Table 3.3a Definitions	
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.
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 and/or within the range of instrument linearity.
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 at regular intervals within a batch and is typically utilized in Metals 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.
Confirmation	The verification of the identity of a compounent through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second column confirmation, alternate wavelength, derivatization, mass spectral interpretation, alternative detectors, additional cleanup procedures, etc.
Corrective Action	An action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

Table 3.3a Definitions	
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.
Data Reduction	The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form.
Document Control	The act of enduring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.
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 media which has been used to rinse the sampling equipment. to demonstrate complete decontamination of the equipment.
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) that is prepared in the field by filling a clean container with pure deionized water and appropriate preservation, if any, for the specific sampling activity being performed.
Holding Time (Max. Holding Time)	The maximum time that samples may be held prior to analysis and still be considered valid or not compromised.
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%. An initial calibration curve is verified using a secondary source if one is available.
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.
Internal Standard	A known amount of standard added to a test portiong of a samples as a reference for evaluating and controlling the precision and bias of the applied analytical method.
Instrument Blank	A clean sample processed through the instrumental measurement process, used to determine the level of instrument contamination.
Instrument Detection Limit (IDL)	IDL is the smallest signal above background noise that an instrument can reliably detect.

Table 3.3a Definitions	
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 an 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.
Laboratory Control Sample (LCS) - also referred to as a Laboratory Fortified Blank (LFB), Spiked Blank, or QC Check Sample	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 LCS is a secondary source if one is available. 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.
Laboratory Duplicate	Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.

Table 3.3a Definitions	
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.
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.

Table 3.3a Definitions	
Matrix Spike (MS), also referred to as a Laboratory Fortified Matrix (LFM), Spiked Sample, or Fortified Sample	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. $$PercentSpikeRecovery = \frac{O_i - O_s}{T_i} X\ 100$$ 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.
Method Blank	A sample of a clean matrix similar to the batch of associated samples, when available, that is free from the analytes of interest and is processed simultaneously under the same conditions as samples through all steps of the analytical procedures. The matrix should not contain target analytes at concentrations that impact the analytical results for the field sample analysis.
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: $$\%\ Recovery = \left[\frac{Observed\ Value}{True\ Value}\right] X\ 100$$
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.

Table 3.3a Definitions	
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 degree to which a set of observations or measurements of the same property obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms
Preparation Batch	A group of samples, as defined by the guidance document, of the same matrix prepared together with the same process and personnel having a maximum elapsed time of 24 hours between the start of processing of the first and last samples in the batch.
Preservation	Refrigeration and/or reagents added to a field sample at collection (or later) to maintain the integrity of the sample.
Proficiency Testing	A means to evaluate a laboratory's performance under controlled conditions relative to a given set of criteria, through analysis of unknown samples provided by an external source.
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	An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.
Quality Control	The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users.
Quality Control Sample	A sample used to assess the performance of all or a portion of the measurement system.
Reagent Blank	A sample consisting of reagents, without the target analyte or sample matrix, introducted into the analytical procedure at appropriate points and carried through all subsequent steps to determine the contaminant contribution of the reagents and the involved analytical steps.
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.

Table 3.3a Definitions	
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.
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.

Table 3.3a Definitions	
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.
Traceability	The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons.
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.
Validation	The confirmation by examination and provision of evidence that the particular requirement for specific intended use are fulfilled.
Verification	Confirmation by examination and provision of evidence that specified requirements have been met.

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	Method	Parameter
AE	EPA TO-15	Ethanol
AE	EPA TO-15	Gasoline range organic
AE	EPA TO-15	Naphthalene
AE	EPA TO-15	Allyl chloride
AE	EPA TO-15	Chlorotoluene (2-)
AE	EPA TO-15	Isopropylbenzene
AE	EPA TO-15	Methyl methacrylate
AE	EPA TO-15	Trimethylpentane (2,2,4-)
AE	EPA TO-15	Tert-butyl alcohol
AE	EPA TO-15	Tetrahydrofuran
AE	EPA TO-15	Vinyl bromide
AE	EPA TO-15	Dibromoethane (1,2-) (EDB)
AE	EPA TO-15	Dichloroethene (1,1-)
AE	EPA TO-15	Hexachlorobutadiene (1,3-)
AE	EPA TO-15	Hexanone (2-)
AE	EPA TO-15	Acetone
AE	EPA TO-15	Chloromethane
AE	EPA TO-15	Dibromochloromethane
AE	EPA TO-15	Dichlorodifluoromethane
AE	EPA TO-15	Dichloroethene (cis-1,2-)
AE	EPA TO-15	Dichloroethene (trans-1,2-)
AE	EPA TO-15	Dichloropropene (trans-1,3-)
AE	EPA TO-15	Dichlorotetrafluoroethane (1,2-)
AE	EPA TO-15	Ethylbenzene
AE	EPA TO-15	Ethyltoluene (4-)
AE	EPA TO-15	Isopropanol
AE	EPA TO-15	Propylene
AE	EPA TO-15	Trichlorofluoromethane
AE	EPA TO-15	Vinyl chloride
AE	EPA TO-15	Acetaldehyde
AE	EPA TO-15	Acetonitrile
AE	EPA TO-15	Benzene

Matrix	Method	Parameter
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	Cyclohexane
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	Dichloroethane (1,1-)
AE	EPA TO-15	Dichloroethane (1,2-)
AE	EPA TO-15	Dichloropropane (1,2-)
AE	EPA TO-15	Dichloropropene (cis-1,3-)
AE	EPA TO-15	Dioxane (1,4-)
AE	EPA TO-15	Heptane (n-)
AE	EPA TO-15	Hexane (n-)
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 (MIBK)
AE	EPA TO-15	Methyl tert-butyl ether
AE	EPA TO-15	Methylene chloride (Dichloromethane)
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	Tetrachloroethane (1,1,2,2-)
AE	EPA TO-15	Tetrachloroethene
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	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
AE	EPA TO-15	Vinyl acetate
AE	EPA TO-15	Xylene (m-)

Matrix	Method	Parameter
AE	EPA TO-15	Xylene (o-)
AE	EPA TO-15	Xylene (p-)
AE	EPA TO-15	Xylenes (total)
AE/NPW	RSK-175	Ethane
AE/NPW	RSK-175	Ethene
AE/NPW	RSK-175	Methane
AE/NPW	RSK-175	Propane
AE/NPW	RSK-175	Acetylene
DW	EPA 150.1	pH
DW	EPA 1622	Cryptosporidium
DW	EPA 1623	Cryptosporidium
DW	EPA 180.1	Turbidity
DW	EPA 200.7	Silica
DW	EPA 200.7	Arsenic
DW	EPA 200.7	Cadmium
DW	EPA 200.7	Chromium
DW	EPA 200.7	Copper
DW	EPA 200.7	Calcium-hardness
DW	EPA 200.7	Total hardness
DW	EPA 200.7	Magnesium
DW	EPA 200.7	Sodium
DW	EPA 200.7	Calcium
DW	EPA 200.7	Aluminum
DW	EPA 200.7	Barium
DW	EPA 200.7	Beryllium
DW	EPA 200.7	Iron
DW	EPA 200.7	Manganese
DW	EPA 200.7	Nickel
DW	EPA 200.7	Silver
DW	EPA 200.7	Zinc
DW	EPA 200.8	Barium
DW	EPA 200.8	Manganese
DW	EPA 200.8	Beryllium
DW	EPA 200.8	Nickel
DW	EPA 200.8	Zinc
DW	EPA 200.8	Silver
DW	EPA 200.8	Antimony
DW	EPA 200.8	Arsenic
DW	EPA 200.8	Cadmium
DW	EPA 200.8	Chromium

Matrix	Method	Parameter
DW	EPA 200.8	Copper
DW	EPA 200.8	Lead
DW	EPA 200.8	Selenium
DW	EPA 200.8	Thallium
DW	EPA 218.6	Chromium (VI)
DW	EPA 218.7	Chromium (VI)
DW	EPA 245.1	Mercury
DW	EPA 300.0	Nitrite
DW	EPA 300.0	Nitrate
DW	EPA 300.0	Fluoride
DW	EPA 300.0	Sulfate
DW	EPA 300.0	Bromide
DW	EPA 300.0	Chloride
DW	EPA 300.1	Nitrite
DW	EPA 300.1	Nitrate
DW	EPA 300.1	Fluoride
DW	EPA 300.1	Chloride
DW	EPA 314.0	Perchlorate
DW	EPA 335.4	Cyanide
DW	EPA 350.1	Ammonia
DW	EPA 353.2	Nitrate
DW	EPA 353.2	Nitrite
DW	EPA 504.1	Dibromoethane (1,2-) (EDB)
DW	EPA 504.1	Dibromo-3-chloropropane (1,2-)
DW	EPA 507	Alachlor
DW	EPA 507	Butachlor
DW	EPA 507	Metolachlor
DW	EPA 507	Metribuzin
DW	EPA 507	Atrazine
DW	EPA 507	Simazine
DW	EPA 524.2	Tetrahydrofuran
DW	EPA 524.2	Dichloro-2-butene (trans-1,4-)
DW	EPA 524.2	Hexachloroethane
DW	EPA 524.2	Acetone
DW	EPA 524.2	Butanone (2-)
DW	EPA 524.2	Carbon disulfide
DW	EPA 524.2	Hexanone (2-)
DW	EPA 524.2	Methyl iodide
DW	EPA 524.2	Pentanone (4-methyl-2-) (MIBK)
DW	EPA 524.2	Trichlorobenzene (1,3,5-)

Matrix	Method	Parameter
DW	EPA 524.2	Bromochloromethane
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-)
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	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-)

Matrix	Method	Parameter
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-)
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 552.2	Bromochloroacetic acid
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	SM 2120 B	Color
DW	SM 2130 B	Turbidity
DW	SM 2150 B	Odor
DW	SM 2320 B	Alkalinity
DW	SM 2340 B	Total hardness
DW	SM 2340 C	Total hardness
DW	SM 2510 B	Conductivity
DW	SM 2540 C	Total dissolved solids (TDS)
DW	SM 3120 B-11	Total hardness
DW	SM 4110 B	Bromide
DW	SM 4110 B	Nitrite
DW	SM 4110 B	Nitrate
DW	SM 4110 B	Fluoride
DW	SM 4110 B	Sulfate
DW	SM 4110 B	Chloride

Matrix	Method	Parameter
DW	SM 4500-Cl G	Chlorine - residual
DW	SM 4500-CN C, E	Cyanide
DW	SM 4500-CN C, G	Cyanide
DW	SM 4500-H B	pH
DW	SM 4500-NH3 G	Ammonia
DW	SM 4500-NO3 F	Nitrate
DW	SM 4500-NO3 F	Nitrite
DW	SM 4500-P E	Orthophosphate
DW	SM 5310 B	Total organic carbon (TOC)
DW	SM 5310 C	Dissolved organic carbon (DOC)
DW	SM 5310 C	Total organic carbon (TOC)
DW	SM 5320 B	Total organic halides (TOX)
DW	SM 5540 C	Foaming agents
DW	SM 5910 B	UV-absorbing compounds
DW	SM 9215B (Pour Plate)	Heterotropic Bacteria
DW	SM 9223 B (Colilert)	Total coliform / E. coli
DW	User Defined 524.2	Diisopropyl Ether [DIPE]
NPW	ASTM D6503	Enterococci
NPW	ASTM F1647-02A	Total organic carbon (TOC)
NPW	EPA 1000.0	Toxicity - chronic, FW organism
NPW	EPA 1002.0	Toxicity - chronic, FW organism
NPW	EPA 120.1	Specific conductance
NPW	EPA 130.1	Hardness - total as CaCO3
NPW	EPA 160.4	Residue - volatile
NPW	EPA 1657	Phorate
NPW	EPA 1657	Bolstar
NPW	EPA 1657	Chlorpyrifos
NPW	EPA 1657	Coumaphos
NPW	EPA 1657	Dichlorvos
NPW	EPA 1657	Dimethoate
NPW	EPA 1657	EPN
NPW	EPA 1657	Fensulfothion
NPW	EPA 1657	Fenthion
NPW	EPA 1657	Naled
NPW	EPA 1657	Parathion ethyl
NPW	EPA 1657	Parathion methyl
NPW	EPA 1657	Ronnel
NPW	EPA 1657	Stirofos
NPW	EPA 1657	Sulfotepp
NPW	EPA 1657	TEPP

Matrix	Method	Parameter
NPW	EPA 1657	Tokuthion [Protothiofos]
NPW	EPA 1657	Trichloronate
NPW	EPA 1658	D (2,4-)
NPW	EPA 1658	Dalapon
NPW	EPA 1658	Dichlorprop
NPW	EPA 1664A and B	Oil & grease - hem-SPE
NPW	EPA 1664A and B	Oil & grease - non polar
NPW	EPA 1664A and B	Oil & grease - hem-LL
NPW	EPA 1664A and B	Oil & grease - sgt-non polar-SPE
NPW	EPA 180.1	Turbidity
NPW	EPA 200.7	Silica - dissolved
NPW	EPA 200.7	Titanium
NPW	EPA 200.7	Hardness - total as CaCO3
NPW	EPA 200.7	Cobalt
NPW	EPA 200.7	Aluminum
NPW	EPA 200.7	Antimony
NPW	EPA 200.7	Arsenic
NPW	EPA 200.7	Barium
NPW	EPA 200.7	Beryllium
NPW	EPA 200.7	Cadmium
NPW	EPA 200.7	Chromium
NPW	EPA 200.7	Copper
NPW	EPA 200.7	Iron
NPW	EPA 200.7	Lead
NPW	EPA 200.7	Manganese
NPW	EPA 200.7	Molybdenum
NPW	EPA 200.7	Nickel
NPW	EPA 200.7	Selenium
NPW	EPA 200.7	Silver
NPW	EPA 200.7	Thallium
NPW	EPA 200.7	Tin
NPW	EPA 200.7	Vanadium
NPW	EPA 200.7	Zinc
NPW	EPA 200.7	Boron
NPW	EPA 200.7	Calcium
NPW	EPA 200.7	Magnesium
NPW	EPA 200.7	Potassium
NPW	EPA 200.7	Sodium
NPW	EPA 200.8	Antimony
NPW	EPA 200.8	Arsenic

Matrix	Method	Parameter
NPW	EPA 200.8	Barium
NPW	EPA 200.8	Beryllium
NPW	EPA 200.8	Cadmium
NPW	EPA 200.8	Chromium
NPW	EPA 200.8	Copper
NPW	EPA 200.8	Lead
NPW	EPA 200.8	Manganese
NPW	EPA 200.8	Molybdenum
NPW	EPA 200.8	Nickel
NPW	EPA 200.8	Selenium
NPW	EPA 200.8	Silver
NPW	EPA 200.8	Thallium
NPW	EPA 200.8	Tin
NPW	EPA 200.8	Vanadium
NPW	EPA 200.8	Zinc
NPW	EPA 2000.0	Toxicity - acute, FW organism
NPW	EPA 2002.0	Toxicity - acute, FW organism
NPW	EPA 218.6	Chromium (VI)
NPW	EPA 245.1	Mercury
NPW	EPA 300.0	Guanidine nitrate
NPW	EPA 300.0	Bromide
NPW	EPA 300.0	Chloride
NPW	EPA 300.0	Fluoride
NPW	EPA 300.0	Nitrate
NPW	EPA 300.0	Nitrite
NPW	EPA 300.0	Sulfate
NPW	EPA 300.0	Nitrate - nitrite
NPW	EPA 300.1	Nitrate - nitrite
NPW	EPA 300.1	Bromide
NPW	EPA 300.1	Chloride
NPW	EPA 300.1	Fluoride
NPW	EPA 300.1	Nitrate
NPW	EPA 300.1	Nitrite
NPW	EPA 300.1	Sulfate
NPW	EPA 310.2	Alkalinity as CaCO3
NPW	EPA 314.0	Perchlorate
NPW	EPA 335.4	Cyanide
NPW	EPA 350.1	Ammonia
NPW	EPA 351.1, .2 - 350.1	Organic nitrogen
NPW	EPA 351.2	Kjeldahl nitrogen - total

Matrix	Method	Parameter
NPW	EPA 353.2	Nitrate - nitrite
NPW	EPA 410.4	Chemical oxygen demand
NPW	EPA 420.4	Phenols
NPW	EPA 507	Alachlor
NPW	EPA 507	Metribuzin
NPW	EPA 507	Ethoprop
NPW	EPA 507	Merphos
NPW	EPA 507	Mevinphos
NPW	EPA 602	Benzene
NPW	EPA 602	Ethylbenzene
NPW	EPA 602	Methyl tert-butyl ether
NPW	EPA 602	Tert-butyl alcohol
NPW	EPA 602	Toluene
NPW	EPA 602	Xylenes (total)
NPW	EPA 608	Chloroneb
NPW	EPA 608	Chlorothalonil
NPW	EPA 608	Chlordane (alpha)
NPW	EPA 608	Chlordane (gamma)
NPW	EPA 608	Hexachlorobenzene
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 608	Aldrin
NPW	EPA 608	Alpha BHC
NPW	EPA 608	Beta BHC
NPW	EPA 608	Delta BHC
NPW	EPA 608	Lindane (gamma BHC)
NPW	EPA 608	Chlordane
NPW	EPA 608	DDD (4,4'-)
NPW	EPA 608	DDE (4,4'-)
NPW	EPA 608	DDT (4,4'-)
NPW	EPA 608	Dieldrin
NPW	EPA 608	Endosulfan I
NPW	EPA 608	Endosulfan II
NPW	EPA 608	Endosulfan sulfate
NPW	EPA 608	Endrin

Matrix	Method	Parameter
NPW	EPA 608	Endrin aldehyde
NPW	EPA 608	Endrin ketone
NPW	EPA 608	Heptachlor
NPW	EPA 608	Heptachlor epoxide
NPW	EPA 608	Methoxychlor
NPW	EPA 608	Toxaphene
NPW	EPA 610	Acenaphthene
NPW	EPA 610	Acenaphthylene
NPW	EPA 610	Anthracene
NPW	EPA 610	Benzo(a)anthracene
NPW	EPA 610	Benzo(a)pyrene
NPW	EPA 610	Benzo(b)fluoranthene
NPW	EPA 610	Benzo(ghi)perylene
NPW	EPA 610	Benzo(k)fluoranthene
NPW	EPA 610	Chrysene
NPW	EPA 610	Dibenzo(a,h)anthracene
NPW	EPA 610	Fluoranthene
NPW	EPA 610	Fluorene
NPW	EPA 610	Indeno(1,2,3-cd)pyrene
NPW	EPA 610	Naphthalene
NPW	EPA 610	Phenanthrene
NPW	EPA 610	Pyrene
NPW	EPA 615	Dicamba
NPW	EPA 622	Coumaphos
NPW	EPA 622	Demeton (o-)
NPW	EPA 622	Demeton (s-)
NPW	EPA 622	Dimethoate
NPW	EPA 622	Parathion ethyl
NPW	EPA 622	Parathion methyl
NPW	EPA 622	Stirofos
NPW	EPA 622	Sulfotepp
NPW	EPA 622	TEPP
NPW	EPA 622	Tokuthion [Protothiofos]
NPW	EPA 622	Trichloronate
NPW	EPA 624	Amyl alcohol (n-)
NPW	EPA 624	Propionitrile
NPW	EPA 624	Trimethylbenzene (1,2,3-)
NPW	EPA 624	Allyl chloride
NPW	EPA 624	Bromoethane
NPW	EPA 624	Butanone (2-)

Matrix	Method	Parameter
NPW	EPA 624	Butadiene (2-chloro-1,3-)
NPW	EPA 624	Carbon disulfide
NPW	EPA 624	Cyclohexanone
NPW	EPA 624	Dichloro-2-butene (cis-1,4-)
NPW	EPA 624	Dichloro-2-butene (trans-1,4-)
NPW	EPA 624	Diethyl ether (Ethyl ether)
NPW	EPA 624	Isopropanol
NPW	EPA 624	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
NPW	EPA 624	Vinyl acetate
NPW	EPA 624	Acetonitrile
NPW	EPA 624	Cyclohexane
NPW	EPA 624	Hexanone (2-)
NPW	EPA 624	Methyl acetate
NPW	EPA 624	Methylcyclohexane
NPW	EPA 624	Methyl iodide
NPW	EPA 624	Ethyl-tert-butyl Ether [ETBE]
NPW	EPA 624	Diisopropyl Ether [DIPE]
NPW	EPA 624	Dioxane (1,4-)
NPW	EPA 624	Butanol (1-)
NPW	EPA 624	Ethanol
NPW	EPA 624	Ethyl methacrylate
NPW	EPA 624	Iso-butyl alcohol
NPW	EPA 624	Methacrylonitrile
NPW	EPA 624	Methyl methacrylate
NPW	EPA 624	Octane (-n)
NPW	EPA 624	Nitropropane (2-)
NPW	EPA 624	Pentachloroethane
NPW	EPA 624	tert-Amylmethyl ether [TAME]
NPW	EPA 624	Acrolein
NPW	EPA 624	Acrylonitrile
NPW	EPA 624	Bromobenzene
NPW	EPA 624	Bromochloromethane
NPW	EPA 624	Butyl benzene (n-)
NPW	EPA 624	Chlorotoluene (2-)
NPW	EPA 624	Chlorotoluene (4-)
NPW	EPA 624	Dibromo-3-chloropropane (1,2-)
NPW	EPA 624	Dibromoethane (1,2-) (EDB)
NPW	EPA 624	Dibromomethane
NPW	EPA 624	Dichlorodifluoromethane
NPW	EPA 624	Dichloroethene (cis-1,2-)

Matrix	Method	Parameter
NPW	EPA 624	Dichloropropane (1,3-)
NPW	EPA 624	Dichloropropane (2,2-)
NPW	EPA 624	Dichloropropene (1,1-)
NPW	EPA 624	Hexane (n-)
NPW	EPA 624	Methyl isobutyl ketone (MIBK)
NPW	EPA 624	Tetrahydrofuran
NPW	EPA 624	Styrene
NPW	EPA 624	Tetrachloroethane (1,1,1,2-)
NPW	EPA 624	Xylene (m-)
NPW	EPA 624	Xylene (o-)
NPW	EPA 624	Xylene (p-)
NPW	EPA 624	Hexachlorobutadiene (1,3-)
NPW	EPA 624	Isopropylbenzene
NPW	EPA 624	Isopropyltoluene (4-)
NPW	EPA 624	Naphthalene
NPW	EPA 624	Propylbenzene (n-)
NPW	EPA 624	Sec-butylbenzene
NPW	EPA 624	Tert-butylbenzene
NPW	EPA 624	Trichlorobenzene (1,2,3-)
NPW	EPA 624	Trichlorobenzene (1,2,4-)
NPW	EPA 624	Trichloropropane (1,2,3-)
NPW	EPA 624	Trimethylbenzene (1,2,4-)
NPW	EPA 624	Trimethylbenzene (1,3,5-)
NPW	EPA 624	Acetone
NPW	EPA 624	Ethyl acetate
NPW	EPA 624	Methyl tert-butyl ether
NPW	EPA 624	Tert-butyl alcohol
NPW	EPA 624	Xylenes (total)
NPW	EPA 624	Benzene
NPW	EPA 624	Bromodichloromethane
NPW	EPA 624	Bromoform
NPW	EPA 624	Bromomethane
NPW	EPA 624	Carbon tetrachloride
NPW	EPA 624	Chlorobenzene
NPW	EPA 624	Chloroethane
NPW	EPA 624	Chloroethyl vinyl ether (2-)
NPW	EPA 624	Chloroform
NPW	EPA 624	Chloromethane
NPW	EPA 624	Dibromochloromethane
NPW	EPA 624	Dichlorobenzene (1,2-)

Matrix	Method	Parameter
NPW	EPA 624	Dichlorobenzene (1,3-)
NPW	EPA 624	Dichlorobenzene (1,4-)
NPW	EPA 624	Dichloroethane (1,1-)
NPW	EPA 624	Dichloroethane (1,2-)
NPW	EPA 624	Dichloroethene (1,1-)
NPW	EPA 624	Dichloroethene (trans-1,2-)
NPW	EPA 624	Dichloropropane (1,2-)
NPW	EPA 624	Dichloropropene (cis-1,3-)
NPW	EPA 624	Dichloropropene (trans-1,3-)
NPW	EPA 624	Ethylbenzene
NPW	EPA 624	Methylene chloride (Dichloromethane)
NPW	EPA 624	Tetrachloroethane (1,1,2,2-)
NPW	EPA 624	Tetrachloroethene
NPW	EPA 624	Toluene
NPW	EPA 624	Trichloroethane (1,1,1-)
NPW	EPA 624	Trichloroethane (1,1,2-)
NPW	EPA 624	Trichloroethene
NPW	EPA 624	Trichlorofluoromethane
NPW	EPA 624	Vinyl chloride
NPW	EPA 625	Tetrachlorophenol (2,3,4,6-)
NPW	EPA 625	Hexachlorophene
NPW	EPA 625	Decane (n-)
NPW	EPA 625	Octadecane (n-)
NPW	EPA 625	Biphenylamine (4-)
NPW	EPA 625	Chloronaphthalene (1-)
NPW	EPA 625	Famphur
NPW	EPA 625	Hexachloropropene
NPW	EPA 625	Kepone
NPW	EPA 625	Napththylamine (1-)
NPW	EPA 625	Napththylamine (2-)
NPW	EPA 625	Pentachloroethane
NPW	EPA 625	Napthoquinone (1,4-)
NPW	EPA 625	Methylnaphthalene (2-)
NPW	EPA 625	Chloroaniline (4-)
NPW	EPA 625	Nitroaniline (2-)
NPW	EPA 625	Nitroaniline (3-)
NPW	EPA 625	Nitroaniline (4-)
NPW	EPA 625	Pentachlorobenzene
NPW	EPA 625	Tetrachlorobenzene (1,2,4,5-)
NPW	EPA 625	Methylphenol (4-)

Matrix	Method	Parameter
NPW	EPA 625	Acetophenone
NPW	EPA 625	Alpha - terpineol
NPW	EPA 625	Aniline
NPW	EPA 625	Dichloroaniline (2,3-)
NPW	EPA 625	Diphenylhydrazine (1,2-)
NPW	EPA 625	Methylphenol (2-)
NPW	EPA 625	N-Nitroso-di-n-butylamine
NPW	EPA 625	N-Nitrosodiethylamine
NPW	EPA 625	N-Nitrosopyrrolidine
NPW	EPA 625	Hexachlorocyclopentadiene
NPW	EPA 625	N-Nitrosodimethylamine
NPW	EPA 625	N-Nitrosodiphenylamine
NPW	EPA 625	Dibenzofuran
NPW	EPA 625	Methylphenol (2-)
NPW	EPA 625	Methylphenol (4-)
NPW	EPA 625	Trichlorophenol (2,4,5-)
NPW	EPA 625	Benzoic acid
NPW	EPA 625	Benzidine
NPW	EPA 625	Carbazole
NPW	EPA 625	Pyridine
NPW	EPA 625	Acenaphthene
NPW	EPA 625	Acenaphthylene
NPW	EPA 625	Anthracene
NPW	EPA 625	Benzo(a)anthracene
NPW	EPA 625	Benzo(b)fluoranthene
NPW	EPA 625	Benzo(k)fluoranthene
NPW	EPA 625	Benzo(a)pyrene
NPW	EPA 625	Benzo(ghi)perylene
NPW	EPA 625	Butyl benzyl phthalate
NPW	EPA 625	Bis (2-chloroethyl) ether
NPW	EPA 625	Bis (2-chloroethoxy) methane
NPW	EPA 625	Bis (2-ethylhexyl) phthalate
NPW	EPA 625	Bis (2-chloroisopropyl) ether
NPW	EPA 625	Bromophenyl-phenyl ether (4-)
NPW	EPA 625	Chloronaphthalene (2-)
NPW	EPA 625	Chlorophenyl-phenyl ether (4-)
NPW	EPA 625	Chrysene
NPW	EPA 625	Dibenzo(a,h)anthracene
NPW	EPA 625	Di-n-butyl phthalate
NPW	EPA 625	Dichlorobenzidine (3,3'-)

Matrix	Method	Parameter
NPW	EPA 625	Diethyl phthalate
NPW	EPA 625	Dimethyl phthalate
NPW	EPA 625	Dinitrotoluene (2,4-)
NPW	EPA 625	Dinitrotoluene (2,6-)
NPW	EPA 625	Di-n-octyl phthalate
NPW	EPA 625	Fluoranthene
NPW	EPA 625	Fluorene
NPW	EPA 625	Hexachlorobenzene
NPW	EPA 625	Hexachlorobutadiene (1,3-)
NPW	EPA 625	Hexachloroethane
NPW	EPA 625	Indeno(1,2,3-cd)pyrene
NPW	EPA 625	Isophorone
NPW	EPA 625	Naphthalene
NPW	EPA 625	Nitrobenzene
NPW	EPA 625	N-Nitroso-di-n-propylamine
NPW	EPA 625	Phenanthrene
NPW	EPA 625	Pyrene
NPW	EPA 625	Trichlorobenzene (1,2,4-)
NPW	EPA 625	Methyl phenol (4-chloro-3-)
NPW	EPA 625	Chlorophenol (2-)
NPW	EPA 625	Dichlorophenol (2,4-)
NPW	EPA 625	Dimethylphenol (2,4-)
NPW	EPA 625	Dinitrophenol (2,4-)
NPW	EPA 625	Dinitrophenol (2-methyl-4,6-)
NPW	EPA 625	Nitrophenol (2-)
NPW	EPA 625	Nitrophenol (4-)
NPW	EPA 625	Pentachlorophenol
NPW	EPA 625	Phenol
NPW	EPA 625	Trichlorophenol (2,4,6-)
NPW	Other FL - PRO	Petroleum Organics
NPW	Other IA - OA-1	Petroleum Organics
NPW	Other IA - OA-2	Petroleum Organics
NPW	Other NJ-OQA-QAM-025	Petroleum Organics
NPW	Other NJ-OQA-QAM-025, Rev. 7	Petroleum Organics
NPW	Other NJ-OQA-QAM-025, Rev. 7	Petroleum Organics
NPW	Other USDA-LOI (Loss on ignition)	Total organic carbon (TOC)
NPW	Other Walkley Black	Total organic carbon (TOC)
NPW	SM 2120 B-11	Color
NPW	SM 2130 B-11	Turbidity
NPW	SM 2310 B-11	Acidity as CaCO3

Matrix	Method	Parameter
NPW	SM 2320 B-11	Alkalinity as CaCO3
NPW	SM 2340 B-11	Hardness - total as CaCO3
NPW	SM 2340 C-11	Hardness - total as CaCO3
NPW	SM 2510 B-11	Specific conductance
NPW	SM 2540 B-11	Residue - total
NPW	SM 2540 C-11	Residue - filterable (TDS)
NPW	SM 2540 D-11	Residue - nonfilterable (TSS)
NPW	SM 2540 F-11	Residue - settleable
NPW	SM 2540 G SM 18th Ed.	Total, fixed, and volatile solids (SQAR)
NPW	SM 2550 B-00	Temperature
NPW	SM 3500-Cr B-11	Chromium (VI)
NPW	SM 3500-Cr C-11	Chromium (VI)
NPW	SM 3500-Cr D (18/19th ed)	Chromium (VI)
NPW	SM 3500-Cr E (18/19th ed)	Chromium (VI)
NPW	SM 3500-Fe B-11	Iron, Ferrous
NPW	SM 4110 B or C-11	Nitrate - nitrite
NPW	SM 4110 B or C-11	Chloride
NPW	SM 4110 B or C-11	Fluoride
NPW	SM 4110 B or C-11	Nitrate
NPW	SM 4110 B or C-11	Nitrite
NPW	SM 4110 B or C-11	Sulfate
NPW	SM 4500-Cl G-11	Chlorine
NPW	SM 4500-Cl G-11	Chlorine
NPW	SM 4500-CN B or C-11 plus E-11	Cyanide
NPW	SM 4500-CN B or C-11 and G-11	Cyanide - amenable to Cl2
NPW	SM 4500-H B-11	pH
NPW	SM 4500-N Org B or C-11 plus NH3 B-11 plus NH3 C-11	Kjeldahl nitrogen - total
NPW	SM 4500-NH3 B plus G-11	Ammonia
NPW	SM 4500-NH3 B, C, D, E, F, G, H-11	Organic nitrogen
NPW	SM 4500-NO3 F-11	Nitrate - nitrite
NPW	SM 4500-O C-11	Oxygen (dissolved)
NPW	SM 4500-O G-11	Oxygen (dissolved)
NPW	SM 4500-P B5-11 plus E-11	Phosphorus (total)
NPW	SM 4500-P E-11	Orthophosphate
NPW	SM 4500-S B, C plus D-11	Sulfides
NPW	SM 4500-SO3 B-11	Sulfite - SO3
NPW	SM 5210 B-11	Carbonaceous BOD (CBOD)
NPW	SM 5210 B-11	Biochemical oxygen demand
NPW	SM 5220 D-11	Chemical oxygen demand

Matrix	Method	Parameter
NPW	SM 5310 B, C or D-11	Dissolved organic carbon (DOC)
NPW	SM 5310 B-11	Total organic carbon (TOC)
NPW	SM 5320 B-11	Total organic halides (TOX)
NPW	SM 5520 B-11	Oil & grease - total recov
NPW	SM 5520 B-11	Oil & grease - hem-LL
NPW	SM 5540 C-11	Surfactants
NPW	SM 6200 B-97	Propionitrile
NPW	SM 6200 B-97	Trimethylbenzene (1,2,3-)
NPW	SM 6200 B-97	Allyl chloride
NPW	SM 6200 B-97	Bromoethane
NPW	SM 6200 B-97	Butadiene (2-chloro-1,3-)
NPW	SM 6200 B-97	Cyclohexanone
NPW	SM 6200 B-97	Dichloro-2-butene (cis-1,4-)
NPW	SM 6200 B-97	Dichloro-2-butene (trans-1,4-)
NPW	SM 6200 B-97	Diethyl ether (Ethyl ether)
NPW	SM 6200 B-97	Isopropanol
NPW	SM 6200 B-97	Ethyl-tert-butyl Ether [ETBE]
NPW	SM 6200 B-97	Diisopropyl Ether [DIPE]
NPW	SM 6200 B-97	Dioxane (1,4-)
NPW	SM 6200 B-97	Ethanol
NPW	SM 6200 B-97	Ethyl methacrylate
NPW	SM 6200 B-97	Iso-butyl alcohol
NPW	SM 6200 B-97	Methacrylonitrile
NPW	SM 6200 B-97	Methyl methacrylate
NPW	SM 6200 B-97	Pentachloroethane
NPW	SM 6200 B-97	tert-Amylmethyl ether [TAME]
NPW	SM 6200 B-97	Acrolein
NPW	SM 6200 B-97	Acrylonitrile
NPW	SM 6200 B-97	Bromobenzene
NPW	SM 6200 B-97	Bromochloromethane
NPW	SM 6200 B-97	Butyl benzene (n-)
NPW	SM 6200 B-97	Chlorotoluene (2-)
NPW	SM 6200 B-97	Chlorotoluene (4-)
NPW	SM 6200 B-97	Dibromo-3-chloropropane (1,2-)
NPW	SM 6200 B-97	Dibromomethane
NPW	SM 6200 B-97	Dichlorodifluoromethane
NPW	SM 6200 B-97	Dichloropropane (1,3-)
NPW	SM 6200 B-97	Dichloropropane (2,2-)
NPW	SM 6200 B-97	Dichloropropene (1,1-)
NPW	SM 6200 B-97	Hexane (n-)

Matrix	Method	Parameter
NPW	SM 6200 B-97	Methyl isobutyl ketone (MIBK)
NPW	SM 6200 B-97	Tetrahydrofuran
NPW	SM 6200 B-97	Tetrachloroethane (1,1,1,2-)
NPW	SM 6200 B-97	Xylene (m-)
NPW	SM 6200 B-97	Xylene (p-)
NPW	SM 6200 B-97	Hexachlorobutadiene (1,3-)
NPW	SM 6200 B-97	Isopropylbenzene
NPW	SM 6200 B-97	Isopropyltoluene (4-)
NPW	SM 6200 B-97	Propylbenzene (n-)
NPW	SM 6200 B-97	Sec-butylbenzene
NPW	SM 6200 B-97	Tert-butylbenzene
NPW	SM 6200 B-97	Trichlorobenzene (1,2,3-)
NPW	SM 6200 B-97	Trichloropropane (1,2,3-)
NPW	SM 6200 B-97	Trimethylbenzene (1,2,4-)
NPW	SM 6200 B-97	Trimethylbenzene (1,3,5-)
NPW	SM 6200 B-97	Acetone
NPW	SM 6200 B-97	Ethyl acetate
NPW	SM 6200 B-97	Methyl tert-butyl ether
NPW	SM 6200 B-97	Tert-butyl alcohol
NPW	SM 6200 B-97	Benzene
NPW	SM 6200 B-97	Bromodichloromethane
NPW	SM 6200 B-97	Bromoform
NPW	SM 6200 B-97	Bromomethane
NPW	SM 6200 B-97	Carbon tetrachloride
NPW	SM 6200 B-97	Chlorobenzene
NPW	SM 6200 B-97	Chloroethane
NPW	SM 6200 B-97	Chloroform
NPW	SM 6200 B-97	Chloromethane
NPW	SM 6200 B-97	Dibromochloromethane
NPW	SM 6200 B-97	Dichlorobenzene (1,2-)
NPW	SM 6200 B-97	Dichlorobenzene (1,3-)
NPW	SM 6200 B-97	Dichlorobenzene (1,4-)
NPW	SM 6200 B-97	Dichloroethane (1,1-)
NPW	SM 6200 B-97	Dichloroethane (1,2-)
NPW	SM 6200 B-97	Dichloroethene (1,1-)
NPW	SM 6200 B-97	Dichloroethene (trans-1,2-)
NPW	SM 6200 B-97	Dichloropropane (1,2-)
NPW	SM 6200 B-97	Dichloropropene (cis-1,3-)
NPW	SM 6200 B-97	Dichloropropene (trans-1,3-)
NPW	SM 6200 B-97	Ethylbenzene

Matrix	Method	Parameter
NPW	SM 6200 B-97	Methylene chloride (Dichloromethane)
NPW	SM 6200 B-97	Tetrachloroethane (1,1,2,2-)
NPW	SM 6200 B-97	Tetrachloroethene
NPW	SM 6200 B-97	Toluene
NPW	SM 6200 B-97	Trichloroethane (1,1,1-)
NPW	SM 6200 B-97	Trichloroethane (1,1,2-)
NPW	SM 6200 B-97	Trichloroethene
NPW	SM 6200 B-97	Trichlorofluoromethane
NPW	SM 6200 B-97	Vinyl chloride
NPW	SM 6200 B-97	Naphthalene
NPW	SM 6200 B-97	Trichlorobenzene (1,2,4-)
NPW	SM 6410 B-00	Tetrachlorophenol (2,3,4,6-)
NPW	SM 6410 B-00	Hexachlorophene
NPW	SM 6410 B-00	Decane (n-)
NPW	SM 6410 B-00	Octadecane (n-)
NPW	SM 6410 B-00	Biphenylamine (4-)
NPW	SM 6410 B-00	Chloronaphthalene (1-)
NPW	SM 6410 B-00	Famphur
NPW	SM 6410 B-00	Hexachloropropene
NPW	SM 6410 B-00	Kepone
NPW	SM 6410 B-00	Napththylamine (1-)
NPW	SM 6410 B-00	Napththylamine (2-)
NPW	SM 6410 B-00	Pentachloroethane
NPW	SM 6410 B-00	Napthoquinone (1,4-)
NPW	SM 6410 B-00	Methylphenol (4-)
NPW	SM 6410 B-00	Acetophenone
NPW	SM 6410 B-00	Alpha - terpineol
NPW	SM 6410 B-00	Aniline
NPW	SM 6410 B-00	Dichloroaniline (2,3-)
NPW	SM 6410 B-00	Methylphenol (2-)
NPW	SM 6410 B-00	Hexachlorocyclopentadiene
NPW	SM 6410 B-00	N-Nitrosodimethylamine
NPW	SM 6410 B-00	N-Nitrosodiphenylamine
NPW	SM 6410 B-00	Benzoic acid
NPW	SM 6410 B-00	Benzidine
NPW	SM 6410 B-00	Carbazole
NPW	SM 6410 B-00	Pyridine
NPW	SM 6410 B-00	Acenaphthene
NPW	SM 6410 B-00	Acenaphthylene
NPW	SM 6410 B-00	Anthracene

Matrix	Method	Parameter
NPW	SM 6410 B-00	Benzo(a)anthracene
NPW	SM 6410 B-00	Benzo(b)fluoranthene
NPW	SM 6410 B-00	Benzo(k)fluoranthene
NPW	SM 6410 B-00	Benzo(a)pyrene
NPW	SM 6410 B-00	Benzo(ghi)perylene
NPW	SM 6410 B-00	Butyl benzyl phthalate
NPW	SM 6410 B-00	Bis (2-chloroethyl) ether
NPW	SM 6410 B-00	Bis (2-chloroethoxy) methane
NPW	SM 6410 B-00	Bis (2-ethylhexyl) phthalate
NPW	SM 6410 B-00	Bis (2-chloroisopropyl) ether
NPW	SM 6410 B-00	Bromophenyl-phenyl ether (4-)
NPW	SM 6410 B-00	Chloronaphthalene (2-)
NPW	SM 6410 B-00	Chlorophenyl-phenyl ether (4-)
NPW	SM 6410 B-00	Chrysene
NPW	SM 6410 B-00	Dibenzo(a,h)anthracene
NPW	SM 6410 B-00	Di-n-butyl phthalate
NPW	SM 6410 B-00	Dichlorobenzidine (3,3'-)
NPW	SM 6410 B-00	Diethyl phthalate
NPW	SM 6410 B-00	Dimethyl phthalate
NPW	SM 6410 B-00	Dinitrotoluene (2,4-)
NPW	SM 6410 B-00	Dinitrotoluene (2,6-)
NPW	SM 6410 B-00	Di-n-octyl phthalate
NPW	SM 6410 B-00	Fluoranthene
NPW	SM 6410 B-00	Fluorene
NPW	SM 6410 B-00	Hexachlorobenzene
NPW	SM 6410 B-00	Hexachlorobutadiene (1,3-)
NPW	SM 6410 B-00	Hexachloroethane
NPW	SM 6410 B-00	Indeno(1,2,3-cd)pyrene
NPW	SM 6410 B-00	Isophorone
NPW	SM 6410 B-00	Naphthalene
NPW	SM 6410 B-00	Nitrobenzene
NPW	SM 6410 B-00	N-Nitroso-di-n-propylamine
NPW	SM 6410 B-00	Phenanthrene
NPW	SM 6410 B-00	Pyrene
NPW	SM 6410 B-00	Trichlorobenzene (1,2,4-)
NPW	SM 6410 B-00	Methyl phenol (4-chloro-3-)
NPW	SM 6410 B-00	Chlorophenol (2-)
NPW	SM 6410 B-00	Dichlorophenol (2,4-)
NPW	SM 6410 B-00	Dimethylphenol (2,4-)
NPW	SM 6410 B-00	Dinitrophenol (2,4-)

Matrix	Method	Parameter
NPW	SM 6410 B-00	Dinitrophenol (2-methyl-4,6-)
NPW	SM 6410 B-00	Nitrophenol (2-)
NPW	SM 6410 B-00	Nitrophenol (4-)
NPW	SM 6410 B-00	Pentachlorophenol
NPW	SM 6410 B-00	Phenol
NPW	SM 6410 B-00	Trichlorophenol (2,4,6-)
NPW	SM 6440 B-00	Acenaphthene
NPW	SM 6440 B-00	Acenaphthylene
NPW	SM 6440 B-00	Anthracene
NPW	SM 6440 B-00	Benzo(a)anthracene
NPW	SM 6440 B-00	Benzo(a)pyrene
NPW	SM 6440 B-00	Benzo(b)fluoranthene
NPW	SM 6440 B-00	Benzo(ghi)perylene
NPW	SM 6440 B-00	Benzo(k)fluoranthene
NPW	SM 6440 B-00	Chrysene
NPW	SM 6440 B-00	Dibenzo(a,h)anthracene
NPW	SM 6440 B-00	Fluoranthene
NPW	SM 6440 B-00	Fluorene
NPW	SM 6440 B-00	Indeno(1,2,3-cd)pyrene
NPW	SM 6440 B-00	Naphthalene
NPW	SM 6440 B-00	Phenanthrene
NPW	SM 6440 B-00	Pyrene
NPW	SM 6630 B-00	Trifluralin
NPW	SM 6630 B-00	Aldrin
NPW	SM 6630 B-00	Alpha BHC
NPW	SM 6630 B-00	Lindane (gamma BHC)
NPW	SM 6630 B-00	Chlordane
NPW	SM 6630 B-00	DDD (4,4'-)
NPW	SM 6630 B-00	DDE (4,4'-)
NPW	SM 6630 B-00	DDT (4,4'-)
NPW	SM 6630 B-00	Dieldrin
NPW	SM 6630 B-00	Endosulfan I
NPW	SM 6630 B-00	Endosulfan II
NPW	SM 6630 B-00	Endrin
NPW	SM 6630 B-00	Heptachlor
NPW	SM 6630 B-00	Heptachlor epoxide
NPW	SM 6630 B-00	Methoxychlor
NPW	SM 6630 B-00	Toxaphene
NPW	SM 6630C-00	Etridiazole
NPW	SM 6630C-00	Aldrin

Matrix	Method	Parameter
NPW	SM 6630C-00	Alpha BHC
NPW	SM 6630C-00	Beta BHC
NPW	SM 6630C-00	Delta BHC
NPW	SM 6630C-00	Lindane (gamma BHC)
NPW	SM 6630C-00	Chlordane
NPW	SM 6630C-00	DDD (4,4'-)
NPW	SM 6630C-00	DDE (4,4'-)
NPW	SM 6630C-00	DDT (4,4'-)
NPW	SM 6630C-00	Dieldrin
NPW	SM 6630C-00	Endosulfan I
NPW	SM 6630C-00	Endosulfan II
NPW	SM 6630C-00	Endosulfan sulfate
NPW	SM 6630C-00	Endrin
NPW	SM 6630C-00	Heptachlor
NPW	SM 6630C-00	Heptachlor epoxide
NPW	SM 6630C-00	Methoxychlor
NPW	SM 6630C-00	Toxaphene
NPW	SM 6640 B-01	D (2,4-)
NPW	SM 6640 B-01	Dalapon
NPW	SM 6640 B-01	T (2,4,5-)
NPW	SM 6640 B-01	TP (2,4,5-) (Silvex)
NPW	SM 9215 B-00	Heterotrophic plate count
NPW	SM 9222 B-97	Total coliform
NPW	SM 9222 D-97	Fecal coliform
NPW	SM 9222D-97 (Class B only) plus EPA 625/R-92/013 App. F	Fecal coliform
NPW	SM 9260 D plus EPA 625/R-92/013 Appendix F	Salmonella sp. Bacteria
NPW	SW-846 1010	Ignitability
NPW	SW-846 1010A	Ignitability
NPW	SW-846 1110	Corrosivity toward steel
NPW	SW-846 1110A	Corrosivity toward steel
NPW	SW-846 1310A	Metals - organics
NPW	SW-846 1310B	Metals - organics
NPW	SW-846 1311	Volatile organics
NPW	SW-846 1311	Semivolatile organics
NPW	SW-846 1311	Metals
NPW	SW-846 1312	Metals - organics
NPW	SW-846 1320	Metals - organics
NPW	SW-846 3005A	Metals, Total Rec and Dissolved

Matrix	Method	Parameter
NPW	SW-846 3010A	Metals, Total
NPW	SW-846 3015	Metals
NPW	SW-846 3015A	Metals
NPW	SW-846 3020A	Metals
NPW	SW-846 3510C	Semivolatile organics
NPW	SW-846 3511	Semivolatile organics
NPW	SW-846 3520C	Semivolatile organics
NPW	SW-846 5030B	Volatile organics
NPW	SW-846 6010B	Lithium
NPW	SW-846 6010B	Strontium
NPW	SW-846 6010B	Titanium
NPW	SW-846 6010B	Silver
NPW	SW-846 6010B	Tin
NPW	SW-846 6010B	Aluminum
NPW	SW-846 6010B	Antimony
NPW	SW-846 6010B	Arsenic
NPW	SW-846 6010B	Barium
NPW	SW-846 6010B	Beryllium
NPW	SW-846 6010B	Boron
NPW	SW-846 6010B	Cadmium
NPW	SW-846 6010B	Calcium
NPW	SW-846 6010B	Chromium
NPW	SW-846 6010B	Cobalt
NPW	SW-846 6010B	Copper
NPW	SW-846 6010B	Iron
NPW	SW-846 6010B	Lead
NPW	SW-846 6010B	Magnesium
NPW	SW-846 6010B	Manganese
NPW	SW-846 6010B	Molybdenum
NPW	SW-846 6010B	Nickel
NPW	SW-846 6010B	Potassium
NPW	SW-846 6010B	Selenium
NPW	SW-846 6010B	Sodium
NPW	SW-846 6010B	Thallium
NPW	SW-846 6010B	Vanadium
NPW	SW-846 6010B	Zinc
NPW	SW-846 6010C	Lithium
NPW	SW-846 6010C	Strontium
NPW	SW-846 6010C	Titanium
NPW	SW-846 6010C	Silver

Matrix	Method	Parameter
NPW	SW-846 6010C	Tin
NPW	SW-846 6010C	Aluminum
NPW	SW-846 6010C	Antimony
NPW	SW-846 6010C	Arsenic
NPW	SW-846 6010C	Barium
NPW	SW-846 6010C	Beryllium
NPW	SW-846 6010C	Boron
NPW	SW-846 6010C	Cadmium
NPW	SW-846 6010C	Calcium
NPW	SW-846 6010C	Chromium
NPW	SW-846 6010C	Cobalt
NPW	SW-846 6010C	Copper
NPW	SW-846 6010C	Iron
NPW	SW-846 6010C	Lead
NPW	SW-846 6010C	Magnesium
NPW	SW-846 6010C	Manganese
NPW	SW-846 6010C	Molybdenum
NPW	SW-846 6010C	Nickel
NPW	SW-846 6010C	Potassium
NPW	SW-846 6010C	Selenium
NPW	SW-846 6010C	Sodium
NPW	SW-846 6010C	Thallium
NPW	SW-846 6010C	Vanadium
NPW	SW-846 6010C	Zinc
NPW	SW-846 6020	Tin
NPW	SW-846 6020	Barium
NPW	SW-846 6020	Manganese
NPW	SW-846 6020	Molybdenum
NPW	SW-846 6020	Vanadium
NPW	SW-846 6020	Zinc
NPW	SW-846 6020	Beryllium
NPW	SW-846 6020	Nickel
NPW	SW-846 6020	Selenium
NPW	SW-846 6020	Antimony
NPW	SW-846 6020	Arsenic
NPW	SW-846 6020	Cadmium
NPW	SW-846 6020	Chromium
NPW	SW-846 6020	Copper
NPW	SW-846 6020	Lead
NPW	SW-846 6020	Silver

Matrix	Method	Parameter
NPW	SW-846 6020	Thallium
NPW	SW-846 6020A	Tin
NPW	SW-846 6020A	Barium
NPW	SW-846 6020A	Manganese
NPW	SW-846 6020A	Molybdenum
NPW	SW-846 6020A	Vanadium
NPW	SW-846 6020A	Zinc
NPW	SW-846 6020A	Beryllium
NPW	SW-846 6020A	Nickel
NPW	SW-846 6020A	Selenium
NPW	SW-846 6020A	Antimony
NPW	SW-846 6020A	Arsenic
NPW	SW-846 6020A	Cadmium
NPW	SW-846 6020A	Chromium
NPW	SW-846 6020A	Copper
NPW	SW-846 6020A	Lead
NPW	SW-846 6020A	Silver
NPW	SW-846 6020A	Thallium
NPW	SW-846 7196A	Chromium (VI)
NPW	SW-846 7199	Chromium (VI)
NPW	SW-846 7470A	Mercury - liquid waste
NPW	SW-846 8011	Dibromoethane (1,2-) (EDB)
NPW	SW-846 8011	Dibromo-3-chloropropane (1,2-)
NPW	SW-846 8015B	Ethylene glycol
NPW	SW-846 8015B	Propylene glycol
NPW	SW-846 8015B	Gasoline range organic
NPW	SW-846 8015B	Diesel range organic
NPW	SW-846 8015C	Ethylene glycol
NPW	SW-846 8015C	Propylene glycol
NPW	SW-846 8015D	Ethylene glycol
NPW	SW-846 8015D	Propylene glycol
NPW	SW-846 8015D	Gasoline range organic
NPW	SW-846 8015D	Diesel range organic
NPW	SW-846 8021B	Xylenes (total)
NPW	SW-846 8021B	Methyl tert-butyl ether
NPW	SW-846 8021B	Benzene
NPW	SW-846 8021B	Ethylbenzene
NPW	SW-846 8021B	Toluene
NPW	SW-846 8021B	Xylene (o-)
NPW	SW-846 8021B	Xylene (m-)

Matrix	Method	Parameter
NPW	SW-846 8021B	Xylene (p-)
NPW	SW-846 8081A	Alachlor
NPW	SW-846 8081A	Chlordane (alpha)
NPW	SW-846 8081A	Chlordane (gamma)
NPW	SW-846 8081A	Chloroneb
NPW	SW-846 8081A	Chlorothalonil
NPW	SW-846 8081A	Etridiazole
NPW	SW-846 8081A	Hexachlorobenzene
NPW	SW-846 8081A	Hexachlorocyclopentadiene
NPW	SW-846 8081A	Permethrin
NPW	SW-846 8081A	Propachlor
NPW	SW-846 8081A	Trifluralin
NPW	SW-846 8081A	Aldrin
NPW	SW-846 8081A	Alpha BHC
NPW	SW-846 8081A	Beta BHC
NPW	SW-846 8081A	Delta BHC
NPW	SW-846 8081A	Lindane (gamma BHC)
NPW	SW-846 8081A	Chlordane (technical)
NPW	SW-846 8081A	DDD (4,4'-)
NPW	SW-846 8081A	DDE (4,4'-)
NPW	SW-846 8081A	DDT (4,4'-)
NPW	SW-846 8081A	Dieldrin
NPW	SW-846 8081A	Endosulfan I
NPW	SW-846 8081A	Endosulfan II
NPW	SW-846 8081A	Endosulfan sulfate
NPW	SW-846 8081A	Endrin
NPW	SW-846 8081A	Endrin aldehyde
NPW	SW-846 8081A	Endrin ketone
NPW	SW-846 8081A	Heptachlor
NPW	SW-846 8081A	Heptachlor epoxide
NPW	SW-846 8081A	Methoxychlor
NPW	SW-846 8081A	Toxaphene
NPW	SW-846 8081B	Alachlor
NPW	SW-846 8081B	Chlordane (alpha)
NPW	SW-846 8081B	Chlordane (gamma)
NPW	SW-846 8081B	Chloroneb
NPW	SW-846 8081B	Chlorothalonil
NPW	SW-846 8081B	Etridiazole
NPW	SW-846 8081B	Hexachlorobenzene
NPW	SW-846 8081B	Hexachlorocyclopentadiene

Matrix	Method	Parameter
NPW	SW-846 8081B	Permethrin
NPW	SW-846 8081B	Propachlor
NPW	SW-846 8081B	Trifluralin
NPW	SW-846 8081B	Aldrin
NPW	SW-846 8081B	Alpha BHC
NPW	SW-846 8081B	Beta BHC
NPW	SW-846 8081B	Delta BHC
NPW	SW-846 8081B	Lindane (gamma BHC)
NPW	SW-846 8081B	Chlordane (technical)
NPW	SW-846 8081B	DDD (4,4'-)
NPW	SW-846 8081B	DDE (4,4'-)
NPW	SW-846 8081B	DDT (4,4'-)
NPW	SW-846 8081B	Dieldrin
NPW	SW-846 8081B	Endosulfan I
NPW	SW-846 8081B	Endosulfan II
NPW	SW-846 8081B	Endosulfan sulfate
NPW	SW-846 8081B	Endrin
NPW	SW-846 8081B	Endrin aldehyde
NPW	SW-846 8081B	Endrin ketone
NPW	SW-846 8081B	Heptachlor
NPW	SW-846 8081B	Heptachlor epoxide
NPW	SW-846 8081B	Methoxychlor
NPW	SW-846 8081B	Toxaphene
NPW	SW-846 8082	PCB 1016
NPW	SW-846 8082	PCB 1221
NPW	SW-846 8082	PCB 1232
NPW	SW-846 8082	PCB 1242
NPW	SW-846 8082	PCB 1248
NPW	SW-846 8082	PCB 1254
NPW	SW-846 8082	PCB 1260
NPW	SW-846 8082A	PCB 1016
NPW	SW-846 8082A	PCB 1221
NPW	SW-846 8082A	PCB 1232
NPW	SW-846 8082A	PCB 1242
NPW	SW-846 8082A	PCB 1248
NPW	SW-846 8082A	PCB 1254
NPW	SW-846 8082A	PCB 1260
NPW	SW-846 8141A	Azinphos methyl
NPW	SW-846 8141A	Chlorpyrifos
NPW	SW-846 8141A	Demeton (o-)

Matrix	Method	Parameter
NPW	SW-846 8141A	Demeton (s-)
NPW	SW-846 8141A	Disulfoton
NPW	SW-846 8141A	Bolstar
NPW	SW-846 8141A	Coumaphos
NPW	SW-846 8141A	Dichlorvos
NPW	SW-846 8141A	Dimethoate
NPW	SW-846 8141A	EPN
NPW	SW-846 8141A	Ethoprop
NPW	SW-846 8141A	Fensulfothion
NPW	SW-846 8141A	Fenthion
NPW	SW-846 8141A	Merphos
NPW	SW-846 8141A	Mevinphos
NPW	SW-846 8141A	Naled
NPW	SW-846 8141A	Parathion
NPW	SW-846 8141A	Parathion methyl
NPW	SW-846 8141A	Phorate
NPW	SW-846 8141A	Ronnel
NPW	SW-846 8141A	Stirofos
NPW	SW-846 8141A	Sulfotepp
NPW	SW-846 8141A	TEPP
NPW	SW-846 8141A	Tokuthion [Protothiofos]
NPW	SW-846 8141A	Trichloronate
NPW	SW-846 8141A	Diazinon
NPW	SW-846 8141A	Malathion
NPW	SW-846 8141B	Azinphos methyl
NPW	SW-846 8141B	Chlorpyrifos
NPW	SW-846 8141B	Demeton (o-)
NPW	SW-846 8141B	Demeton (s-)
NPW	SW-846 8141B	Disulfoton
NPW	SW-846 8141B	Bolstar
NPW	SW-846 8141B	Coumaphos
NPW	SW-846 8141B	Dichlorvos
NPW	SW-846 8141B	Dimethoate
NPW	SW-846 8141B	EPN
NPW	SW-846 8141B	Ethoprop
NPW	SW-846 8141B	Fensulfothion
NPW	SW-846 8141B	Fenthion
NPW	SW-846 8141B	Merphos
NPW	SW-846 8141B	Mevinphos
NPW	SW-846 8141B	Naled

Matrix	Method	Parameter
NPW	SW-846 8141B	Parathion
NPW	SW-846 8141B	Parathion methyl
NPW	SW-846 8141B	Phorate
NPW	SW-846 8141B	Ronnel
NPW	SW-846 8141B	Stirofos
NPW	SW-846 8141B	Sulfotepp
NPW	SW-846 8141B	TEPP
NPW	SW-846 8141B	Tokuthion [Protothiofos]
NPW	SW-846 8141B	Trichloronate
NPW	SW-846 8141B	Diazinon
NPW	SW-846 8141B	Malathion
NPW	SW-846 8151A	Dicamba
NPW	SW-846 8151A	DB (2,4-)
NPW	SW-846 8151A	Dinoseb
NPW	SW-846 8151A	Dalapon
NPW	SW-846 8151A	Dichlorprop
NPW	SW-846 8151A	D (2,4-)
NPW	SW-846 8151A	T (2,4,5-)
NPW	SW-846 8151A	TP (2,4,5-) (Silvex)
NPW	SW-846 8151A	MCPA
NPW	SW-846 8151A	MCPP
NPW	SW-846 8260B	Methyl alcohol (Methanol)
NPW	SW-846 8260B	Ethyl alcohol
NPW	SW-846 8260B	Hexane (n-)
NPW	SW-846 8260B	Trimethylpentane (2,2,4-)
NPW	SW-846 8260B	Methylnaphthalene (1-)
NPW	SW-846 8260B	Methylnaphthalene (2-)
NPW	SW-846 8260B	Butanol (3,3-Dimethyl-1-)
NPW	SW-846 8260B	Trimethylpentane (2,2,4-)
NPW	SW-846 8260B	Trimethylbenzene (1,2,3-)
NPW	SW-846 8260B	Cyclohexane
NPW	SW-846 8260B	Butanol (1-)
NPW	SW-846 8260B	Nitropropane (2-)
NPW	SW-846 8260B	Butyl formate (t-)
NPW	SW-846 8260B	Methyl acetate
NPW	SW-846 8260B	Pentanol (2-Methyl-2-)
NPW	SW-846 8260B	Amyl alcohol (t-)
NPW	SW-846 8260B	Methylcyclohexane
NPW	SW-846 8260B	Octane (-n)
NPW	SW-846 8260B	tert-Amylmethyl ether [TAME]

Matrix	Method	Parameter
NPW	SW-846 8260B	Bromoethane
NPW	SW-846 8260B	Cyclohexanone
NPW	SW-846 8260B	Diisopropyl Ether [DIPE]
NPW	SW-846 8260B	Tetrahydrofuran
NPW	SW-846 8260B	Ethyl-tert-butyl Ether [ETBE]
NPW	SW-846 8260B	Safrole
NPW	SW-846 8260B	Xylene (m-)
NPW	SW-846 8260B	Xylene (o-)
NPW	SW-846 8260B	Xylene (p-)
NPW	SW-846 8260B	Dichloro-2-butene (cis-1,4-)
NPW	SW-846 8260B	Diethyl ether (Ethyl ether)
NPW	SW-846 8260B	Dichloro-2-butene (trans-1,4-)
NPW	SW-846 8260B	Ethanol
NPW	SW-846 8260B	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
NPW	SW-846 8260B	Vinyl acetate
NPW	SW-846 8260B	Pentachloroethane
NPW	SW-846 8260B	Tert-butyl alcohol
NPW	SW-846 8260B	Dioxane (1,4-)
NPW	SW-846 8260B	Bromobenzene
NPW	SW-846 8260B	Butyl benzene (n-)
NPW	SW-846 8260B	Sec-butylbenzene
NPW	SW-846 8260B	Tert-butylbenzene
NPW	SW-846 8260B	Chlorotoluene (2-)
NPW	SW-846 8260B	Chlorotoluene (4-)
NPW	SW-846 8260B	Isopropylbenzene
NPW	SW-846 8260B	Propylbenzene (n-)
NPW	SW-846 8260B	Isopropyltoluene (4-)
NPW	SW-846 8260B	Trichlorobenzene (1,2,3-)
NPW	SW-846 8260B	Trimethylbenzene (1,2,4-)
NPW	SW-846 8260B	Trimethylbenzene (1,3,5-)
NPW	SW-846 8260B	Allyl chloride
NPW	SW-846 8260B	Bromochloromethane
NPW	SW-846 8260B	Butadiene (2-chloro-1,3-)
NPW	SW-846 8260B	Dibromoethane (1,2-) (EDB)
NPW	SW-846 8260B	Dibromomethane
NPW	SW-846 8260B	Dibromo-3-chloropropane (1,2-)
NPW	SW-846 8260B	Dichloropropane (1,3-)
NPW	SW-846 8260B	Dichloropropane (2,2-)
NPW	SW-846 8260B	Dichloropropene (1,1-)
NPW	SW-846 8260B	Trichloropropane (1,2,3-)

Matrix	Method	Parameter
NPW	SW-846 8260B	Ethyl acetate
NPW	SW-846 8260B	Ethyl methacrylate
NPW	SW-846 8260B	Methacrylonitrile
NPW	SW-846 8260B	Methyl acrylate
NPW	SW-846 8260B	Methyl methacrylate
NPW	SW-846 8260B	Methyl iodide
NPW	SW-846 8260B	Iso-butyl alcohol
NPW	SW-846 8260B	Isopropanol
NPW	SW-846 8260B	N-Nitroso-di-n-butylamine
NPW	SW-846 8260B	Propionitrile
NPW	SW-846 8260B	Acetonitrile
NPW	SW-846 8260B	Benzene
NPW	SW-846 8260B	Chlorobenzene
NPW	SW-846 8260B	Dichlorobenzene (1,2-)
NPW	SW-846 8260B	Dichlorobenzene (1,3-)
NPW	SW-846 8260B	Dichlorobenzene (1,4-)
NPW	SW-846 8260B	Ethylbenzene
NPW	SW-846 8260B	Toluene
NPW	SW-846 8260B	Xylenes (total)
NPW	SW-846 8260B	Bromodichloromethane
NPW	SW-846 8260B	Bromoform
NPW	SW-846 8260B	Bromomethane
NPW	SW-846 8260B	Carbon tetrachloride
NPW	SW-846 8260B	Chloroethane
NPW	SW-846 8260B	Chloroethyl vinyl ether (2-)
NPW	SW-846 8260B	Chloroform
NPW	SW-846 8260B	Chloromethane
NPW	SW-846 8260B	Dichloropropene (trans-1,3-)
NPW	SW-846 8260B	Dibromochloromethane
NPW	SW-846 8260B	Dichlorodifluoromethane
NPW	SW-846 8260B	Dichloroethane (1,1-)
NPW	SW-846 8260B	Dichloroethane (1,2-)
NPW	SW-846 8260B	Dichloroethene (1,1-)
NPW	SW-846 8260B	Dichloroethene (trans-1,2-)
NPW	SW-846 8260B	Dichloroethene (cis-1,2-)
NPW	SW-846 8260B	Dichloropropane (1,2-)
NPW	SW-846 8260B	Dichloropropene (cis-1,3-)
NPW	SW-846 8260B	Methylene chloride (Dichloromethane)
NPW	SW-846 8260B	Tetrachloroethane (1,1,2,2-)
NPW	SW-846 8260B	Tetrachloroethene

Matrix	Method	Parameter
NPW	SW-846 8260B	Trichloroethane (1,1,1-)
NPW	SW-846 8260B	Trichloroethane (1,1,2-)
NPW	SW-846 8260B	Trichloroethene
NPW	SW-846 8260B	Trichlorofluoromethane
NPW	SW-846 8260B	Vinyl chloride
NPW	SW-846 8260B	Acetone
NPW	SW-846 8260B	Carbon disulfide
NPW	SW-846 8260B	Butanone (2-)
NPW	SW-846 8260B	Hexanone (2-)
NPW	SW-846 8260B	Pentanone (4-methyl-2-) (MIBK)
NPW	SW-846 8260B	Methyl tert-butyl ether
NPW	SW-846 8260B	Acrolein
NPW	SW-846 8260B	Acrylonitrile
NPW	SW-846 8260B	Hexachlorobutadiene (1,3-)
NPW	SW-846 8260B	Hexachloroethane
NPW	SW-846 8260B	Naphthalene
NPW	SW-846 8260B	Styrene
NPW	SW-846 8260B	Tetrachloroethane (1,1,1,2-)
NPW	SW-846 8260B	Trichlorobenzene (1,2,4-)
NPW	SW-846 8260C	Methyl alcohol (Methanol)
NPW	SW-846 8260C	Ethyl alcohol
NPW	SW-846 8260C	Trimethylpentane (2,2,4-)
NPW	SW-846 8260C	Methylnaphthalene (1-)
NPW	SW-846 8260C	Methylnaphthalene (2-)
NPW	SW-846 8260C	Butanol (3,3-Dimethyl-1-)
NPW	SW-846 8260C	Trimethylbenzene (1,2,3-)
NPW	SW-846 8260C	Cyclohexane
NPW	SW-846 8260C	Butanol (1-)
NPW	SW-846 8260C	Nitropropane (2-)
NPW	SW-846 8260C	Butyl formate (t-)
NPW	SW-846 8260C	Methyl acetate
NPW	SW-846 8260C	Pentanol (2-Methyl-2-)
NPW	SW-846 8260C	Amyl alcohol (t-)
NPW	SW-846 8260C	Methylcyclohexane
NPW	SW-846 8260C	Octane (-n)
NPW	SW-846 8260C	tert-Amylmethyl ether [TAME]
NPW	SW-846 8260C	Bromoethane
NPW	SW-846 8260C	Cyclohexanone
NPW	SW-846 8260C	Diisopropyl Ether [DIPE]
NPW	SW-846 8260C	Tetrahydrofuran

Matrix	Method	Parameter
NPW	SW-846 8260C	Ethyl-tert-butyl Ether [ETBE]
NPW	SW-846 8260C	Xylene (m-)
NPW	SW-846 8260C	Xylene (o-)
NPW	SW-846 8260C	Xylene (p-)
NPW	SW-846 8260C	Dichloro-2-butene (cis-1,4-)
NPW	SW-846 8260C	Diethyl ether (Ethyl ether)
NPW	SW-846 8260C	Dichloro-2-butene (trans-1,4-)
NPW	SW-846 8260C	Ethanol
NPW	SW-846 8260C	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
NPW	SW-846 8260C	Vinyl acetate
NPW	SW-846 8260C	Pentachloroethane
NPW	SW-846 8260C	Tert-butyl alcohol
NPW	SW-846 8260C	Dioxane (1,4-)
NPW	SW-846 8260C	Bromobenzene
NPW	SW-846 8260C	Butyl benzene (n-)
NPW	SW-846 8260C	Sec-butylbenzene
NPW	SW-846 8260C	Tert-butylbenzene
NPW	SW-846 8260C	Chlorotoluene (2-)
NPW	SW-846 8260C	Chlorotoluene (4-)
NPW	SW-846 8260C	Isopropylbenzene
NPW	SW-846 8260C	Propylbenzene (n-)
NPW	SW-846 8260C	Isopropyltoluene (4-)
NPW	SW-846 8260C	Trichlorobenzene (1,2,3-)
NPW	SW-846 8260C	Trimethylbenzene (1,2,4-)
NPW	SW-846 8260C	Trimethylbenzene (1,3,5-)
NPW	SW-846 8260C	Allyl chloride
NPW	SW-846 8260C	Bromochloromethane
NPW	SW-846 8260C	Butadiene (2-chloro-1,3-)
NPW	SW-846 8260C	Dibromoethane (1,2-) (EDB)
NPW	SW-846 8260C	Dibromomethane
NPW	SW-846 8260C	Dibromo-3-chloropropane (1,2-)
NPW	SW-846 8260C	Dichloropropane (1,3-)
NPW	SW-846 8260C	Dichloropropane (2,2-)
NPW	SW-846 8260C	Dichloropropene (1,1-)
NPW	SW-846 8260C	Trichloropropane (1,2,3-)
NPW	SW-846 8260C	Ethyl acetate
NPW	SW-846 8260C	Ethyl methacrylate
NPW	SW-846 8260C	Methacrylonitrile
NPW	SW-846 8260C	Methyl acrylate
NPW	SW-846 8260C	Methyl methacrylate

Matrix	Method	Parameter
NPW	SW-846 8260C	Methyl iodide
NPW	SW-846 8260C	Iso-butyl alcohol
NPW	SW-846 8260C	Isopropanol
NPW	SW-846 8260C	N-Nitroso-di-n-butylamine
NPW	SW-846 8260C	Propionitrile
NPW	SW-846 8260C	Acetonitrile
NPW	SW-846 8260C	Benzene
NPW	SW-846 8260C	Chlorobenzene
NPW	SW-846 8260C	Dichlorobenzene (1,2-)
NPW	SW-846 8260C	Dichlorobenzene (1,3-)
NPW	SW-846 8260C	Dichlorobenzene (1,4-)
NPW	SW-846 8260C	Ethylbenzene
NPW	SW-846 8260C	Toluene
NPW	SW-846 8260C	Xylenes (total)
NPW	SW-846 8260C	Bromodichloromethane
NPW	SW-846 8260C	Bromoform
NPW	SW-846 8260C	Bromomethane
NPW	SW-846 8260C	Carbon tetrachloride
NPW	SW-846 8260C	Chloroethane
NPW	SW-846 8260C	Chloroethyl vinyl ether (2-)
NPW	SW-846 8260C	Chloroform
NPW	SW-846 8260C	Chloromethane
NPW	SW-846 8260C	Dichloropropene (trans-1,3-)
NPW	SW-846 8260C	Dibromochloromethane
NPW	SW-846 8260C	Dichlorodifluoromethane
NPW	SW-846 8260C	Dichloroethane (1,1-)
NPW	SW-846 8260C	Dichloroethane (1,2-)
NPW	SW-846 8260C	Dichloroethene (1,1-)
NPW	SW-846 8260C	Dichloroethene (trans-1,2-)
NPW	SW-846 8260C	Dichloroethene (cis-1,2-)
NPW	SW-846 8260C	Dichloropropane (1,2-)
NPW	SW-846 8260C	Dichloropropene (cis-1,3-)
NPW	SW-846 8260C	Methylene chloride (Dichloromethane)
NPW	SW-846 8260C	Tetrachloroethane (1,1,2,2-)
NPW	SW-846 8260C	Tetrachloroethene
NPW	SW-846 8260C	Trichloroethane (1,1,1-)
NPW	SW-846 8260C	Trichloroethane (1,1,2-)
NPW	SW-846 8260C	Trichloroethene
NPW	SW-846 8260C	Trichlorofluoromethane
NPW	SW-846 8260C	Vinyl chloride

Matrix	Method	Parameter
NPW	SW-846 8260C	Acetone
NPW	SW-846 8260C	Carbon disulfide
NPW	SW-846 8260C	Butanone (2-)
NPW	SW-846 8260C	Hexanone (2-)
NPW	SW-846 8260C	Pentanone (4-methyl-2-) (MIBK)
NPW	SW-846 8260C	Methyl tert-butyl ether
NPW	SW-846 8260C	Acrolein
NPW	SW-846 8260C	Acrylonitrile
NPW	SW-846 8260C	Hexachlorobutadiene (1,3-)
NPW	SW-846 8260C	Hexachloroethane
NPW	SW-846 8260C	Naphthalene
NPW	SW-846 8260C	Styrene
NPW	SW-846 8260C	Tetrachloroethane (1,1,1,2-)
NPW	SW-846 8260C	Trichlorobenzene (1,2,4-)
NPW	SW-846 8270C	Biphenyl (1,1'-)
NPW	SW-846 8270C	Benzaldehyde
NPW	SW-846 8270C	Caprolactam
NPW	SW-846 8270C	Atrazine
NPW	SW-846 8270C	Phenanthrene
NPW	SW-846 8270C	Pyrene
NPW	SW-846 8270C	Acenaphthene
NPW	SW-846 8270C	Acenaphthylene
NPW	SW-846 8270C	Anthracene
NPW	SW-846 8270C	Benzo(ghi)perylene
NPW	SW-846 8270C	Chrysene
NPW	SW-846 8270C	Methylnaphthalene (1-)
NPW	SW-846 8270C	Methylnaphthalene (2-)
NPW	SW-846 8270C	Naphthalene
NPW	SW-846 8270C	Fluoranthene
NPW	SW-846 8270C	Fluorene
NPW	SW-846 8270C	Methylnaphthalene (1-)
NPW	SW-846 8270C	Nitrodiphenylamine (2-)
NPW	SW-846 8270C	Nitrodiphenylamine (2-)
NPW	SW-846 8270C	Hexachlorophene
NPW	SW-846 8270C	Diphenylhydrazine (1,2-)
NPW	SW-846 8270C	Decane (n-)
NPW	SW-846 8270C	Octadecane (n-)
NPW	SW-846 8270C	Benzo(a)anthracene
NPW	SW-846 8270C	Benzo(a)pyrene
NPW	SW-846 8270C	Benzo(b)fluoranthene

Matrix	Method	Parameter
NPW	SW-846 8270C	Benzo(k)fluoranthene
NPW	SW-846 8270C	Dibenzo(a,h)anthracene
NPW	SW-846 8270C	Indeno(1,2,3-cd)pyrene
NPW	SW-846 8270C	Benzal chloride
NPW	SW-846 8270C	Benzo(j)fluoranthene
NPW	SW-846 8270C	Benzotrichloride
NPW	SW-846 8270C	Benzyl chloride
NPW	SW-846 8270C	Chlorobenzilate
NPW	SW-846 8270C	Dibenz(a,h)acridine
NPW	SW-846 8270C	Dibenzo(a,h)pyrene
NPW	SW-846 8270C	Dibenzo(a,i)pyrene
NPW	SW-846 8270C	Dibenzo(c,g)carbazole (7H-)
NPW	SW-846 8270C	Pentachloroethane
NPW	SW-846 8270C	Tetrachlorobenzene (1,2,3,4-)
NPW	SW-846 8270C	Tetrachlorobenzene (1,2,3,5-)
NPW	SW-846 8270C	Benzyl alcohol
NPW	SW-846 8270C	Acetophenone
NPW	SW-846 8270C	Acetylaminofluorene (2-)
NPW	SW-846 8270C	Aminobiphenyl (4-)
NPW	SW-846 8270C	Aramite
NPW	SW-846 8270C	Chloronaphthalene (1-)
NPW	SW-846 8270C	Diallate (cis)
NPW	SW-846 8270C	Diallate (trans)
NPW	SW-846 8270C	Dibenzo(a,e)pyrene
NPW	SW-846 8270C	Dibenz(a,j)acridine
NPW	SW-846 8270C	Dichlorophenol (2,6-)
NPW	SW-846 8270C	Dimethoate
NPW	SW-846 8270C	Dimethylaminoazobenzene
NPW	SW-846 8270C	Dimethylbenz(a)anthracene (7,12-)
NPW	SW-846 8270C	Dimethyl benzidine (3,3-)
NPW	SW-846 8270C	Dinitrobenzene (1,3-)
NPW	SW-846 8270C	Dinoseb
NPW	SW-846 8270C	Disulfoton
NPW	SW-846 8270C	Famphur
NPW	SW-846 8270C	Hexachloropropene
NPW	SW-846 8270C	Isodrin
NPW	SW-846 8270C	Isosafrole (cis-)
NPW	SW-846 8270C	Isosafrole (trans-)
NPW	SW-846 8270C	Kepone
NPW	SW-846 8270C	Methanesulfonate (Ethyl-)

Matrix	Method	Parameter
NPW	SW-846 8270C	Methanesulfonate (Methyl-)
NPW	SW-846 8270C	Methapyrilene
NPW	SW-846 8270C	Methylcholanthrene (3-)
NPW	SW-846 8270C	Napthoquinone (1,4-)
NPW	SW-846 8270C	Napththylamine (1-)
NPW	SW-846 8270C	Napththylamine (2-)
NPW	SW-846 8270C	N-Nitroso-di-n-butylamine
NPW	SW-846 8270C	N-Nitrosomorpholine
NPW	SW-846 8270C	N-Nitrosopiperidine
NPW	SW-846 8270C	Parathion
NPW	SW-846 8270C	Parathion methyl
NPW	SW-846 8270C	Pentachlorobenzene
NPW	SW-846 8270C	Pentachloronitrobenzene
NPW	SW-846 8270C	Phenacetin
NPW	SW-846 8270C	Phenylenediamine (1,4-)
NPW	SW-846 8270C	Phenylethylamine (alpha, alpha-Dimethyl)
NPW	SW-846 8270C	Phorate
NPW	SW-846 8270C	Phosphorothioate (O,O,O-triethyl)
NPW	SW-846 8270C	Phosphorothioate (O,O-diethyl-O-2-pyrazinyl) [Thionazin]
NPW	SW-846 8270C	Picoline (2-)
NPW	SW-846 8270C	Pronamide
NPW	SW-846 8270C	Quinoline -1-Oxide (4-Nitro)
NPW	SW-846 8270C	Safrole
NPW	SW-846 8270C	Sulfotepp
NPW	SW-846 8270C	Tetrachlorobenzene (1,2,4,5-)
NPW	SW-846 8270C	Tetrachlorophenol (2,3,4,6-)
NPW	SW-846 8270C	Toluidine (2-) (2-Methylaniline)
NPW	SW-846 8270C	Toluidine (5-nitro-2-)
NPW	SW-846 8270C	Trinitrobenzene (1,3,5-)
NPW	SW-846 8270C	N-Nitrosodiethylamine
NPW	SW-846 8270C	N-Nitrosopyrrolidine
NPW	SW-846 8270C	Diphenylamine
NPW	SW-846 8270C	Carbazole
NPW	SW-846 8270C	Dichlorobenzene (1,2-)
NPW	SW-846 8270C	Dichlorobenzene (1,3-)
NPW	SW-846 8270C	N-Nitrosodimethylamine
NPW	SW-846 8270C	N-Nitroso-di-n-propylamine
NPW	SW-846 8270C	N-Nitrosomethylethylamine
NPW	SW-846 8270C	Benzidine

Matrix	Method	Parameter
NPW	SW-846 8270C	Aniline
NPW	SW-846 8270C	Hexachloropropene
NPW	SW-846 8270C	Dibenzofuran
NPW	SW-846 8270C	Benzoic acid
NPW	SW-846 8270C	N-Nitrosodiphenylamine
NPW	SW-846 8270C	Dichlorobenzidine (3,3'-)
NPW	SW-846 8270C	Chloroaniline (4-)
NPW	SW-846 8270C	Nitroaniline (2-)
NPW	SW-846 8270C	Nitroaniline (3-)
NPW	SW-846 8270C	Nitroaniline (4-)
NPW	SW-846 8270C	Chloronaphthalene (2-)
NPW	SW-846 8270C	Hexachlorobenzene
NPW	SW-846 8270C	Hexachlorobutadiene (1,3-)
NPW	SW-846 8270C	Hexachlorocyclopentadiene
NPW	SW-846 8270C	Hexachloroethane
NPW	SW-846 8270C	Trichlorobenzene (1,2,4-)
NPW	SW-846 8270C	Bis (2-chloroethoxy) methane
NPW	SW-846 8270C	Bis (2-chloroethyl) ether
NPW	SW-846 8270C	Bis (2-chloroisopropyl) ether
NPW	SW-846 8270C	Chlorophenyl-phenyl ether (4-)
NPW	SW-846 8270C	Bromophenyl-phenyl ether (4-)
NPW	SW-846 8270C	Dinitrotoluene (2,4-)
NPW	SW-846 8270C	Dinitrotoluene (2,6-)
NPW	SW-846 8270C	Isophorone
NPW	SW-846 8270C	Nitrobenzene
NPW	SW-846 8270C	Butyl benzyl phthalate
NPW	SW-846 8270C	Bis (2-ethylhexyl) phthalate
NPW	SW-846 8270C	Diethyl phthalate
NPW	SW-846 8270C	Dimethyl phthalate
NPW	SW-846 8270C	Di-n-butyl phthalate
NPW	SW-846 8270C	Di-n-octyl phthalate
NPW	SW-846 8270C	Acenaphthene
NPW	SW-846 8270C	Anthracene
NPW	SW-846 8270C	Acenaphthylene
NPW	SW-846 8270C	Benzo(a)anthracene
NPW	SW-846 8270C	Benzo(a)pyrene
NPW	SW-846 8270C	Benzo(b)fluoranthene
NPW	SW-846 8270C	Benzo(ghi)perylene
NPW	SW-846 8270C	Benzo(k)fluoranthene
NPW	SW-846 8270C	Chrysene

Matrix	Method	Parameter
NPW	SW-846 8270C	Dibenzo(a,h)anthracene
NPW	SW-846 8270C	Fluoranthene
NPW	SW-846 8270C	Fluorene
NPW	SW-846 8270C	Indeno(1,2,3-cd)pyrene
NPW	SW-846 8270C	Methylnaphthalene (2-)
NPW	SW-846 8270C	Naphthalene
NPW	SW-846 8270C	Phenanthrene
NPW	SW-846 8270C	Pyrene
NPW	SW-846 8270C	Methyl phenol (4-chloro-3-)
NPW	SW-846 8270C	Chlorophenol (2-)
NPW	SW-846 8270C	Dichlorophenol (2,4-)
NPW	SW-846 8270C	Dimethylphenol (2,4-)
NPW	SW-846 8270C	Dinitrophenol (2,4-)
NPW	SW-846 8270C	Dinitrophenol (2-methyl-4,6-)
NPW	SW-846 8270C	Methylphenol (2-)
NPW	SW-846 8270C	Methylphenol (4-)
NPW	SW-846 8270C	Nitrophenol (2-)
NPW	SW-846 8270C	Nitrophenol (4-)
NPW	SW-846 8270C	Pentachlorophenol
NPW	SW-846 8270C	Phenol
NPW	SW-846 8270C	Trichlorophenol (2,4,5-)
NPW	SW-846 8270C	Trichlorophenol (2,4,6-)
NPW	SW-846 8270C	Dichlorobenzene (1,4-)
NPW	SW-846 8270C	Pyridine
NPW	SW-846 8270D	Biphenyl (1,1'-)
NPW	SW-846 8270D	Benzaldehyde
NPW	SW-846 8270D	Caprolactam
NPW	SW-846 8270D	Atrazine
NPW	SW-846 8270D	Phenanthrene
NPW	SW-846 8270D	Pyrene
NPW	SW-846 8270D	Acenaphthene
NPW	SW-846 8270D	Acenaphthylene
NPW	SW-846 8270D	Anthracene
NPW	SW-846 8270D	Benzo(ghi)perylene
NPW	SW-846 8270D	Chrysene
NPW	SW-846 8270D	Methylnaphthalene (1-)
NPW	SW-846 8270D	Methylnaphthalene (2-)
NPW	SW-846 8270D	Naphthalene
NPW	SW-846 8270D	Fluoranthene
NPW	SW-846 8270D	Fluorene

Matrix	Method	Parameter
NPW	SW-846 8270D	Methylnaphthalene (1-)
NPW	SW-846 8270D	Nitrodiphenylamine (2-)
NPW	SW-846 8270D	Hexachlorophene
NPW	SW-846 8270D	Diphenylhydrazine (1,2-)
NPW	SW-846 8270D	Decane (n-)
NPW	SW-846 8270D	Octadecane (n-)
NPW	SW-846 8270D	Benzo(a)anthracene
NPW	SW-846 8270D	Benzo(a)pyrene
NPW	SW-846 8270D	Benzo(b)fluoranthene
NPW	SW-846 8270D	Benzo(k)fluoranthene
NPW	SW-846 8270D	Dibenzo(a,h)anthracene
NPW	SW-846 8270D	Indeno(1,2,3-cd)pyrene
NPW	SW-846 8270D	Benzal chloride
NPW	SW-846 8270D	Benzo(j)fluoranthene
NPW	SW-846 8270D	Benzotrichloride
NPW	SW-846 8270D	Benzyl chloride
NPW	SW-846 8270D	Chlorobenzilate
NPW	SW-846 8270D	Dibenz(a,h)acridine
NPW	SW-846 8270D	Dibenzo(a,h)pyrene
NPW	SW-846 8270D	Dibenzo(a,i)pyrene
NPW	SW-846 8270D	Dibenzo(c,g)carbazole (7H-)
NPW	SW-846 8270D	Pentachloroethane
NPW	SW-846 8270D	Tetrachlorobenzene (1,2,3,4-)
NPW	SW-846 8270D	Tetrachlorobenzene (1,2,3,5-)
NPW	SW-846 8270D	Benzyl alcohol
NPW	SW-846 8270D	Acetophenone
NPW	SW-846 8270D	Acetylaminofluorene (2-)
NPW	SW-846 8270D	Aminobiphenyl (4-)
NPW	SW-846 8270D	Aramite
NPW	SW-846 8270D	Chloronaphthalene (1-)
NPW	SW-846 8270D	Diallate (cis)
NPW	SW-846 8270D	Diallate (trans)
NPW	SW-846 8270D	Dibenzo(a,e)pyrene
NPW	SW-846 8270D	Dibenz(a,j)acridine
NPW	SW-846 8270D	Dichlorophenol (2,6-)
NPW	SW-846 8270D	Dimethoate
NPW	SW-846 8270D	Dimethylaminoazobenzene
NPW	SW-846 8270D	Dimethylbenz(a)anthracene (7,12-)
NPW	SW-846 8270D	Dimethyl benzidine (3,3-)
NPW	SW-846 8270D	Dinitrobenzene (1,3-)

Matrix	Method	Parameter
NPW	SW-846 8270D	Dinoseb
NPW	SW-846 8270D	Disulfoton
NPW	SW-846 8270D	Famphur
NPW	SW-846 8270D	Isodrin
NPW	SW-846 8270D	Isosafrole (cis-)
NPW	SW-846 8270D	Isosafrole (trans-)
NPW	SW-846 8270D	Kepone
NPW	SW-846 8270D	Methanesulfonate (Ethyl-)
NPW	SW-846 8270D	Methanesulfonate (Methyl-)
NPW	SW-846 8270D	Methapyrilene
NPW	SW-846 8270D	Methylcholanthrene (3-)
NPW	SW-846 8270D	Napthoquinone (1,4-)
NPW	SW-846 8270D	Napththylamine (1-)
NPW	SW-846 8270D	Napththylamine (2-)
NPW	SW-846 8270D	N-Nitroso-di-n-butylamine
NPW	SW-846 8270D	N-Nitrosomorpholine
NPW	SW-846 8270D	N-Nitrosopiperidine
NPW	SW-846 8270D	Parathion
NPW	SW-846 8270D	Parathion methyl
NPW	SW-846 8270D	Pentachlorobenzene
NPW	SW-846 8270D	Pentachloronitrobenzene
NPW	SW-846 8270D	Phenacetin
NPW	SW-846 8270D	Phenylenediamine (1,4-)
NPW	SW-846 8270D	Phenylethylamine (alpha, alpha-Dimethyl)
NPW	SW-846 8270D	Phorate
NPW	SW-846 8270D	Phosphorothioate (O,O,O-triethyl)
NPW	SW-846 8270D	Phosphorothioate (O,O-diethyl-O-2-pyrazinyl) [Thionazin]
NPW	SW-846 8270D	Picoline (2-)
NPW	SW-846 8270D	Pronamide
NPW	SW-846 8270D	Quinoline -1-Oxide (4-Nitro)
NPW	SW-846 8270D	Safrole
NPW	SW-846 8270D	Sulfotepp
NPW	SW-846 8270D	Tetrachlorobenzene (1,2,4,5-)
NPW	SW-846 8270D	Tetrachlorophenol (2,3,4,6-)
NPW	SW-846 8270D	Toluidine (2-) (2-Methylaniline)
NPW	SW-846 8270D	Toluidine (5-nitro-2-)
NPW	SW-846 8270D	Trinitrobenzene (1,3,5-)
NPW	SW-846 8270D	N-Nitrosodiethylamine
NPW	SW-846 8270D	N-Nitrosopyrrolidine

Matrix	Method	Parameter
NPW	SW-846 8270D	Diphenylamine
NPW	SW-846 8270D	Carbazole
NPW	SW-846 8270D	Dichlorobenzene (1,2-)
NPW	SW-846 8270D	Dichlorobenzene (1,3-)
NPW	SW-846 8270D	N-Nitrosodimethylamine
NPW	SW-846 8270D	N-Nitroso-di-n-propylamine
NPW	SW-846 8270D	N-Nitrosomethylethylamine
NPW	SW-846 8270D	Benzidine
NPW	SW-846 8270D	Aniline
NPW	SW-846 8270D	Hexachloropropene
NPW	SW-846 8270D	Dibenzofuran
NPW	SW-846 8270D	Benzoic acid
NPW	SW-846 8270D	N-Nitrosodiphenylamine
NPW	SW-846 8270D	Dichlorobenzidine (3,3'-)
NPW	SW-846 8270D	Chloroaniline (4-)
NPW	SW-846 8270D	Nitroaniline (2-)
NPW	SW-846 8270D	Nitroaniline (3-)
NPW	SW-846 8270D	Nitroaniline (4-)
NPW	SW-846 8270D	Chloronaphthalene (2-)
NPW	SW-846 8270D	Hexachlorobenzene
NPW	SW-846 8270D	Hexachlorobutadiene (1,3-)
NPW	SW-846 8270D	Hexachlorocyclopentadiene
NPW	SW-846 8270D	Hexachloroethane
NPW	SW-846 8270D	Trichlorobenzene (1,2,4-)
NPW	SW-846 8270D	Bis (2-chloroethoxy) methane
NPW	SW-846 8270D	Bis (2-chloroethyl) ether
NPW	SW-846 8270D	Bis (2-chloroisopropyl) ether
NPW	SW-846 8270D	Chlorophenyl-phenyl ether (4-)
NPW	SW-846 8270D	Bromophenyl-phenyl ether (4-)
NPW	SW-846 8270D	Dinitrotoluene (2,4-)
NPW	SW-846 8270D	Dinitrotoluene (2,6-)
NPW	SW-846 8270D	Isophorone
NPW	SW-846 8270D	Nitrobenzene
NPW	SW-846 8270D	Butyl benzyl phthalate
NPW	SW-846 8270D	Bis (2-ethylhexyl) phthalate
NPW	SW-846 8270D	Diethyl phthalate
NPW	SW-846 8270D	Dimethyl phthalate
NPW	SW-846 8270D	Di-n-butyl phthalate
NPW	SW-846 8270D	Di-n-octyl phthalate
NPW	SW-846 8270D	Acenaphthene

Matrix	Method	Parameter
NPW	SW-846 8270D	Anthracene
NPW	SW-846 8270D	Acenaphthylene
NPW	SW-846 8270D	Benzo(a)anthracene
NPW	SW-846 8270D	Benzo(a)pyrene
NPW	SW-846 8270D	Benzo(b)fluoranthene
NPW	SW-846 8270D	Benzo(ghi)perylene
NPW	SW-846 8270D	Benzo(k)fluoranthene
NPW	SW-846 8270D	Chrysene
NPW	SW-846 8270D	Dibenzo(a,h)anthracene
NPW	SW-846 8270D	Fluoranthene
NPW	SW-846 8270D	Fluorene
NPW	SW-846 8270D	Indeno(1,2,3-cd)pyrene
NPW	SW-846 8270D	Methylnaphthalene (2-)
NPW	SW-846 8270D	Naphthalene
NPW	SW-846 8270D	Phenanthrene
NPW	SW-846 8270D	Pyrene
NPW	SW-846 8270D	Methyl phenol (4-chloro-3-)
NPW	SW-846 8270D	Chlorophenol (2-)
NPW	SW-846 8270D	Dichlorophenol (2,4-)
NPW	SW-846 8270D	Dimethylphenol (2,4-)
NPW	SW-846 8270D	Dinitrophenol (2,4-)
NPW	SW-846 8270D	Dinitrophenol (2-methyl-4,6-)
NPW	SW-846 8270D	Methylphenol (2-)
NPW	SW-846 8270D	Methylphenol (4-)
NPW	SW-846 8270D	Nitrophenol (2-)
NPW	SW-846 8270D	Nitrophenol (4-)
NPW	SW-846 8270D	Pentachlorophenol
NPW	SW-846 8270D	Phenol
NPW	SW-846 8270D	Trichlorophenol (2,4,5-)
NPW	SW-846 8270D	Trichlorophenol (2,4,6-)
NPW	SW-846 8270D	Dichlorobenzene (1,4-)
NPW	SW-846 8270D	Pyridine
NPW	SW-846 8310	Acenaphthene
NPW	SW-846 8310	Acenaphthylene
NPW	SW-846 8310	Anthracene
NPW	SW-846 8310	Benzo(a)anthracene
NPW	SW-846 8310	Benzo(a)pyrene
NPW	SW-846 8310	Benzo(b)fluoranthene
NPW	SW-846 8310	Benzo(ghi)perylene
NPW	SW-846 8310	Benzo(k)fluoranthene

Matrix	Method	Parameter
NPW	SW-846 8310	Chrysene
NPW	SW-846 8310	Dibenzo(a,h)anthracene
NPW	SW-846 8310	Fluoranthene
NPW	SW-846 8310	Fluorene
NPW	SW-846 8310	Indeno(1,2,3-cd)pyrene
NPW	SW-846 8310	Naphthalene
NPW	SW-846 8310	Phenanthrene
NPW	SW-846 8310	Pyrene
NPW	SW-846 8330	Nitroglycerine
NPW	SW-846 8330	Guanidine nitrate
NPW	SW-846 8330	PETN
NPW	SW-846 8330	HMX
NPW	SW-846 8330	RDX
NPW	SW-846 8330	Trinitrobenzene (1,3,5-)
NPW	SW-846 8330	Dinitrobenzene (1,3-)
NPW	SW-846 8330	Tetryl
NPW	SW-846 8330	Nitrobenzene
NPW	SW-846 8330	Trinitrotoluene (2,4,6-)
NPW	SW-846 8330	Dinitrotoluene (4-amino-2,6-)
NPW	SW-846 8330	Dinitrotoluene (2-amino-4,6-)
NPW	SW-846 8330	Dinitrotoluene (2,4-)
NPW	SW-846 8330	Dinitrotoluene (2,6-)
NPW	SW-846 8330	Nitrotoluene (2-)
NPW	SW-846 8330	Nitrotoluene (3-)
NPW	SW-846 8330	Nitrotoluene (4-)
NPW	SW-846 8330A	Nitroglycerine
NPW	SW-846 8330A	PETN
NPW	SW-846 8330A	HMX
NPW	SW-846 8330A	RDX
NPW	SW-846 8330A	Trinitrobenzene (1,3,5-)
NPW	SW-846 8330A	Dinitrobenzene (1,3-)
NPW	SW-846 8330A	Tetryl
NPW	SW-846 8330A	Nitrobenzene
NPW	SW-846 8330A	Trinitrotoluene (2,4,6-)
NPW	SW-846 8330A	Dinitrotoluene (4-amino-2,6-)
NPW	SW-846 8330A	Dinitrotoluene (2-amino-4,6-)
NPW	SW-846 8330A	Dinitrotoluene (2,4-)
NPW	SW-846 8330A	Dinitrotoluene (2,6-)
NPW	SW-846 8330A	Nitrotoluene (2-)
NPW	SW-846 8330A	Nitrotoluene (3-)

Matrix	Method	Parameter
NPW	SW-846 8330A	Nitrotoluene (4-)
NPW	SW-846 9010C	Cyanide - amenable to Cl2
NPW	SW-846 9010C	Cyanide
NPW	SW-846 9012B	Cyanide
NPW	SW-846 9020B	Total organic halides (TOX)
NPW	SW-846 9030B	Sulfides, acid sol. & insol.
NPW	SW-846 9034	Sulfides, acid sol. & insol.
NPW	SW-846 9040B	Corrosivity - pH waste, >20% water
NPW	SW-846 9040B	pH
NPW	SW-846 9040C	Corrosivity - pH waste, >20% water
NPW	SW-846 9040C	pH
NPW	SW-846 9040C	pH - waste, >20% water
NPW	SW-846 9050A	Specific conductance
NPW	SW-846 9056	Bromide
NPW	SW-846 9056	Nitrite
NPW	SW-846 9056	Sulfate
NPW	SW-846 9056	Nitrate
NPW	SW-846 9056	Chloride
NPW	SW-846 9056	Fluoride
NPW	SW-846 9056A	Bromide
NPW	SW-846 9056A	Nitrite
NPW	SW-846 9056A	Sulfate
NPW	SW-846 9056A	Nitrate
NPW	SW-846 9056A	Chloride
NPW	SW-846 9056A	Fluoride
NPW	SW-846 9060	Total organic carbon (TOC)
NPW	SW-846 9060A	Total organic carbon (TOC)
NPW	SW-846 9066	Phenols
NPW	User Defined 5030C	Volatile organics
NPW	User Defined 8260C	Hexane (n-)
NPW	User Defined 9010B	Cyanide - amenable to Cl2
NPW	User Defined 9010B	Cyanide
NPW	User Defined 9012A	Cyanide
NPW	User Defined ASTM D93	Ignitability
NPW	User Defined CA LUFT - diesel	Petroleum Organics
NPW	User Defined CA LUFT - diesel	Petroleum Organics
NPW	User Defined EPA 1657	Parathion ethyl
NPW	User Defined EPA 1657	Azinphos methyl
NPW	User Defined EPA 1657	Demeton (o-)
NPW	User Defined EPA 1657	Demeton (s-)

Matrix	Method	Parameter
NPW	User Defined EPA 1657	Diazinon
NPW	User Defined EPA 1657	Disulfoton
NPW	User Defined EPA 1657	Malathion
NPW	User Defined EPA 1657	Parathion methyl
NPW	User Defined EPA 353.2 Modified	Nitrocellulose
NPW	User Defined EPA 624	Dichlorodifluoromethane
NPW	User Defined LUFT	Xylene (m-)
NPW	User Defined LUFT	Xylene (o-)
NPW	User Defined LUFT	Xylene (p-)
NPW	User Defined LUFT	Benzene
NPW	User Defined LUFT	Ethylbenzene
NPW	User Defined LUFT	Toluene
NPW	User Defined LUFT	Xylenes (total)
NPW	User Defined LUFT	Methyl tert-butyl ether
NPW	User Defined MA-DEP-EPH, TN-EPH, WI DRO, NW TPH Dx	Diesel range organic
NPW	User Defined MA-DEP-VPH, WI GRO, NW TPH Gx	Gasoline range organic
NPW	User Defined NWTPH-Dx, NWTPH-Gx, NWTPHID	Petroleum Organics
NPW	User Defined SM 6200 B-97	Butanone (2-)
NPW	User Defined SM 6200 B-97	Carbon disulfide
NPW	User Defined SM 6200 B-97	Isopropanol
NPW	User Defined SM 6200 B-97	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
NPW	User Defined SM 6200 B-97	Vinyl acetate
NPW	User Defined SM 6200 B-97	Acetonitrile
NPW	User Defined SM 6200 B-97	Hexanone (2-)
NPW	User Defined SM 6200 B-97	Methyl iodide
NPW	User Defined SM 6200 B-97	Dibromoethane (1,2-) (EDB)
NPW	User Defined SM 6200 B-97	Dichlorodifluoromethane
NPW	User Defined SM 6200 B-97	Dichloroethene (cis-1,2-)
NPW	User Defined SM 6200 B-97	Hexane (n-)
NPW	User Defined SM 6200 B-97	Methyl isobutyl ketone (MIBK)
NPW	User Defined SM 6200 B-97	Tetrahydrofuran
NPW	User Defined SM 6200 B-97	Styrene
NPW	User Defined SM 6200 B-97	Xylene (o-)
NPW	User Defined SM 6200 B-97	Acetone
NPW	User Defined SM 6200 B-97	Ethyl acetate
NPW	User Defined SM 6200 B-97	Methyl tert-butyl ether
NPW	User Defined SM 6200 B-97	Tert-butyl alcohol

Matrix	Method	Parameter
NPW	User Defined SM 6200 B-97	Xylenes (total)
NPW	User Defined SM 6200 B-97	Benzene
NPW	User Defined SM 6200 B-97	Bromodichloromethane
NPW	User Defined SM 6200 B-97	Bromoform
NPW	User Defined SM 6200 B-97	Bromomethane
NPW	User Defined SM 6200 B-97	Carbon tetrachloride
NPW	User Defined SM 6200 B-97	Chlorobenzene
NPW	User Defined SM 6200 B-97	Chloroethane
NPW	User Defined SM 6200 B-97	Chloroethyl vinyl ether (2-)
NPW	User Defined SM 6200 B-97	Chloroform
NPW	User Defined SM 6200 B-97	Chloromethane
NPW	User Defined SM 6200 B-97	Dibromochloromethane
NPW	User Defined SM 6200 B-97	Dichlorobenzene (1,2-)
NPW	User Defined SM 6200 B-97	Dichlorobenzene (1,3-)
NPW	User Defined SM 6200 B-97	Dichlorobenzene (1,4-)
NPW	User Defined SM 6200 B-97	Dichloroethane (1,1-)
NPW	User Defined SM 6200 B-97	Dichloroethane (1,2-)
NPW	User Defined SM 6200 B-97	Dichloroethene (1,1-)
NPW	User Defined SM 6200 B-97	Dichloroethene (trans-1,2-)
NPW	User Defined SM 6200 B-97	Dichloropropane (1,2-)
NPW	User Defined SM 6200 B-97	Dichloropropene (cis-1,3-)
NPW	User Defined SM 6200 B-97	Dichloropropene (trans-1,3-)
NPW	User Defined SM 6200 B-97	Ethylbenzene
NPW	User Defined SM 6200 B-97	Methylene chloride (Dichloromethane)
NPW	User Defined SM 6200 B-97	Tetrachloroethane (1,1,2,2-)
NPW	User Defined SM 6200 B-97	Tetrachloroethene
NPW	User Defined SM 6200 B-97	Toluene
NPW	User Defined SM 6200 B-97	Trichloroethane (1,1,1-)
NPW	User Defined SM 6200 B-97	Trichloroethane (1,1,2-)
NPW	User Defined SM 6200 B-97	Trichloroethene
NPW	User Defined SM 6200 B-97	Trichlorofluoromethane
NPW	User Defined SM 6200 B-97	Vinyl chloride
NPW	User Defined SM 6200C-97	Benzene
NPW	User Defined SM 6200C-97	Ethylbenzene
NPW	User Defined SM 6200C-97	Methyl tert-butyl ether
NPW	User Defined SM 6200C-97	Tert-butyl alcohol
NPW	User Defined SM 6200C-97	Toluene
NPW	User Defined SM 6200C-97	Xylenes (total)
NPW	User Defined SM 6630C-00	Chlordane (alpha)
NPW	User Defined SM 6630C-00	Chlordane (gamma)

Matrix	Method	Parameter
NPW	User Defined SM 6630C-00	Hexachlorobenzene
NPW	User Defined SM 6630C-00	Endrin aldehyde
NPW	User Defined SM 6630C-00	Endrin ketone
NPW	User Defined SM 6640B-01	Dinoseb
NPW	User Defined SM 6640B-01	Dicamba
NPW	User Defined SW846 8260B & 8260C	Gasoline range organic
NPW	User Defined SW-846 8330	Nitroguanidine
NPW	User Defined TX 1005, TX 1006, CT ETPH, NW TPH ID	Petroleum Organics
SCM	EPA 314.0-mod	Perchlorate
SCM	ASTM D240	Heat of combustion (BTU)
SCM	ASTM D5468 and D482	% ash
SCM	ASTM F1647-02A	Total organic carbon (TOC)
SCM	EPA 300.0	Guanidine nitrate
SCM	Other FL - PRO	Petroleum Organics
SCM	Other IA - OA-1	Petroleum Organics
SCM	Other IA - OA-2	Petroleum Organics
SCM	Other NJDEP EPH 10/08, Rev. 3	Extractable Petroleum Hydrocarbons
SCM	Other NJDEP EPH 10/08, Rev. 3	Extractable Petroleum Hydrocarbons
SCM	Other NJ-OQA-QAM-025, Rev. 7	Petroleum Organics
SCM	Other USDA-LOI (Loss on ignition)	Total organic carbon (TOC)
SCM	Other Walkley Black	Total organic carbon (TOC)
SCM	SM 2540 G SM 18th Ed.	Total, fixed, and volatile solids (SQAR)
SCM	SM 9222D-97 (Class B only) plus EPA 625/R-92/013 App. F	Fecal coliform
SCM	SM 9260 D plus EPA 625/R-92/013 Appendix F	Salmonella sp. Bacteria
SCM	SW-846 1010	Ignitability
SCM	SW-846 1010A	Ignitability
SCM	SW-846 1030	Ignitability of solids
SCM	SW-846 1110	Corrosivity toward steel
SCM	SW-846 1110A	Corrosivity toward steel
SCM	SW-846 1310A	Metals - organics
SCM	SW-846 1310B	Metals - organics
SCM	SW-846 1311	Volatile organics
SCM	SW-846 1311	Semivolatile organics
SCM	SW-846 1311	Metals
SCM	SW-846 1312	Metals - organics
SCM	SW-846 1320	Metals - organics
SCM	SW-846 3031	Metals

Matrix	Method	Parameter
SCM	SW-846 3040A	Metals
SCM	SW-846 3050B	Metals
SCM	SW-846 3051	Metals
SCM	SW-846 3051A	Metals
SCM	SW-846 3052	Metals
SCM	SW-846 3060A	Metals
SCM	SW-846 3540C	Semivolatile organics
SCM	SW-846 3546	Semivolatile organics
SCM	SW-846 3550B	Semivolatile organics
SCM	SW-846 3550C	Semivolatile organics
SCM	SW-846 3580A	Organics
SCM	SW-846 3585	Organics
SCM	SW-846 3610B	Semivolatile organics
SCM	SW-846 3611B	Semivolatile organics
SCM	SW-846 3620B	Semivolatile organics
SCM	SW-846 3620C	Semivolatile organics
SCM	SW-846 3630C	Semivolatile organics
SCM	SW-846 3660B	Semivolatile organics
SCM	SW-846 3665A	Semivolatile organics
SCM	SW-846 5035A-H	Volatile organics - high conc.
SCM	SW-846 5035A-L	Volatile organics - low conc.
SCM	SW-846 5035H	Volatile organics - high conc.
SCM	SW-846 5035L	Volatile organics - low conc.
SCM	SW-846 6010B	Lithium
SCM	SW-846 6010B	Strontium
SCM	SW-846 6010B	Titanium
SCM	SW-846 6010B	Silver
SCM	SW-846 6010B	Tin
SCM	SW-846 6010B	Aluminum
SCM	SW-846 6010B	Antimony
SCM	SW-846 6010B	Arsenic
SCM	SW-846 6010B	Barium
SCM	SW-846 6010B	Beryllium
SCM	SW-846 6010B	Boron
SCM	SW-846 6010B	Cadmium
SCM	SW-846 6010B	Calcium
SCM	SW-846 6010B	Chromium
SCM	SW-846 6010B	Cobalt
SCM	SW-846 6010B	Copper
SCM	SW-846 6010B	Iron

Matrix	Method	Parameter
SCM	SW-846 6010B	Lead
SCM	SW-846 6010B	Magnesium
SCM	SW-846 6010B	Manganese
SCM	SW-846 6010B	Molybdenum
SCM	SW-846 6010B	Nickel
SCM	SW-846 6010B	Potassium
SCM	SW-846 6010B	Selenium
SCM	SW-846 6010B	Sodium
SCM	SW-846 6010B	Thallium
SCM	SW-846 6010B	Vanadium
SCM	SW-846 6010B	Zinc
SCM	SW-846 6010C	Lithium
SCM	SW-846 6010C	Strontium
SCM	SW-846 6010C	Titanium
SCM	SW-846 6010C	Silver
SCM	SW-846 6010C	Tin
SCM	SW-846 6010C	Aluminum
SCM	SW-846 6010C	Antimony
SCM	SW-846 6010C	Arsenic
SCM	SW-846 6010C	Barium
SCM	SW-846 6010C	Beryllium
SCM	SW-846 6010C	Boron
SCM	SW-846 6010C	Cadmium
SCM	SW-846 6010C	Calcium
SCM	SW-846 6010C	Chromium
SCM	SW-846 6010C	Cobalt
SCM	SW-846 6010C	Copper
SCM	SW-846 6010C	Iron
SCM	SW-846 6010C	Lead
SCM	SW-846 6010C	Magnesium
SCM	SW-846 6010C	Manganese
SCM	SW-846 6010C	Molybdenum
SCM	SW-846 6010C	Nickel
SCM	SW-846 6010C	Potassium
SCM	SW-846 6010C	Selenium
SCM	SW-846 6010C	Sodium
SCM	SW-846 6010C	Thallium
SCM	SW-846 6010C	Vanadium
SCM	SW-846 6010C	Zinc
SCM	SW-846 6020	Tin

Matrix	Method	Parameter
SCM	SW-846 6020	Barium
SCM	SW-846 6020	Manganese
SCM	SW-846 6020	Molybdenum
SCM	SW-846 6020	Vanadium
SCM	SW-846 6020	Zinc
SCM	SW-846 6020	Beryllium
SCM	SW-846 6020	Nickel
SCM	SW-846 6020	Selenium
SCM	SW-846 6020	Antimony
SCM	SW-846 6020	Arsenic
SCM	SW-846 6020	Cadmium
SCM	SW-846 6020	Chromium
SCM	SW-846 6020	Copper
SCM	SW-846 6020	Lead
SCM	SW-846 6020	Silver
SCM	SW-846 6020	Thallium
SCM	SW-846 6020A	Tin
SCM	SW-846 6020A	Barium
SCM	SW-846 6020A	Manganese
SCM	SW-846 6020A	Molybdenum
SCM	SW-846 6020A	Vanadium
SCM	SW-846 6020A	Zinc
SCM	SW-846 6020A	Beryllium
SCM	SW-846 6020A	Nickel
SCM	SW-846 6020A	Selenium
SCM	SW-846 6020A	Antimony
SCM	SW-846 6020A	Arsenic
SCM	SW-846 6020A	Cadmium
SCM	SW-846 6020A	Chromium
SCM	SW-846 6020A	Copper
SCM	SW-846 6020A	Lead
SCM	SW-846 6020A	Silver
SCM	SW-846 6020A	Thallium
SCM	SW-846 7.3.3.2	Reactivity
SCM	SW-846 7.3.4.2	Reactivity
SCM	SW-846 7196A	Chromium (VI)
SCM	SW-846 7199	Chromium (VI)
SCM	SW-846 7471A	Mercury - solid waste
SCM	SW-846 7471B	Mercury - solid waste
SCM	SW-846 8011	Dibromoethane (1,2-) (EDB)

Matrix	Method	Parameter
SCM	SW-846 8011	Dibromo-3-chloropropane (1,2-)
SCM	SW-846 8015B	Ethylene glycol
SCM	SW-846 8015B	Propylene glycol
SCM	SW-846 8015B	Gasoline range organic
SCM	SW-846 8015B	Diesel range organic
SCM	SW-846 8015C	Ethylene glycol
SCM	SW-846 8015C	Propylene glycol
SCM	SW-846 8015D	Ethylene glycol
SCM	SW-846 8015D	Propylene glycol
SCM	SW-846 8015D	Gasoline range organic
SCM	SW-846 8015D	Diesel range organic
SCM	SW-846 8021B	Xylenes (total)
SCM	SW-846 8021B	Methyl tert-butyl ether
SCM	SW-846 8021B	Benzene
SCM	SW-846 8021B	Ethylbenzene
SCM	SW-846 8021B	Toluene
SCM	SW-846 8021B	Xylene (o-)
SCM	SW-846 8021B	Xylene (m-)
SCM	SW-846 8021B	Xylene (p-)
SCM	SW-846 8081A	Alachlor
SCM	SW-846 8081A	Chlordane (alpha)
SCM	SW-846 8081A	Chlordane (gamma)
SCM	SW-846 8081A	Chloroneb
SCM	SW-846 8081A	Chlorothalonil
SCM	SW-846 8081A	Etridiazole
SCM	SW-846 8081A	Hexachlorobenzene
SCM	SW-846 8081A	Hexachlorocyclopentadiene
SCM	SW-846 8081A	Permethrin
SCM	SW-846 8081A	Propachlor
SCM	SW-846 8081A	Trifluralin
SCM	SW-846 8081A	Aldrin
SCM	SW-846 8081A	Alpha BHC
SCM	SW-846 8081A	Beta BHC
SCM	SW-846 8081A	Delta BHC
SCM	SW-846 8081A	Lindane (gamma BHC)
SCM	SW-846 8081A	Chlordane (technical)
SCM	SW-846 8081A	DDD (4,4'-)
SCM	SW-846 8081A	DDE (4,4'-)
SCM	SW-846 8081A	DDT (4,4'-)
SCM	SW-846 8081A	Dieldrin

Matrix	Method	Parameter
SCM	SW-846 8081A	Endosulfan I
SCM	SW-846 8081A	Endosulfan II
SCM	SW-846 8081A	Endosulfan sulfate
SCM	SW-846 8081A	Endrin
SCM	SW-846 8081A	Endrin aldehyde
SCM	SW-846 8081A	Endrin ketone
SCM	SW-846 8081A	Heptachlor
SCM	SW-846 8081A	Heptachlor epoxide
SCM	SW-846 8081A	Methoxychlor
SCM	SW-846 8081A	Toxaphene
SCM	SW-846 8081B	Alachlor
SCM	SW-846 8081B	Chlordane (alpha)
SCM	SW-846 8081B	Chlordane (gamma)
SCM	SW-846 8081B	Chloroneb
SCM	SW-846 8081B	Chlorothalonil
SCM	SW-846 8081B	Etridiazole
SCM	SW-846 8081B	Hexachlorobenzene
SCM	SW-846 8081B	Hexachlorocyclopentadiene
SCM	SW-846 8081B	Permethrin
SCM	SW-846 8081B	Propachlor
SCM	SW-846 8081B	Trifluralin
SCM	SW-846 8081B	Aldrin
SCM	SW-846 8081B	Alpha BHC
SCM	SW-846 8081B	Beta BHC
SCM	SW-846 8081B	Delta BHC
SCM	SW-846 8081B	Lindane (gamma BHC)
SCM	SW-846 8081B	Chlordane (technical)
SCM	SW-846 8081B	DDD (4,4'-)
SCM	SW-846 8081B	DDE (4,4'-)
SCM	SW-846 8081B	DDT (4,4'-)
SCM	SW-846 8081B	Dieldrin
SCM	SW-846 8081B	Endosulfan I
SCM	SW-846 8081B	Endosulfan II
SCM	SW-846 8081B	Endosulfan sulfate
SCM	SW-846 8081B	Endrin
SCM	SW-846 8081B	Endrin aldehyde
SCM	SW-846 8081B	Endrin ketone
SCM	SW-846 8081B	Heptachlor
SCM	SW-846 8081B	Heptachlor epoxide
SCM	SW-846 8081B	Methoxychlor

Matrix	Method	Parameter
SCM	SW-846 8081B	Toxaphene
SCM	SW-846 8082	PCB 1016
SCM	SW-846 8082	PCB 1221
SCM	SW-846 8082	PCB 1232
SCM	SW-846 8082	PCB 1242
SCM	SW-846 8082	PCB 1248
SCM	SW-846 8082	PCB 1254
SCM	SW-846 8082	PCB 1260
SCM	SW-846 8082A	PCB 1016
SCM	SW-846 8082A	PCB 1221
SCM	SW-846 8082A	PCB 1232
SCM	SW-846 8082A	PCB 1242
SCM	SW-846 8082A	PCB 1248
SCM	SW-846 8082A	PCB 1254
SCM	SW-846 8082A	PCB 1260
SCM	SW-846 8141A	Azinphos methyl
SCM	SW-846 8141A	Chlorpyrifos
SCM	SW-846 8141A	Demeton (o-)
SCM	SW-846 8141A	Demeton (s-)
SCM	SW-846 8141A	Disulfoton
SCM	SW-846 8141A	Bolstar
SCM	SW-846 8141A	Coumaphos
SCM	SW-846 8141A	Dichlorvos
SCM	SW-846 8141A	Dimethoate
SCM	SW-846 8141A	EPN
SCM	SW-846 8141A	Ethoprop
SCM	SW-846 8141A	Fensulfothion
SCM	SW-846 8141A	Fenthion
SCM	SW-846 8141A	Merphos
SCM	SW-846 8141A	Mevinphos
SCM	SW-846 8141A	Naled
SCM	SW-846 8141A	Parathion
SCM	SW-846 8141A	Parathion methyl
SCM	SW-846 8141A	Phorate
SCM	SW-846 8141A	Ronnel
SCM	SW-846 8141A	Stirofos
SCM	SW-846 8141A	Sulfotepp
SCM	SW-846 8141A	TEPP
SCM	SW-846 8141A	Tokuthion [Protothiofos]
SCM	SW-846 8141A	Trichloronate

Matrix	Method	Parameter
SCM	SW-846 8141A	Diazinon
SCM	SW-846 8141A	Malathion
SCM	SW-846 8141B	Azinphos methyl
SCM	SW-846 8141B	Chlorpyrifos
SCM	SW-846 8141B	Demeton (o-)
SCM	SW-846 8141B	Demeton (s-)
SCM	SW-846 8141B	Disulfoton
SCM	SW-846 8141B	Bolstar
SCM	SW-846 8141B	Coumaphos
SCM	SW-846 8141B	Dichlorvos
SCM	SW-846 8141B	Dimethoate
SCM	SW-846 8141B	EPN
SCM	SW-846 8141B	Ethoprop
SCM	SW-846 8141B	Fensulfothion
SCM	SW-846 8141B	Fenthion
SCM	SW-846 8141B	Merphos
SCM	SW-846 8141B	Mevinphos
SCM	SW-846 8141B	Naled
SCM	SW-846 8141B	Parathion
SCM	SW-846 8141B	Parathion methyl
SCM	SW-846 8141B	Phorate
SCM	SW-846 8141B	Ronnel
SCM	SW-846 8141B	Stirofos
SCM	SW-846 8141B	Sulfotepp
SCM	SW-846 8141B	TEPP
SCM	SW-846 8141B	Tokuthion [Protothiofos]
SCM	SW-846 8141B	Trichloronate
SCM	SW-846 8141B	Diazinon
SCM	SW-846 8141B	Malathion
SCM	SW-846 8151A	Dicamba
SCM	SW-846 8151A	DB (2,4-)
SCM	SW-846 8151A	Dinoseb
SCM	SW-846 8151A	Dalapon
SCM	SW-846 8151A	Dichlorprop
SCM	SW-846 8151A	D (2,4-)
SCM	SW-846 8151A	T (2,4,5-)
SCM	SW-846 8151A	TP (2,4,5-) (Silvex)
SCM	SW-846 8151A	MCPA
SCM	SW-846 8151A	MCPP
SCM	SW-846 8260B	Methyl alcohol (Methanol)

Matrix	Method	Parameter
SCM	SW-846 8260B	Ethyl alcohol
SCM	SW-846 8260B	Hexane (n-)
SCM	SW-846 8260B	Trimethylpentane (2,2,4-)
SCM	SW-846 8260B	Methylnaphthalene (1-)
SCM	SW-846 8260B	Methylnaphthalene (2-)
SCM	SW-846 8260B	Butanol (3,3-Dimethyl-1-)
SCM	SW-846 8260B	Trimethylpentane (2,2,4-)
SCM	SW-846 8260B	Trimethylbenzene (1,2,3-)
SCM	SW-846 8260B	Cyclohexane
SCM	SW-846 8260B	Butanol (1-)
SCM	SW-846 8260B	Nitropropane (2-)
SCM	SW-846 8260B	Butyl formate (t-)
SCM	SW-846 8260B	Methyl acetate
SCM	SW-846 8260B	Pentanol (2-Methyl-2-)
SCM	SW-846 8260B	Amyl alcohol (t-)
SCM	SW-846 8260B	Methylcyclohexane
SCM	SW-846 8260B	Octane (-n)
SCM	SW-846 8260B	tert-Amylmethyl ether [TAME]
SCM	SW-846 8260B	Bromoethane
SCM	SW-846 8260B	Cyclohexanone
SCM	SW-846 8260B	Diisopropyl Ether [DIPE]
SCM	SW-846 8260B	Tetrahydrofuran
SCM	SW-846 8260B	Ethyl-tert-butyl Ether [ETBE]
SCM	SW-846 8260B	Safrole
SCM	SW-846 8260B	Xylene (m-)
SCM	SW-846 8260B	Xylene (o-)
SCM	SW-846 8260B	Xylene (p-)
SCM	SW-846 8260B	Dichloro-2-butene (cis-1,4-)
SCM	SW-846 8260B	Diethyl ether (Ethyl ether)
SCM	SW-846 8260B	Dichloro-2-butene (trans-1,4-)
SCM	SW-846 8260B	Ethanol
SCM	SW-846 8260B	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
SCM	SW-846 8260B	Vinyl acetate
SCM	SW-846 8260B	Pentachloroethane
SCM	SW-846 8260B	Tert-butyl alcohol
SCM	SW-846 8260B	Dioxane (1,4-)
SCM	SW-846 8260B	Bromobenzene
SCM	SW-846 8260B	Butyl benzene (n-)
SCM	SW-846 8260B	Sec-butylbenzene
SCM	SW-846 8260B	Tert-butylbenzene

Matrix	Method	Parameter
SCM	SW-846 8260B	Chlorotoluene (2-)
SCM	SW-846 8260B	Chlorotoluene (4-)
SCM	SW-846 8260B	Isopropylbenzene
SCM	SW-846 8260B	Propylbenzene (n-)
SCM	SW-846 8260B	Isopropyltoluene (4-)
SCM	SW-846 8260B	Trichlorobenzene (1,2,3-)
SCM	SW-846 8260B	Trimethylbenzene (1,2,4-)
SCM	SW-846 8260B	Trimethylbenzene (1,3,5-)
SCM	SW-846 8260B	Allyl chloride
SCM	SW-846 8260B	Bromochloromethane
SCM	SW-846 8260B	Butadiene (2-chloro-1,3-)
SCM	SW-846 8260B	Dibromoethane (1,2-) (EDB)
SCM	SW-846 8260B	Dibromomethane
SCM	SW-846 8260B	Dibromo-3-chloropropane (1,2-)
SCM	SW-846 8260B	Dichloropropane (1,3-)
SCM	SW-846 8260B	Dichloropropane (2,2-)
SCM	SW-846 8260B	Dichloropropene (1,1-)
SCM	SW-846 8260B	Trichloropropane (1,2,3-)
SCM	SW-846 8260B	Ethyl acetate
SCM	SW-846 8260B	Ethyl methacrylate
SCM	SW-846 8260B	Methacrylonitrile
SCM	SW-846 8260B	Methyl acrylate
SCM	SW-846 8260B	Methyl methacrylate
SCM	SW-846 8260B	Methyl iodide
SCM	SW-846 8260B	Iso-butyl alcohol
SCM	SW-846 8260B	Isopropanol
SCM	SW-846 8260B	N-Nitroso-di-n-butylamine
SCM	SW-846 8260B	Propionitrile
SCM	SW-846 8260B	Acetonitrile
SCM	SW-846 8260B	Benzene
SCM	SW-846 8260B	Chlorobenzene
SCM	SW-846 8260B	Dichlorobenzene (1,2-)
SCM	SW-846 8260B	Dichlorobenzene (1,3-)
SCM	SW-846 8260B	Dichlorobenzene (1,4-)
SCM	SW-846 8260B	Ethylbenzene
SCM	SW-846 8260B	Toluene
SCM	SW-846 8260B	Xylenes (total)
SCM	SW-846 8260B	Bromodichloromethane
SCM	SW-846 8260B	Bromoform
SCM	SW-846 8260B	Bromomethane

Matrix	Method	Parameter
SCM	SW-846 8260B	Carbon tetrachloride
SCM	SW-846 8260B	Chloroethane
SCM	SW-846 8260B	Chloroethyl vinyl ether (2-)
SCM	SW-846 8260B	Chloroform
SCM	SW-846 8260B	Chloromethane
SCM	SW-846 8260B	Dichloropropene (trans-1,3-)
SCM	SW-846 8260B	Dibromochloromethane
SCM	SW-846 8260B	Dichlorodifluoromethane
SCM	SW-846 8260B	Dichloroethane (1,1-)
SCM	SW-846 8260B	Dichloroethane (1,2-)
SCM	SW-846 8260B	Dichloroethene (1,1-)
SCM	SW-846 8260B	Dichloroethene (trans-1,2-)
SCM	SW-846 8260B	Dichloroethene (cis-1,2-)
SCM	SW-846 8260B	Dichloropropane (1,2-)
SCM	SW-846 8260B	Dichloropropene (cis-1,3-)
SCM	SW-846 8260B	Methylene chloride (Dichloromethane)
SCM	SW-846 8260B	Tetrachloroethane (1,1,2,2-)
SCM	SW-846 8260B	Tetrachloroethene
SCM	SW-846 8260B	Trichloroethane (1,1,1-)
SCM	SW-846 8260B	Trichloroethane (1,1,2-)
SCM	SW-846 8260B	Trichloroethene
SCM	SW-846 8260B	Trichlorofluoromethane
SCM	SW-846 8260B	Vinyl chloride
SCM	SW-846 8260B	Acetone
SCM	SW-846 8260B	Carbon disulfide
SCM	SW-846 8260B	Butanone (2-)
SCM	SW-846 8260B	Hexanone (2-)
SCM	SW-846 8260B	Pentanone (4-methyl-2-) (MIBK)
SCM	SW-846 8260B	Methyl tert-butyl ether
SCM	SW-846 8260B	Acrolein
SCM	SW-846 8260B	Acrylonitrile
SCM	SW-846 8260B	Hexachlorobutadiene (1,3-)
SCM	SW-846 8260B	Hexachloroethane
SCM	SW-846 8260B	Naphthalene
SCM	SW-846 8260B	Styrene
SCM	SW-846 8260B	Tetrachloroethane (1,1,1,2-)
SCM	SW-846 8260B	Trichlorobenzene (1,2,4-)
SCM	SW-846 8260C	Methyl alcohol (Methanol)
SCM	SW-846 8260C	Ethyl alcohol
SCM	SW-846 8260C	Trimethylpentane (2,2,4-)

Matrix	Method	Parameter
SCM	SW-846 8260C	Methylnaphthalene (1-)
SCM	SW-846 8260C	Methylnaphthalene (2-)
SCM	SW-846 8260C	Butanol (3,3-Dimethyl-1-)
SCM	SW-846 8260C	Trimethylbenzene (1,2,3-)
SCM	SW-846 8260C	Cyclohexane
SCM	SW-846 8260C	Butanol (1-)
SCM	SW-846 8260C	Nitropropane (2-)
SCM	SW-846 8260C	Butyl formate (t-)
SCM	SW-846 8260C	Methyl acetate
SCM	SW-846 8260C	Pentanol (2-Methyl-2-)
SCM	SW-846 8260C	Amyl alcohol (t-)
SCM	SW-846 8260C	Methylcyclohexane
SCM	SW-846 8260C	Octane (-n)
SCM	SW-846 8260C	tert-Amylmethyl ether [TAME]
SCM	SW-846 8260C	Bromoethane
SCM	SW-846 8260C	Cyclohexanone
SCM	SW-846 8260C	Diisopropyl Ether [DIPE]
SCM	SW-846 8260C	Tetrahydrofuran
SCM	SW-846 8260C	Ethyl-tert-butyl Ether [ETBE]
SCM	SW-846 8260C	Xylene (m-)
SCM	SW-846 8260C	Xylene (o-)
SCM	SW-846 8260C	Xylene (p-)
SCM	SW-846 8260C	Dichloro-2-butene (cis-1,4-)
SCM	SW-846 8260C	Diethyl ether (Ethyl ether)
SCM	SW-846 8260C	Dichloro-2-butene (trans-1,4-)
SCM	SW-846 8260C	Ethanol
SCM	SW-846 8260C	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
SCM	SW-846 8260C	Vinyl acetate
SCM	SW-846 8260C	Pentachloroethane
SCM	SW-846 8260C	Tert-butyl alcohol
SCM	SW-846 8260C	Dioxane (1,4-)
SCM	SW-846 8260C	Bromobenzene
SCM	SW-846 8260C	Butyl benzene (n-)
SCM	SW-846 8260C	Sec-butylbenzene
SCM	SW-846 8260C	Tert-butylbenzene
SCM	SW-846 8260C	Chlorotoluene (2-)
SCM	SW-846 8260C	Chlorotoluene (4-)
SCM	SW-846 8260C	Isopropylbenzene
SCM	SW-846 8260C	Propylbenzene (n-)
SCM	SW-846 8260C	Isopropyltoluene (4-)

Matrix	Method	Parameter
SCM	SW-846 8260C	Trichlorobenzene (1,2,3-)
SCM	SW-846 8260C	Trimethylbenzene (1,2,4-)
SCM	SW-846 8260C	Trimethylbenzene (1,3,5-)
SCM	SW-846 8260C	Allyl chloride
SCM	SW-846 8260C	Bromochloromethane
SCM	SW-846 8260C	Butadiene (2-chloro-1,3-)
SCM	SW-846 8260C	Dibromoethane (1,2-) (EDB)
SCM	SW-846 8260C	Dibromomethane
SCM	SW-846 8260C	Dibromo-3-chloropropane (1,2-)
SCM	SW-846 8260C	Dichloropropane (1,3-)
SCM	SW-846 8260C	Dichloropropane (2,2-)
SCM	SW-846 8260C	Dichloropropene (1,1-)
SCM	SW-846 8260C	Trichloropropane (1,2,3-)
SCM	SW-846 8260C	Ethyl acetate
SCM	SW-846 8260C	Ethyl methacrylate
SCM	SW-846 8260C	Methacrylonitrile
SCM	SW-846 8260C	Methyl acrylate
SCM	SW-846 8260C	Methyl methacrylate
SCM	SW-846 8260C	Methyl iodide
SCM	SW-846 8260C	Iso-butyl alcohol
SCM	SW-846 8260C	Isopropanol
SCM	SW-846 8260C	N-Nitroso-di-n-butylamine
SCM	SW-846 8260C	Propionitrile
SCM	SW-846 8260C	Acetonitrile
SCM	SW-846 8260C	Benzene
SCM	SW-846 8260C	Chlorobenzene
SCM	SW-846 8260C	Dichlorobenzene (1,2-)
SCM	SW-846 8260C	Dichlorobenzene (1,3-)
SCM	SW-846 8260C	Dichlorobenzene (1,4-)
SCM	SW-846 8260C	Ethylbenzene
SCM	SW-846 8260C	Toluene
SCM	SW-846 8260C	Xylenes (total)
SCM	SW-846 8260C	Bromodichloromethane
SCM	SW-846 8260C	Bromoform
SCM	SW-846 8260C	Bromomethane
SCM	SW-846 8260C	Carbon tetrachloride
SCM	SW-846 8260C	Chloroethane
SCM	SW-846 8260C	Chloroethyl vinyl ether (2-)
SCM	SW-846 8260C	Chloroform
SCM	SW-846 8260C	Chloromethane

Matrix	Method	Parameter
SCM	SW-846 8260C	Dichloropropene (trans-1,3-)
SCM	SW-846 8260C	Dibromochloromethane
SCM	SW-846 8260C	Dichlorodifluoromethane
SCM	SW-846 8260C	Dichloroethane (1,1-)
SCM	SW-846 8260C	Dichloroethane (1,2-)
SCM	SW-846 8260C	Dichloroethene (1,1-)
SCM	SW-846 8260C	Dichloroethene (trans-1,2-)
SCM	SW-846 8260C	Dichloroethene (cis-1,2-)
SCM	SW-846 8260C	Dichloropropane (1,2-)
SCM	SW-846 8260C	Dichloropropene (cis-1,3-)
SCM	SW-846 8260C	Methylene chloride (Dichloromethane)
SCM	SW-846 8260C	Tetrachloroethane (1,1,2,2-)
SCM	SW-846 8260C	Tetrachloroethene
SCM	SW-846 8260C	Trichloroethane (1,1,1-)
SCM	SW-846 8260C	Trichloroethane (1,1,2-)
SCM	SW-846 8260C	Trichloroethene
SCM	SW-846 8260C	Trichlorofluoromethane
SCM	SW-846 8260C	Vinyl chloride
SCM	SW-846 8260C	Acetone
SCM	SW-846 8260C	Carbon disulfide
SCM	SW-846 8260C	Butanone (2-)
SCM	SW-846 8260C	Hexanone (2-)
SCM	SW-846 8260C	Pentanone (4-methyl-2-) (MIBK)
SCM	SW-846 8260C	Methyl tert-butyl ether
SCM	SW-846 8260C	Acrolein
SCM	SW-846 8260C	Acrylonitrile
SCM	SW-846 8260C	Hexachlorobutadiene (1,3-)
SCM	SW-846 8260C	Hexachloroethane
SCM	SW-846 8260C	Naphthalene
SCM	SW-846 8260C	Styrene
SCM	SW-846 8260C	Tetrachloroethane (1,1,1,2-)
SCM	SW-846 8260C	Trichlorobenzene (1,2,4-)
SCM	SW-846 8270C	Biphenyl (1,1'-)
SCM	SW-846 8270C	Benzaldehyde
SCM	SW-846 8270C	Caprolactam
SCM	SW-846 8270C	Atrazine
SCM	SW-846 8270C	Phenanthrene
SCM	SW-846 8270C	Pyrene
SCM	SW-846 8270C	Acenaphthene
SCM	SW-846 8270C	Acenaphthylene

Matrix	Method	Parameter
SCM	SW-846 8270C	Anthracene
SCM	SW-846 8270C	Benzo(ghi)perylene
SCM	SW-846 8270C	Chrysene
SCM	SW-846 8270C	Methylnaphthalene (1-)
SCM	SW-846 8270C	Methylnaphthalene (2-)
SCM	SW-846 8270C	Naphthalene
SCM	SW-846 8270C	Fluoranthene
SCM	SW-846 8270C	Fluorene
SCM	SW-846 8270C	Methylnaphthalene (1-)
SCM	SW-846 8270C	Nitrodiphenylamine (2-)
SCM	SW-846 8270C	Nitrodiphenylamine (2-)
SCM	SW-846 8270C	Hexachlorophene
SCM	SW-846 8270C	Diphenylhydrazine (1,2-)
SCM	SW-846 8270C	Decane (n-)
SCM	SW-846 8270C	Octadecane (n-)
SCM	SW-846 8270C	Benzo(a)anthracene
SCM	SW-846 8270C	Benzo(a)pyrene
SCM	SW-846 8270C	Benzo(b)fluoranthene
SCM	SW-846 8270C	Benzo(k)fluoranthene
SCM	SW-846 8270C	Dibenzo(a,h)anthracene
SCM	SW-846 8270C	Indeno(1,2,3-cd)pyrene
SCM	SW-846 8270C	Benzal chloride
SCM	SW-846 8270C	Benzo(j)fluoranthene
SCM	SW-846 8270C	Benzotrichloride
SCM	SW-846 8270C	Benzyl chloride
SCM	SW-846 8270C	Chlorobenzilate
SCM	SW-846 8270C	Dibenz(a,h)acridine
SCM	SW-846 8270C	Dibenzo(a,h)pyrene
SCM	SW-846 8270C	Dibenzo(a,i)pyrene
SCM	SW-846 8270C	Dibenzo(c,g)carbazole (7H-)
SCM	SW-846 8270C	Pentachloroethane
SCM	SW-846 8270C	Tetrachlorobenzene (1,2,3,4-)
SCM	SW-846 8270C	Tetrachlorobenzene (1,2,3,5-)
SCM	SW-846 8270C	Benzyl alcohol
SCM	SW-846 8270C	Acetophenone
SCM	SW-846 8270C	Acetylaminofluorene (2-)
SCM	SW-846 8270C	Aminobiphenyl (4-)
SCM	SW-846 8270C	Aramite
SCM	SW-846 8270C	Chloronaphthalene (1-)
SCM	SW-846 8270C	Diallate (cis)

Matrix	Method	Parameter
SCM	SW-846 8270C	Diallate (trans)
SCM	SW-846 8270C	Dibenzo(a,e)pyrene
SCM	SW-846 8270C	Dibenz(a,j)acridine
SCM	SW-846 8270C	Dichlorophenol (2,6-)
SCM	SW-846 8270C	Dimethoate
SCM	SW-846 8270C	Dimethylaminoazobenzene
SCM	SW-846 8270C	Dimethylbenz(a)anthracene (7,12-)
SCM	SW-846 8270C	Dimethyl benzidine (3,3-)
SCM	SW-846 8270C	Dinitrobenzene (1,3-)
SCM	SW-846 8270C	Dinoseb
SCM	SW-846 8270C	Disulfoton
SCM	SW-846 8270C	Famphur
SCM	SW-846 8270C	Hexachloropropene
SCM	SW-846 8270C	Isodrin
SCM	SW-846 8270C	Isosafrole (cis-)
SCM	SW-846 8270C	Isosafrole (trans-)
SCM	SW-846 8270C	Kepone
SCM	SW-846 8270C	Methanesulfonate (Ethyl-)
SCM	SW-846 8270C	Methanesulfonate (Methyl-)
SCM	SW-846 8270C	Methapyrilene
SCM	SW-846 8270C	Methylcholanthrene (3-)
SCM	SW-846 8270C	Napthoquinone (1,4-)
SCM	SW-846 8270C	Napththylamine (1-)
SCM	SW-846 8270C	Napththylamine (2-)
SCM	SW-846 8270C	N-Nitroso-di-n-butylamine
SCM	SW-846 8270C	N-Nitrosomorpholine
SCM	SW-846 8270C	N-Nitrosopiperidine
SCM	SW-846 8270C	Parathion
SCM	SW-846 8270C	Parathion methyl
SCM	SW-846 8270C	Pentachlorobenzene
SCM	SW-846 8270C	Pentachloronitrobenzene
SCM	SW-846 8270C	Phenacetin
SCM	SW-846 8270C	Phenylenediamine (1,4-)
SCM	SW-846 8270C	Phenylethylamine (alpha, alpha-Dimethyl)
SCM	SW-846 8270C	Phorate
SCM	SW-846 8270C	Phosphorothioate (O,O,O-triethyl)
SCM	SW-846 8270C	Phosphorothioate (O,O-diethyl-O-2-pyrazinyl) [Thionazin]
SCM	SW-846 8270C	Picoline (2-)
SCM	SW-846 8270C	Pronamide

Matrix	Method	Parameter
SCM	SW-846 8270C	Quinoline -1-Oxide (4-Nitro)
SCM	SW-846 8270C	Safrole
SCM	SW-846 8270C	Sulfotepp
SCM	SW-846 8270C	Tetrachlorobenzene (1,2,4,5-)
SCM	SW-846 8270C	Tetrachlorophenol (2,3,4,6-)
SCM	SW-846 8270C	Toluidine (2-) (2-Methylaniline)
SCM	SW-846 8270C	Toluidine (5-nitro-2-)
SCM	SW-846 8270C	Trinitrobenzene (1,3,5-)
SCM	SW-846 8270C	N-Nitrosodiethylamine
SCM	SW-846 8270C	N-Nitrosopyrrolidine
SCM	SW-846 8270C	Diphenylamine
SCM	SW-846 8270C	Carbazole
SCM	SW-846 8270C	Dichlorobenzene (1,2-)
SCM	SW-846 8270C	Dichlorobenzene (1,3-)
SCM	SW-846 8270C	N-Nitrosodimethylamine
SCM	SW-846 8270C	N-Nitroso-di-n-propylamine
SCM	SW-846 8270C	N-Nitrosomethylethylamine
SCM	SW-846 8270C	Benzidine
SCM	SW-846 8270C	Aniline
SCM	SW-846 8270C	Hexachloropropene
SCM	SW-846 8270C	Dibenzofuran
SCM	SW-846 8270C	Benzoic acid
SCM	SW-846 8270C	N-Nitrosodiphenylamine
SCM	SW-846 8270C	Dichlorobenzidine (3,3'-)
SCM	SW-846 8270C	Chloroaniline (4-)
SCM	SW-846 8270C	Nitroaniline (2-)
SCM	SW-846 8270C	Nitroaniline (3-)
SCM	SW-846 8270C	Nitroaniline (4-)
SCM	SW-846 8270C	Chloronaphthalene (2-)
SCM	SW-846 8270C	Hexachlorobenzene
SCM	SW-846 8270C	Hexachlorobutadiene (1,3-)
SCM	SW-846 8270C	Hexachlorocyclopentadiene
SCM	SW-846 8270C	Hexachloroethane
SCM	SW-846 8270C	Trichlorobenzene (1,2,4-)
SCM	SW-846 8270C	Bis (2-chloroethoxy) methane
SCM	SW-846 8270C	Bis (2-chloroethyl) ether
SCM	SW-846 8270C	Bis (2-chloroisopropyl) ether
SCM	SW-846 8270C	Chlorophenyl-phenyl ether (4-)
SCM	SW-846 8270C	Bromophenyl-phenyl ether (4-)
SCM	SW-846 8270C	Dinitrotoluene (2,4-)

Matrix	Method	Parameter
SCM	SW-846 8270C	Dinitrotoluene (2,6-)
SCM	SW-846 8270C	Isophorone
SCM	SW-846 8270C	Nitrobenzene
SCM	SW-846 8270C	Butyl benzyl phthalate
SCM	SW-846 8270C	Bis (2-ethylhexyl) phthalate
SCM	SW-846 8270C	Diethyl phthalate
SCM	SW-846 8270C	Dimethyl phthalate
SCM	SW-846 8270C	Di-n-butyl phthalate
SCM	SW-846 8270C	Di-n-octyl phthalate
SCM	SW-846 8270C	Acenaphthene
SCM	SW-846 8270C	Anthracene
SCM	SW-846 8270C	Acenaphthylene
SCM	SW-846 8270C	Benzo(a)anthracene
SCM	SW-846 8270C	Benzo(a)pyrene
SCM	SW-846 8270C	Benzo(b)fluoranthene
SCM	SW-846 8270C	Benzo(ghi)perylene
SCM	SW-846 8270C	Benzo(k)fluoranthene
SCM	SW-846 8270C	Chrysene
SCM	SW-846 8270C	Dibenzo(a,h)anthracene
SCM	SW-846 8270C	Fluoranthene
SCM	SW-846 8270C	Fluorene
SCM	SW-846 8270C	Indeno(1,2,3-cd)pyrene
SCM	SW-846 8270C	Methylnaphthalene (2-)
SCM	SW-846 8270C	Naphthalene
SCM	SW-846 8270C	Phenanthrene
SCM	SW-846 8270C	Pyrene
SCM	SW-846 8270C	Methyl phenol (4-chloro-3-)
SCM	SW-846 8270C	Chlorophenol (2-)
SCM	SW-846 8270C	Dichlorophenol (2,4-)
SCM	SW-846 8270C	Dimethylphenol (2,4-)
SCM	SW-846 8270C	Dinitrophenol (2,4-)
SCM	SW-846 8270C	Dinitrophenol (2-methyl-4,6-)
SCM	SW-846 8270C	Methylphenol (2-)
SCM	SW-846 8270C	Methylphenol (4-)
SCM	SW-846 8270C	Nitrophenol (2-)
SCM	SW-846 8270C	Nitrophenol (4-)
SCM	SW-846 8270C	Pentachlorophenol
SCM	SW-846 8270C	Phenol
SCM	SW-846 8270C	Trichlorophenol (2,4,5-)
SCM	SW-846 8270C	Trichlorophenol (2,4,6-)

Matrix	Method	Parameter
SCM	SW-846 8270C	Dichlorobenzene (1,4-)
SCM	SW-846 8270C	Pyridine
SCM	SW-846 8270D	Biphenyl (1,1'-)
SCM	SW-846 8270D	Benzaldehyde
SCM	SW-846 8270D	Caprolactam
SCM	SW-846 8270D	Atrazine
SCM	SW-846 8270D	Phenanthrene
SCM	SW-846 8270D	Pyrene
SCM	SW-846 8270D	Acenaphthene
SCM	SW-846 8270D	Acenaphthylene
SCM	SW-846 8270D	Anthracene
SCM	SW-846 8270D	Benzo(ghi)perylene
SCM	SW-846 8270D	Chrysene
SCM	SW-846 8270D	Methylnaphthalene (1-)
SCM	SW-846 8270D	Methylnaphthalene (2-)
SCM	SW-846 8270D	Naphthalene
SCM	SW-846 8270D	Fluoranthene
SCM	SW-846 8270D	Fluorene
SCM	SW-846 8270D	Methylnaphthalene (1-)
SCM	SW-846 8270D	Nitrodiphenylamine (2-)
SCM	SW-846 8270D	Hexachlorophene
SCM	SW-846 8270D	Diphenylhydrazine (1,2-)
SCM	SW-846 8270D	Decane (n-)
SCM	SW-846 8270D	Octadecane (n-)
SCM	SW-846 8270D	Benzo(a)anthracene
SCM	SW-846 8270D	Benzo(a)pyrene
SCM	SW-846 8270D	Benzo(b)fluoranthene
SCM	SW-846 8270D	Benzo(k)fluoranthene
SCM	SW-846 8270D	Dibenzo(a,h)anthracene
SCM	SW-846 8270D	Indeno(1,2,3-cd)pyrene
SCM	SW-846 8270D	Benzal chloride
SCM	SW-846 8270D	Benzo(j)fluoranthene
SCM	SW-846 8270D	Benzotrichloride
SCM	SW-846 8270D	Benzyl chloride
SCM	SW-846 8270D	Chlorobenzilate
SCM	SW-846 8270D	Dibenz(a,h)acridine
SCM	SW-846 8270D	Dibenzo(a,h)pyrene
SCM	SW-846 8270D	Dibenzo(a,i)pyrene
SCM	SW-846 8270D	Dibenzo(c,g)carbazole (7H-)
SCM	SW-846 8270D	Pentachloroethane

Matrix	Method	Parameter
SCM	SW-846 8270D	Tetrachlorobenzene (1,2,3,4-)
SCM	SW-846 8270D	Tetrachlorobenzene (1,2,3,5-)
SCM	SW-846 8270D	Benzyl alcohol
SCM	SW-846 8270D	Acetophenone
SCM	SW-846 8270D	Acetylaminofluorene (2-)
SCM	SW-846 8270D	Aminobiphenyl (4-)
SCM	SW-846 8270D	Aramite
SCM	SW-846 8270D	Chloronaphthalene (1-)
SCM	SW-846 8270D	Diallate (cis)
SCM	SW-846 8270D	Diallate (trans)
SCM	SW-846 8270D	Dibenzo(a,e)pyrene
SCM	SW-846 8270D	Dibenz(a,j)acridine
SCM	SW-846 8270D	Dichlorophenol (2,6-)
SCM	SW-846 8270D	Dimethoate
SCM	SW-846 8270D	Dimethylaminoazobenzene
SCM	SW-846 8270D	Dimethylbenz(a)anthracene (7,12-)
SCM	SW-846 8270D	Dimethyl benzidine (3,3-)
SCM	SW-846 8270D	Dinitrobenzene (1,3-)
SCM	SW-846 8270D	Dinoseb
SCM	SW-846 8270D	Disulfoton
SCM	SW-846 8270D	Famphur
SCM	SW-846 8270D	Isodrin
SCM	SW-846 8270D	Isosafrole (cis-)
SCM	SW-846 8270D	Isosafrole (trans-)
SCM	SW-846 8270D	Kepone
SCM	SW-846 8270D	Methanesulfonate (Ethyl-)
SCM	SW-846 8270D	Methanesulfonate (Methyl-)
SCM	SW-846 8270D	Methapyrilene
SCM	SW-846 8270D	Methylcholanthrene (3-)
SCM	SW-846 8270D	Napthoquinone (1,4-)
SCM	SW-846 8270D	Napththylamine (1-)
SCM	SW-846 8270D	Napththylamine (2-)
SCM	SW-846 8270D	N-Nitroso-di-n-butylamine
SCM	SW-846 8270D	N-Nitrosomorpholine
SCM	SW-846 8270D	N-Nitrosopiperidine
SCM	SW-846 8270D	Parathion
SCM	SW-846 8270D	Parathion methyl
SCM	SW-846 8270D	Pentachlorobenzene
SCM	SW-846 8270D	Pentachloronitrobenzene
SCM	SW-846 8270D	Phenacetin

Matrix	Method	Parameter
SCM	SW-846 8270D	Phenylenediamine (1,4-)
SCM	SW-846 8270D	Phenylethylamine (alpha, alpha-Dimethyl)
SCM	SW-846 8270D	Phorate
SCM	SW-846 8270D	Phosphorothioate (O,O,O-triethyl)
SCM	SW-846 8270D	Phosphorothioate (O,O-diethyl-O-2-pyrazinyl) [Thionazin]
SCM	SW-846 8270D	Picoline (2-)
SCM	SW-846 8270D	Pronamide
SCM	SW-846 8270D	Quinoline -1-Oxide (4-Nitro)
SCM	SW-846 8270D	Safrole
SCM	SW-846 8270D	Sulfotepp
SCM	SW-846 8270D	Tetrachlorobenzene (1,2,4,5-)
SCM	SW-846 8270D	Tetrachlorophenol (2,3,4,6-)
SCM	SW-846 8270D	Toluidine (2-) (2-Methylaniline)
SCM	SW-846 8270D	Toluidine (5-nitro-2-)
SCM	SW-846 8270D	Trinitrobenzene (1,3,5-)
SCM	SW-846 8270D	N-Nitrosodiethylamine
SCM	SW-846 8270D	N-Nitrosopyrrolidine
SCM	SW-846 8270D	Diphenylamine
SCM	SW-846 8270D	Carbazole
SCM	SW-846 8270D	Dichlorobenzene (1,2-)
SCM	SW-846 8270D	Dichlorobenzene (1,3-)
SCM	SW-846 8270D	N-Nitrosodimethylamine
SCM	SW-846 8270D	N-Nitroso-di-n-propylamine
SCM	SW-846 8270D	N-Nitrosomethylethylamine
SCM	SW-846 8270D	Benzidine
SCM	SW-846 8270D	Aniline
SCM	SW-846 8270D	Hexachloropropene
SCM	SW-846 8270D	Dibenzofuran
SCM	SW-846 8270D	Benzoic acid
SCM	SW-846 8270D	N-Nitrosodiphenylamine
SCM	SW-846 8270D	Dichlorobenzidine (3,3'-)
SCM	SW-846 8270D	Chloroaniline (4-)
SCM	SW-846 8270D	Nitroaniline (2-)
SCM	SW-846 8270D	Nitroaniline (3-)
SCM	SW-846 8270D	Nitroaniline (4-)
SCM	SW-846 8270D	Chloronaphthalene (2-)
SCM	SW-846 8270D	Hexachlorobenzene
SCM	SW-846 8270D	Hexachlorobutadiene (1,3-)
SCM	SW-846 8270D	Hexachlorocyclopentadiene

Matrix	Method	Parameter
SCM	SW-846 8270D	Hexachloroethane
SCM	SW-846 8270D	Trichlorobenzene (1,2,4-)
SCM	SW-846 8270D	Bis (2-chloroethoxy) methane
SCM	SW-846 8270D	Bis (2-chloroethyl) ether
SCM	SW-846 8270D	Bis (2-chloroisopropyl) ether
SCM	SW-846 8270D	Chlorophenyl-phenyl ether (4-)
SCM	SW-846 8270D	Bromophenyl-phenyl ether (4-)
SCM	SW-846 8270D	Dinitrotoluene (2,4-)
SCM	SW-846 8270D	Dinitrotoluene (2,6-)
SCM	SW-846 8270D	Isophorone
SCM	SW-846 8270D	Nitrobenzene
SCM	SW-846 8270D	Butyl benzyl phthalate
SCM	SW-846 8270D	Bis (2-ethylhexyl) phthalate
SCM	SW-846 8270D	Diethyl phthalate
SCM	SW-846 8270D	Dimethyl phthalate
SCM	SW-846 8270D	Di-n-butyl phthalate
SCM	SW-846 8270D	Di-n-octyl phthalate
SCM	SW-846 8270D	Acenaphthene
SCM	SW-846 8270D	Anthracene
SCM	SW-846 8270D	Acenaphthylene
SCM	SW-846 8270D	Benzo(a)anthracene
SCM	SW-846 8270D	Benzo(a)pyrene
SCM	SW-846 8270D	Benzo(b)fluoranthene
SCM	SW-846 8270D	Benzo(ghi)perylene
SCM	SW-846 8270D	Benzo(k)fluoranthene
SCM	SW-846 8270D	Chrysene
SCM	SW-846 8270D	Dibenzo(a,h)anthracene
SCM	SW-846 8270D	Fluoranthene
SCM	SW-846 8270D	Fluorene
SCM	SW-846 8270D	Indeno(1,2,3-cd)pyrene
SCM	SW-846 8270D	Methylnaphthalene (2-)
SCM	SW-846 8270D	Naphthalene
SCM	SW-846 8270D	Phenanthrene
SCM	SW-846 8270D	Pyrene
SCM	SW-846 8270D	Methyl phenol (4-chloro-3-)
SCM	SW-846 8270D	Chlorophenol (2-)
SCM	SW-846 8270D	Dichlorophenol (2,4-)
SCM	SW-846 8270D	Dimethylphenol (2,4-)
SCM	SW-846 8270D	Dinitrophenol (2,4-)
SCM	SW-846 8270D	Dinitrophenol (2-methyl-4,6-)

Matrix	Method	Parameter
SCM	SW-846 8270D	Methylphenol (2-)
SCM	SW-846 8270D	Methylphenol (4-)
SCM	SW-846 8270D	Nitrophenol (2-)
SCM	SW-846 8270D	Nitrophenol (4-)
SCM	SW-846 8270D	Pentachlorophenol
SCM	SW-846 8270D	Phenol
SCM	SW-846 8270D	Trichlorophenol (2,4,5-)
SCM	SW-846 8270D	Trichlorophenol (2,4,6-)
SCM	SW-846 8270D	Dichlorobenzene (1,4-)
SCM	SW-846 8270D	Pyridine
SCM	SW-846 8310	Acenaphthene
SCM	SW-846 8310	Acenaphthylene
SCM	SW-846 8310	Anthracene
SCM	SW-846 8310	Benzo(a)anthracene
SCM	SW-846 8310	Benzo(a)pyrene
SCM	SW-846 8310	Benzo(b)fluoranthene
SCM	SW-846 8310	Benzo(ghi)perylene
SCM	SW-846 8310	Benzo(k)fluoranthene
SCM	SW-846 8310	Chrysene
SCM	SW-846 8310	Dibenzo(a,h)anthracene
SCM	SW-846 8310	Fluoranthene
SCM	SW-846 8310	Fluorene
SCM	SW-846 8310	Indeno(1,2,3-cd)pyrene
SCM	SW-846 8310	Naphthalene
SCM	SW-846 8310	Phenanthrene
SCM	SW-846 8310	Pyrene
SCM	SW-846 8330	Nitroglycerine
SCM	SW-846 8330	Guanidine nitrate
SCM	SW-846 8330	PETN
SCM	SW-846 8330	HMX
SCM	SW-846 8330	RDX
SCM	SW-846 8330	Trinitrobenzene (1,3,5-)
SCM	SW-846 8330	Dinitrobenzene (1,3-)
SCM	SW-846 8330	Tetryl
SCM	SW-846 8330	Nitrobenzene
SCM	SW-846 8330	Trinitrotoluene (2,4,6-)
SCM	SW-846 8330	Dinitrotoluene (4-amino-2,6-)
SCM	SW-846 8330	Dinitrotoluene (2-amino-4,6-)
SCM	SW-846 8330	Dinitrotoluene (2,4-)
SCM	SW-846 8330	Dinitrotoluene (2,6-)

Matrix	Method	Parameter
SCM	SW-846 8330	Nitrotoluene (2-)
SCM	SW-846 8330	Nitrotoluene (3-)
SCM	SW-846 8330	Nitrotoluene (4-)
SCM	SW-846 8330A	Nitroglycerine
SCM	SW-846 8330A	PETN
SCM	SW-846 8330A	HMX
SCM	SW-846 8330A	RDX
SCM	SW-846 8330A	Trinitrobenzene (1,3,5-)
SCM	SW-846 8330A	Dinitrobenzene (1,3-)
SCM	SW-846 8330A	Tetryl
SCM	SW-846 8330A	Nitrobenzene
SCM	SW-846 8330A	Trinitrotoluene (2,4,6-)
SCM	SW-846 8330A	Dinitrotoluene (4-amino-2,6-)
SCM	SW-846 8330A	Dinitrotoluene (2-amino-4,6-)
SCM	SW-846 8330A	Dinitrotoluene (2,4-)
SCM	SW-846 8330A	Dinitrotoluene (2,6-)
SCM	SW-846 8330A	Nitrotoluene (2-)
SCM	SW-846 8330A	Nitrotoluene (3-)
SCM	SW-846 8330A	Nitrotoluene (4-)
SCM	SW-846 8440	Total rec. petroleum hydrocarbons
SCM	SW-846 9010C	Cyanide - amenable to Cl2
SCM	SW-846 9010C	Cyanide
SCM	SW-846 9012B	Cyanide
SCM	SW-846 9013	Cyanide
SCM	SW-846 9023	Extractable organic halides (EOX)
SCM	SW-846 9030B	Sulfides, acid sol. & insol.
SCM	SW-846 9034	Sulfides, acid sol. & insol.
SCM	SW-846 9040B	Corrosivity - pH waste, >20% water
SCM	SW-846 9040C	Corrosivity - pH waste, >20% water
SCM	SW-846 9045C	pH - soil and waste
SCM	SW-846 9045D	pH - soil and waste
SCM	SW-846 9056	Bromide
SCM	SW-846 9056	Nitrite
SCM	SW-846 9056	Sulfate
SCM	SW-846 9056	Nitrate
SCM	SW-846 9056	Chloride
SCM	SW-846 9056	Fluoride
SCM	SW-846 9056	Orthophosphate
SCM	SW-846 9056A	Bromide
SCM	SW-846 9056A	Nitrite

Matrix	Method	Parameter
SCM	SW-846 9056A	Sulfate
SCM	SW-846 9056A	Nitrate
SCM	SW-846 9056A	Chloride
SCM	SW-846 9056A	Fluoride
SCM	SW-846 9056A	Orthophosphate
SCM	SW-846 9060	Total organic carbon (TOC)
SCM	SW-846 9060A	Total organic carbon (TOC)
SCM	SW-846 9071B	Oil & grease - sludge-hem-npm
SCM	SW-846 9071B	Oil & grease - sludge-hem
SCM	SW-846 9095	Free liquid
SCM	SW-846 9095B	Free liquid
SCM	User Defined 8260C	Hexane (n-)
SCM	User Defined 9010B	Cyanide - amenable to Cl2
SCM	User Defined 9010B	Cyanide
SCM	User Defined 9012A	Cyanide
SCM	User Defined 9013A	Cyanide
SCM	User Defined 9095A	Free liquid
SCM	User Defined ASTM D93	Ignitability
SCM	User Defined CA LUFT - diesel	Petroleum Organics
SCM	User Defined CA LUFT - diesel	Petroleum Organics
SCM	User Defined LUFT	Xylene (m-)
SCM	User Defined LUFT	Xylene (o-)
SCM	User Defined LUFT	Xylene (p-)
SCM	User Defined LUFT	Benzene
SCM	User Defined LUFT	Ethylbenzene
SCM	User Defined LUFT	Toluene
SCM	User Defined LUFT	Xylenes (total)
SCM	User Defined LUFT	Methyl tert-butyl ether
SCM	User Defined MA-DEP-EPH, TN-EPH, WI DRO, NW TPH Dx	Diesel range organic
SCM	User Defined MA-DEP-VPH, WI GRO, NW TPH Gx	Gasoline range organic
SCM	User Defined NWTPH-Dx, NWTPH-Gx, NWTPHID	Petroleum Organics
SCM	User Defined SW846 8260B & 8260C	Gasoline range organic
SCM	User Defined SW-846 8330	Nitroguanidine
SCM	User Defined TX 1005, TX 1006, CT ETPH, NW TPH ID	Petroleum Organics

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, INSTRUMENT, REAGENT*
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*
IB	*INSTRUMENT BLANK*
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*
LOQ	*LIMIT OF QUANTITATION*
LDR	*LINEAR DYNAMIC RANGE*
MAT	*MATRIX*
MS	*MATRIX SPIKE*
MSD	*MATRIX SPIKE DUPLICATE*
MDL	*METHOD DETECTION LIMIT*
MB	*METHOD BLANK*
NC	*NEGATIVE CONTROL*
% 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*
RB	*REAGENT BLANK*
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*
TNI	*THE NELAC INSTITUTE*
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 including 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 maintained 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 Chief Operating Officer, Chief Regulatory Officer or the Quality Manager. The organizational structure indicated in this section is designed to minimize the potential for conflicts or undue stresses that might influence the technical

judgment of analytical personnel. Additionally, it provides adequate management for consistent supervision of laboratory practices, personnel 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. A brief description of the operations management positions is given below.

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, Chief Operating Officer, Chief Regulatory Officer, and the Director of Sales.

4.1.5.2 ***Chief Regulatory Officer***

Judith R. Morgan, Master of Science in Analytical Chemistry and Registered Environmental Manager, is the Chief Regulatory Officer (CRO) 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 Environmental Safety, Security and Health practices within the laboratory and 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 Regulatory Affairs functions, in the absence of the CRO.

4.1.5.3 ***Chief Operating Officer***

Eric Johnson, B.S. in Chemistry, is the Chief Operating Officer (COO) 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 Ken Buckley 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. Judith Morgan assumes responsibility for these functions in her absence.

4.1.5.5 ***Technical Director***

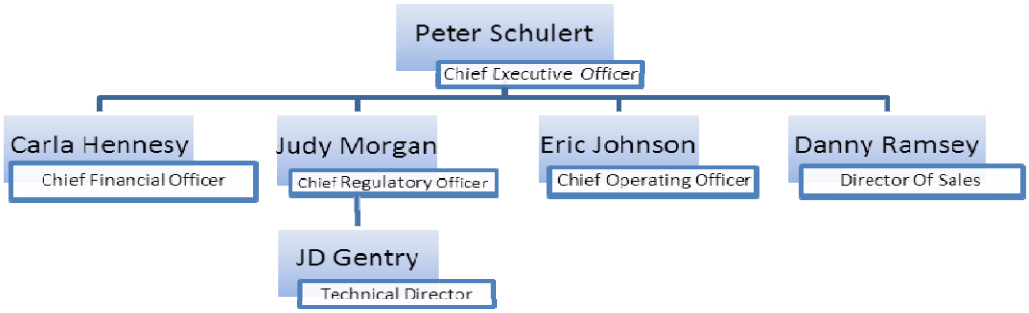
J.D Gentry, B.S. in Chemistry, is the laboratory Technical Director. He has more than 13 years of laboratory experience in analytical methods and instrumentation in the production laboratory environment. He is responsible for coordinating activities between the production areas of the laboratory and the Regulatory Affairs department, He also assists in client and regulatory agency interactions within the laboratory. He reports directly to the CRO and Judith Morgan assumes responsibility for these functions in his absence.

4.1.6 Management System Effectiveness

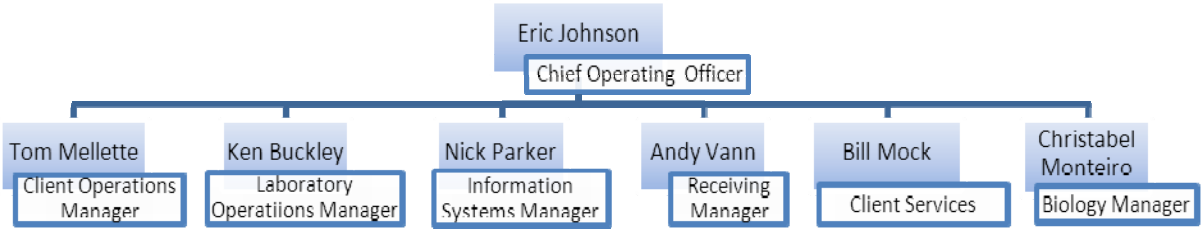
Senior management ensures that appropriate communication processes are established within the laboratory for implementation of the management system and that communication takes place regarding the effectiveness of the management system.

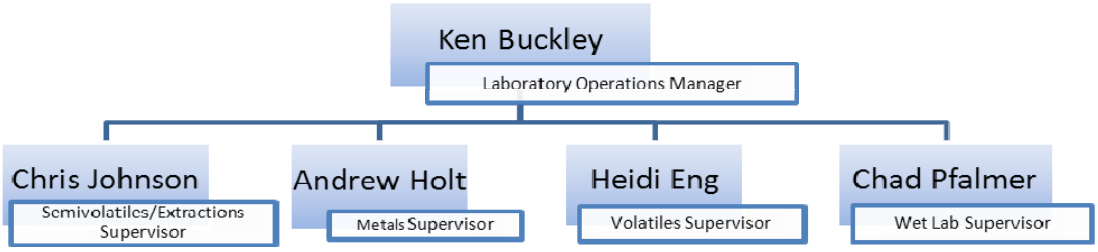
Figure 4.1 is the corporate organizational chart, which lists key individuals and relevant departmental structure.

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 System Implementation and Improvement

ESC management is committed to the development, implementation, and continual improvement 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 Client and Regulatory Requirements

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 Regulatory Affairs Department and is available via the ESC intranet.

4.2.6 Management Roles and Responsibilities

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, TNI, 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*.

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 location. The controlled document list is maintained by the Regulatory Affairs 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/or isolated 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. Minor changes that occur in the interim of each major revision of the procedure 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 and Distribution*. 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 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 Regulatory Affairs 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 Regulatory Affairs Department and Department Manager/Laboratory Operations Manager. Department Manager/Laboratory Operations 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. Evidence of bias that is detected in an analytical result is reported to the client along with a defined qualifier that explains the bias. 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 of the project/client.

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 and relevant regulatory 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

When requested, 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.*

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 Regulatory Affairs Department examine all documents and records associated with complaints and the relevant 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 Regulatory Affairs.
- 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 Regulatory Affairs Department for processing.

4.11.1 General

The initiation, management, tracking, and closure of corrective actions are 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 laboratory 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 Operations Manager/COO
- Regulatory Affairs Department
- Department Supervisor/Senior Analysts
- Technical Service Representative

Department Supervisors/Senior Analysts 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 Laboratory Operations Manager/Deparment Manager, 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. Any bias indicated in non-conforming work is indicated by the presence of data qualifiers that alert the client to the possible bias.

4.11.8 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 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.

4.11.9 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 Regulatory Affairs 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 issues that could lead to inferior data quality or other nonconformances 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.

Data Storage Criteria	
Data Type	**Storage Criteria**
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 or as required by regulatory or client requirements. ESC retains the manifest of documents destroyed and files the verification receipt that is generated at the time of destruction. Additional guidance for records disposal is provided in the SOP, Protection and Transfer of records.

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 section 5.8.7.

4.14 AUDITS

4.14.1 Internal Audits

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

4.14.1.1 The Regulatory Affairs 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 Regulatory Affairs 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/certify/approve 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/IEC/ISO 17025, TNI, and DOD QSM.

Method Specific Criteria – Good Laboratory technique, technical compliance with analytical methods and standard operating procedures, and effectiveness are 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 ethical violations results in a confidential investigation involving only the CRO, or designee, 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.

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. Clients are notified promptly when audit findings cast doubt on the validity of the data.

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	Phenova
WS (Water Supply)	Semi-annually	Phenova
Matrix – Soil RCRA	Semi-annually	Phenova
Matrix – UST Soil/Water	Semi-annually	Phenova
Matrix – Air Canisters	Semi-annually	Phenova
DMRQA – Chemistry	Annually	Phenova
DMRQA – Aquatic Tox.	Annually	Phenova
ELLAP	Quarterly	AIHA
IHLAP	Quarterly	AIHA
EMLAP	Quarterly	AIHA
EMLAP – Direct Exam	Quarterly	AIHA
EMLAP – Fungal / Bacterial	Triannually	AIHA
Cryptosporidium / Giardia	Quarterly	WSLH
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 accreditation for analytical support of microbiological testing and limited inorganic exposure activities. ESC currently participates in the required performance testing studies and maintains the quality systems to satisfy the requirements necessary for accreditation in the following: Environmental Lead (air, soil, paint and wipes), Industrial Hygiene (multi-element metallic air filters), 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 CRO, COO, 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 CRO and Regulatory Affairs 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 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 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, may be 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 by performing primary analytical review
- 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

Chief Operating Officer (COO):

The COO is responsible for all operational laboratory activities. The COO must approve the *Quality Manual* prior to implementation.

Laboratory Operations Manager:

The Operations Manager (OM) is responsible for all day to day laboratory activities of the Organics and Inorganics sections of the laboratory. The OM supervises Department Supervisors and Senior Chemists within each relevant department.

Laboratory Group Leader, Department Manager:

Day to day supervision of technical laboratory departments 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.

Chief Regulatory Officer (CRO)

The CRO has the authority and responsibility for ensuring that the quality system and safe work practices are implemented and followed. The CRO has direct access to the laboratory's Chief Executive Officer (CEO) and is independent of operations. The CRO supervises the Technical Director, Quality Control Manager, Environmental Safety, Security and Health Officer and Technical Specialists within the Regulatory Affairs Department.

Technical Director

The Technical Director works in the Regulatory Affairs Department and shares the authority and responsibility for ensuring that the quality system is implemented and followed. The Technical Director has direct access to the Laboratory Operations Manager, CEO, COO and CRO and is independent of operations.

Laboratory QC Manager (QCM) (Also called Quality Manager)

The QCM has the responsibility for ensuring that the quality system requirements are conveyed to all laboratory personnel. The QCM has direct access to the CEO, COO and CRO and is independent of operations. The QCM routinely reviews QC policies for all analyses to ensure that the data is evaluated within method and regulatory requirements. The QCM is responsible for ensuring method/program compliance and that necessary corrective action measures are taken, completed, and remain effective.

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.

Data Review Specialist (DRS)

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

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 and/or Data Review Specialist 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 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. Where necessary, areas are periodically monitored to detect and resolve specific contamination and/or possible 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 section 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 approval 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 addressed 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*

Detection limits are determined annually and 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 replicate 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 calculated MDL determined 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 to provide added confidence in the validity of the analytical data. 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, when required.

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 the baseline 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 sufficient to provide adequate demonstration of performance.

CDOC

Annual demonstrations are performed by Analysts/Technicians involved in Lead (Pb) analyses to show 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 of 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 20 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 analytical process and matrix. Data set must be 20 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, which are outside the scope of the laboratory's activities, 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, Data Review and Regulatory Affairs. 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.
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	• The section supervisor first approves raw data. • The data entry portion of the LIMS can only be accessed by authorized

Table 5.4.7.4a LIMS	
System	**Description**
(verified by 4-step system)	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 separately from samples and 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 ISO accredited 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 ISO accredited 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). All balances and temperature-indicating devices are calibrated or verified by an outside vendor two times per year. Verifications are performed on balances on each day of use.

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	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 • Temperature ranges are listed in app. SOPs	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 All working thermometers	Calibrated annually by a NIST calibration service, accredited to ISO/IEC 17025 and ANSI/NCSL Z540-1. Verified semi-annually against NIST-certified thermometers by an outside service.	Calibration certificates from the calibration service. "Accuracy Assurance Program Test Data Sheets" provided by the servicer. All thermometers are tagged with current tolerances. Internal daily checks are recorded in a logbook.
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 µmhos /cm is used as the calibration standard. • Wet Lab, potassium chloride with a value of 1413 µmhos/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 – 100fpm.	Semi-annually	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 run log 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. Calibration and calibration check requirements are described in the appendices of this document for each analytical area. 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# 030230, *Standards Logger – Tree Operation)*

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.

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 Operations Manager 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 the change was 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. Field 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 5.7.5.2. Equipment blanks are prepared by rinsing the equipment with analyte-free water collected 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 <u>not</u> 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	Pre-cleaned 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 digital prep logbook 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, digital logbooks 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 Data Review 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 on hardcopy documents 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 submitted to the laboratory 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 (BDR) 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

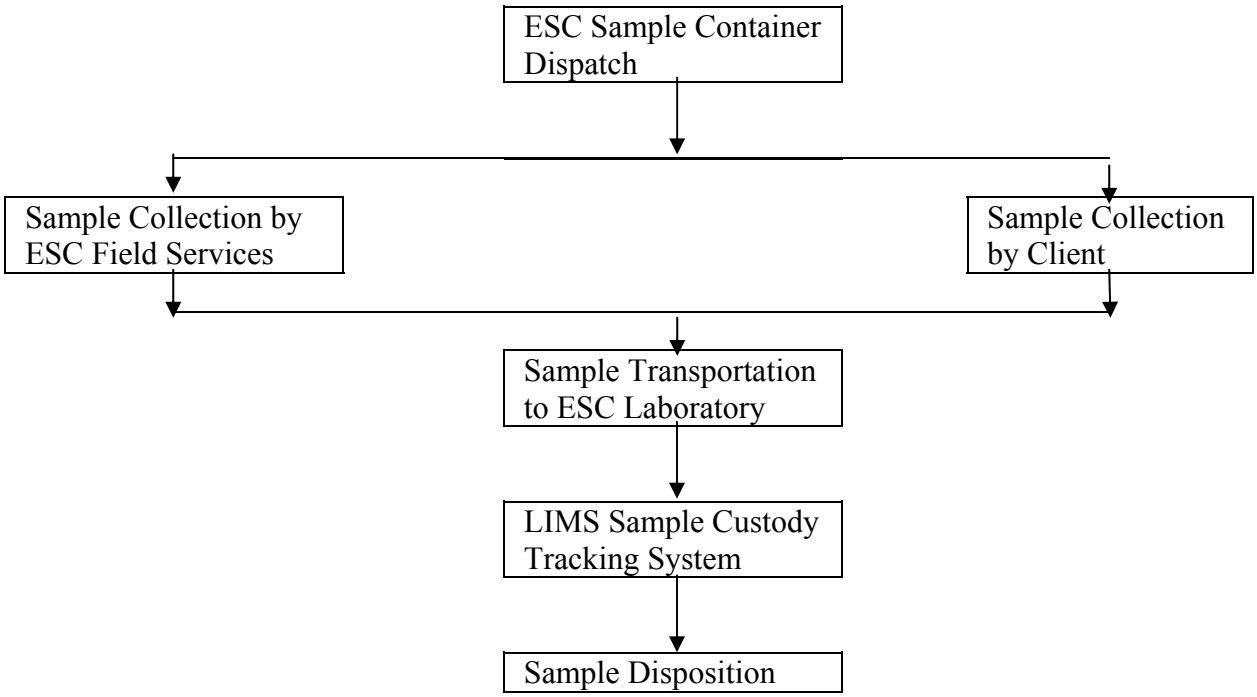


FIGURE 5.8.7b
INDIVIDUAL CONTAINER LOG
EXAMPLE
(Contents varies depending on client kit requirements)

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:

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):
Rush? (Lab MUST Be Notified)
__Same Day 200%
__ Next Day. 100%
__ Two Day 50%
Date Results Needed
Email? __No X Yes
FAX? __No __Yes
Packed on Ice N ___ Y ___

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.

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

Analysis/Container/Preservative

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

```
EMERMFG                    L99999-01
Emerald Manufacturing Corp.
Outfall Manhole-quarterly

Coll. Date/Time:  07/22/98  1400  TN

Sample #1           1L=Amb-NoPres
                                      L99999-01
SV625               999999
```

"BARCODE HERE"

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**	

4/2/2007 5:56:34 PM 1 of 6

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/duplicate analyses
- re-testing or re-calibration
- logic check or correlation of results from related analyses
- The identification and analysis of developing data trends by the use of control charts.

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 during and at end of sequence 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 volume and type 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 Phenova 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 Phenova 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 as required. 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 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 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, where required, are calculated at least annually according to TNI standard as identified in SOP 030207, *QC Charting*. The data are evaluated using ± 4 times the standard deviation or 4σ criteria for marginal excedences. 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 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.
- Marginal excedence (ME) limits, as defined by the TNI standard, are plus/minus four standard deviations from the arithmetic mean and are discussed in determinative SOPs where ME limits may be applied.
- 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:

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

Standard Deviation for Percent Recovery:

$$Sp = \sqrt{\frac{1}{N-1}\sum_{n=1}^{n}(P_i - \bar{x})^2}$$

Where: Sp = Standard deviation for percent recovery
$P_{1,2,3,.}$ = Individual percent recovery results

Matrix Spiked Samples

Spiked samples are typically ten percent of all samples, where matrix and sampled volume 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 instrument calibration 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 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:

$$RPD = \frac{|Duplicate\ 1 - Duplicate\ 2|}{\left[\frac{(Duplicate\ 1 + Duplicate\ 2)}{2}\right]}\ X\ 100$$

- Duplicates are analyzed with every analytical batch.
- X-bar control charts are generated using a minimum of 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 Duplicates of Laboratory Control Samples, Matrix Spikes and unspiked Field Samples - 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 excedances must be random events. If failures can demonstrate a pattern or occur with regularity in the same target analyte , the failure is not random and is 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.

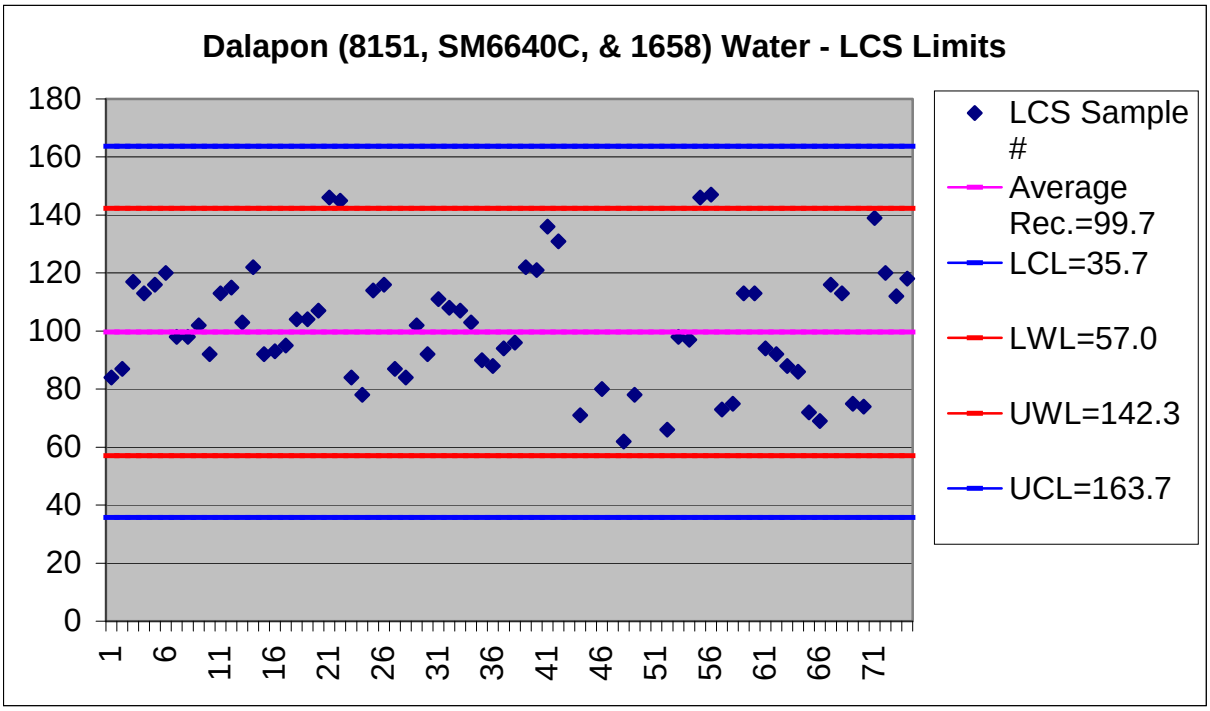
For example, the normal compound list for 8270/625 typically contains 90+ analytes; therefore, per the criteria listed below, only 5 analytes can be considered as marginally exceeding the acceptance criteria. If more than 5 failures occur or if the failures demonstrate a pattern that is causing the outliers, 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.

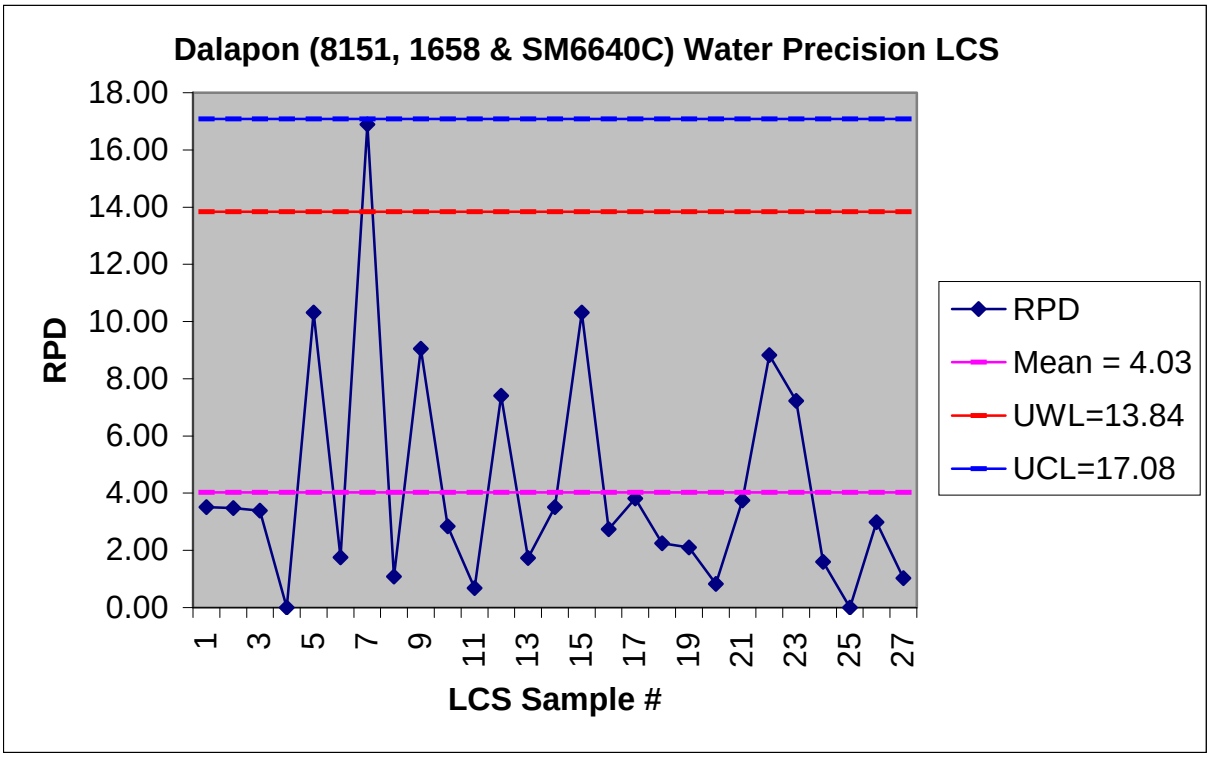
Number of Target Analytes	**Allowable Marginal Excedence Outliers**
>90	5 analytes allowed in the ME limit
71-90	4 analytes allowed in the ME limit
51-70	3 analytes allowed in the ME limit
31-50	2 analytes allowed in the ME limit
11-30	1 analytes allowed in the ME limit
<10	0 analytes allowed in the 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 compliance analyses include, 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 the following pages.

Figure 5.10.2 Example Final Client Report

ESC
L·A·B S·C·I·E·N·C·E·S
YOUR LAB OF CHOICE

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

[redacted]

Report Summary

Friday April 26, 2013

Report Number: I[redacted]
Samples Received: 04/17/13
Client Project: [redacted]

Description: [redacted] Sanitary Landfill

The analytical results in this report are based upon information supplied by you, the client, and are for your exclusive use. If you have any questions regarding this data package, please do not hesitate to call.

Entire Report Reviewed By: Tom Mellette , ESC Representative

Laboratory Certification Numbers

A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - 01157CA, CT - PH-0197, FL - E87487, GA - 923, IN - C-TN-01, KY - 90010, KYUST - 0016, NC - ENV375/DW21704/BIO041, ND - R-140. NJ - TN002, NJ NELAP - TN002, SC - 84004, TN - 2006, VA - 460132, WV - 233, AZ - 0612, MN - 047-999-395, NY - 11742, WI - 998093910, NV - TN000032011-1, TX - T104704245-11-3, OK - 9915, PA - 68-02979, IA Lab #364

Accreditation is only applicable to the test methods specified on each scope of accreditation held by ESC Lab Sciences.
Note: The use of the preparatory EPA Method 3511 is not approved or endorsed by the CA ELAP.

This report may not be reproduced, except in full, without written approval from ESC Lab Sciences.
Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

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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

April 26, 2013

[redacted]

ESC Sample # : [redacted]-01

Date Received : April 17, 2013
Description : [redacted] Sanitary Landfill - Leachate

Sample ID : LEACHATE

Collected By : [redacted]
Collection Date : 04/16/13 16:00

Site ID : [redacted]

Project # : [redacted]

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	530	10.	mg/l	9056	04/18/13	10
Sulfate	120	50.	mg/l	9056	04/18/13	10
Alkalinity	850	200	mg/l	2320 B-2011	04/19/13	10
BOD	18.0	5.00	mg/l	5210 B-2011	04/22/13	1
COD	210	10.	mg/l	410.4	04/20/13	1
Ammonia Nitrogen	12.	0.10	mg/l	350.1	04/24/13	1
pH	8.3		su	9040C	04/19/13	1
Dissolved Solids	1900	10.	mg/l	2540 C-2011	04/19/13	1
Suspended Solids	21.	1.0	mg/l	2540 D-2011	04/19/13	1
Calcium	69.	0.50	mg/l	6010B	04/25/13	1
Iron	1.7	0.10	mg/l	6010B	04/25/13	1
Potassium,Dissolved	110	0.50	mg/l	6010B	04/23/13	1
Sodium,Dissolved	420	0.50	mg/l	6010B	04/23/13	1
Volatile Organics						
Acetone	BDL	0.050	mg/l	8260B	04/18/13	1
Benzene	BDL	0.0010	mg/l	8260B	04/18/13	1
Bromodichloromethane	BDL	0.0010	mg/l	8260B	04/18/13	1
Bromoform	BDL	0.0010	mg/l	8260B	04/18/13	1
Bromomethane	BDL	0.0050	mg/l	8260B	04/18/13	1
Carbon disulfide	BDL	0.0010	mg/l	8260B	04/18/13	1
Carbon tetrachloride	BDL	0.0010	mg/l	8260B	04/18/13	1
Chlorobenzene	BDL	0.0010	mg/l	8260B	04/18/13	1
Chlorodibromomethane	BDL	0.0010	mg/l	8260B	04/18/13	1
Chloroethane	BDL	0.0050	mg/l	8260B	04/18/13	1
2-Chloroethyl vinyl ether	BDL	0.050	mg/l	8260B	04/18/13	1
Chloroform	BDL	0.0050	mg/l	8260B	04/18/13	1
Chloromethane	BDL	0.0025	mg/l	8260B	04/18/13	1
1,1-Dichloroethane	BDL	0.0010	mg/l	8260B	04/18/13	1
1,2-Dibromoethane	BDL	0.0010	mg/l	8260B	04/18/13	1
1,2-Dichloroethane	BDL	0.0010	mg/l	8260B	04/18/13	1
1,3-Dichloropropane	BDL	0.0010	mg/l	8260B	04/18/13	1
1,1-Dichloroethene	BDL	0.0010	mg/l	8260B	04/18/13	1
cis-1,2-Dichloroethene	BDL	0.0010	mg/l	8260B	04/18/13	1
Dichlorodifluoromethane	BDL	0.0050	mg/l	8260B	04/18/13	1
trans-1,2-Dichloroethene	BDL	0.0010	mg/l	8260B	04/18/13	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
L630883-01 (PH) - 8.3@18.5c

12065 Lebanon Rd.
Mt. Juliet, TN 37122
(615) 758-5858
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Tax I.D. 62-0814289

Est. 1970

REPORT OF ANALYSIS

[redacted]

April 26, 2013

Date Received : April 17, 2013
Description : [redacted] Sanitary Landfill - Leachate

Sample ID : LEACHATE

Collected By : [redacted]
Collection Date : 04/16/13 16:00

ESC Sample # : [redacted]-01

Site ID : [redacted]

Project # : [redacted]

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
1,2-Dichloropropane	BDL	0.0010	mg/l	8260B	04/18/13	1
cis-1,3-Dichloropropene	BDL	0.0010	mg/l	8260B	04/18/13	1
trans-1,3-Dichloropropene	BDL	0.0010	mg/l	8260B	04/18/13	1
Ethylbenzene	BDL	0.0010	mg/l	8260B	04/18/13	1
2-Hexanone	BDL	0.010	mg/l	8260B	04/18/13	1
2-Butanone (MEK)	BDL	0.010	mg/l	8260B	04/18/13	1
Methylene Chloride	BDL	0.0050	mg/l	8260B	04/18/13	1
Methyl tert-butyl ether	BDL	0.0050	mg/l	8260B	04/18/13	1
4-Methyl-2-pentanone (MIBK)	BDL	0.010	mg/l	8260B	04/18/13	1
Styrene	BDL	0.0010	mg/l	8260B	04/18/13	1
1,1,2,2-Tetrachloroethane	BDL	0.0010	mg/l	8260B	04/18/13	1
Tetrachloroethene	BDL	0.0010	mg/l	8260B	04/18/13	1
Toluene	BDL	0.0050	mg/l	8260B	04/18/13	1
1,1,1-Trichloroethane	BDL	0.0010	mg/l	8260B	04/18/13	1
1,1,2-Trichloroethane	BDL	0.0010	mg/l	8260B	04/18/13	1
Trichloroethene	BDL	0.0010	mg/l	8260B	04/18/13	1
Vinyl acetate	BDL	0.010	mg/l	8260B	04/18/13	1
Vinyl chloride	BDL	0.0010	mg/l	8260B	04/18/13	1
Xylenes, Total	BDL	0.0030	mg/l	8260B	04/18/13	1
Surrogate Recovery						
Toluene-d8	96.3		% Rec.	8260B	04/18/13	1
Dibromofluoromethane	96.1		% Rec.	8260B	04/18/13	1
4-Bromofluorobenzene	96.8		% Rec.	8260B	04/18/13	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: 04/26/13 09:25 Printed: 04/26/13 09:26
L630883-01 (PH) - 8.3@18.5c

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 12/17/13) *Subject to Revision*

QUAL	DESCRIPTION
A	ALC (EPA) - Aldol Condensation: Labels a suspected Aldol Condensation product for TICs.
A1	Result exceeds Montana Risk Based Screening Levels (RBSLs).
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 lower control limits; associated data has a potential negative bias
J+	The associated batch QC was outside the upper control limits; associated data has a potential positive 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 cannot be used for control limit evaluation due to dilution.
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.

Table 5.10.2 **ESC Qualifiers and Descriptions (**Updated 12/17/13) *Subject to Revision*

QUAL	DESCRIPTION
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.
L3	(ESC) Sample reanalysis and/or spiking 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 the method required serial dilution test and/or subsequent post-spike criteria. These failures indicate matrix interference.
O2	(ESC) The original sample exhibited a negative response. A subsequent dilution confirmed the presence of 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.

Table 5.10.2 ESC Qualifiers and Descriptions (Updated 12/17/13) *Subject to Revision*

QUAL	DESCRIPTION
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.
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:

- Spreadsheet calculation.
- Input of raw data for computer processing.
- Direct acquisition of raw data by computer.

5.11.1 Spreadsheet Calculations

All data that are not captured by automatic acquisition are calculated using approved and controlled spreadsheets. No hand-calculations are performed. Any spreadsheets used are controlled, verified and locked to prevent unintentional changes.

5.11.2 Data Input

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 persons 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, dilution factors, 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 are 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 performed on hardcopy records 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 analyzed 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 performed and documented per the manual integration SOP, QC samples are within established limits, and supporting documentation is complete.
- The benchsheet is then given to a Data Review 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 supervisors 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 Data Review Specialist performs a final review before the data is approved for input into the computer.
- This review includes performance of the various blanks, precision and accuracy 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 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 Data Review 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 results 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 qualified.
- 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	DR 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 DR Specialist
Data Entry to LIMS	Data Transfer - Application of Qualifiers	Data Entry Specialist followed by DR Specialist Verification
Data Entry to LIMS	Manual Entry of Data and Qualifiers	Data Entry Specialist followed by DR 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). 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 are documented in Standards Logger and labels contain the following information: unique ESC identifier, date prepared, analyst initials, expiration date, and reagent name. In house reagents are recorded with the same information in Standards Logger.
- Purchased reagent solutions are labeled with a unique identifier assigned in Standards Logger 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 6.3 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 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 for lead contamination. Any detectable concentration must be <u>less than</u> the established regulatory limit for lead. If any detectable amount exceeds the established criteria, then the area must be cleaned and verified before analysis can resume. See ESC SOP#: 340706, *Quarterly Monitoring for Lead Contamination.*

6.4.2 VOCs

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 6.3 - 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/ Suspended/Dissolved	None		
Turbidity	None	none	none
Metals	acids, metal solutions	corrosive, toxic	highly toxic metal standards and samples - dispose via haz waste regulations

PARAMETER	WASTE PRODUCTS	WASTE CLASSIFICATION	DISPOSAL METHOD
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	Gloves, plastic containers	none	Standard refuse

FIGURE 6.1 (*reprint of excerpt – current as of 3/24/14*)

40 CFR PART 261-IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

Subpart A-General Sec.
261.1 Purpose and scope.
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.
261.9 Requirements for Universal Waste.

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 sample 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

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Prepared by

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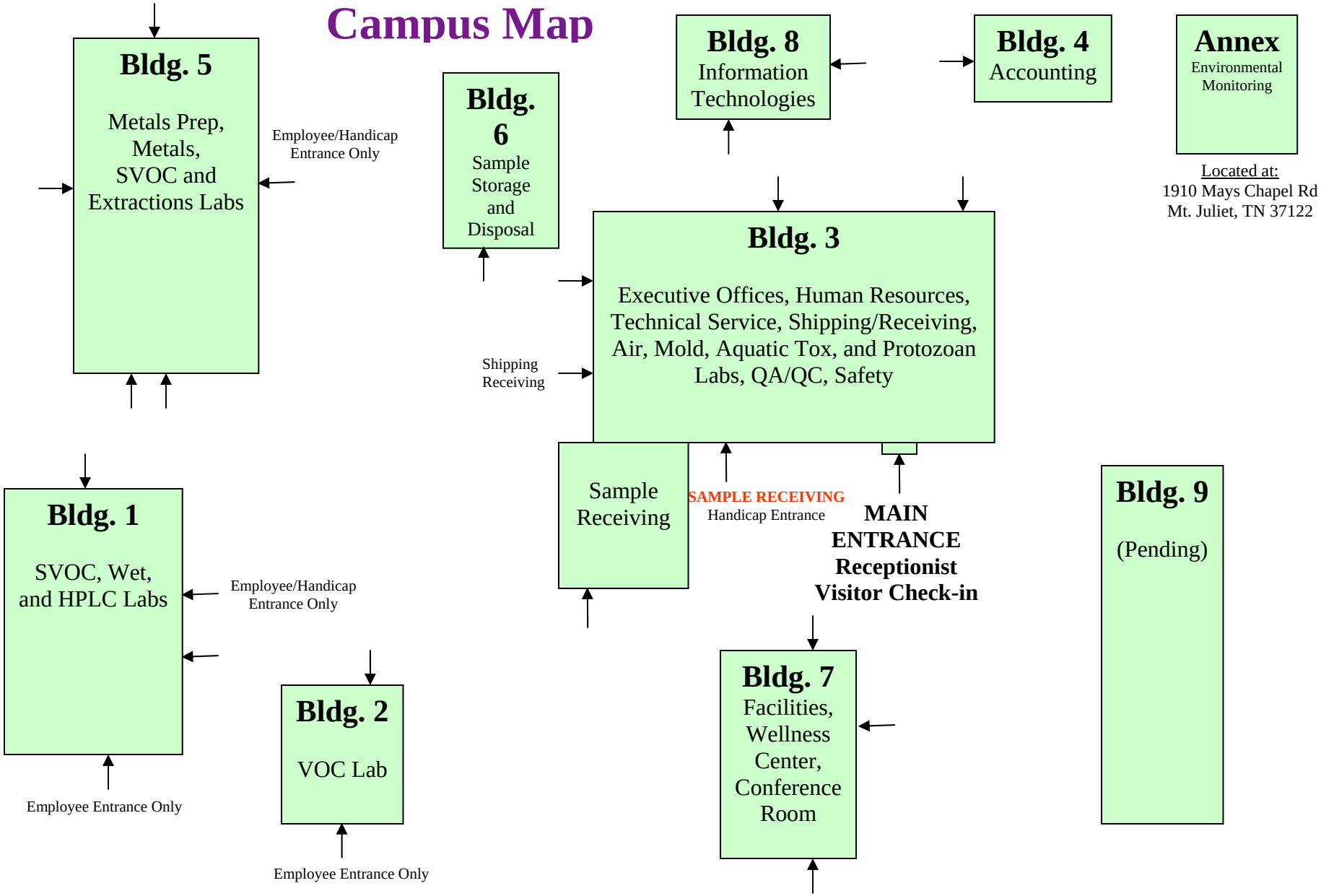
Campus Map


Bldg. 5
Metals Prep, Metals, SVOC and Extractions Labs
Employee/Handicap Entrance Only
Bldg. 6
Sample Storage and Disposal
Bldg. 8
Information Technologies
Bldg. 4
Accounting
Annex
Environmental Monitoring
Located at:
1910 Mays Chapel Rd
Mt. Juliet, TN 37122
Bldg. 3
Executive Offices, Human Resources, Technical Service, Shipping/Receiving, Air, Mold, Aquatic Tox, and Protozoan Labs, QA/QC, Safety
Shipping Receiving
Sample Receiving
SAMPLE RECEIVING
Handicap Entrance
MAIN ENTRANCE
Receptionist
Visitor Check-in
Bldg. 9
(Pending)
Bldg. 1
SVOC, Wet, and HPLC Labs
Employee/Handicap Entrance Only
Employee Entrance Only
Bldg. 2
VOC Lab
Employee Entrance Only
Bldg. 7
Facilities, Wellness Center, Conference Room

ESC Certifications

APPENDIX II TO THE ESC QUALITY ASSURANCE MANUAL

for

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Updated 4/13/14 (May be revised without notice)

State/ Agency	Certificate Number	Expiration Date/ Status	Date Issued	Certified Programs	Approved Programs	Cert. Type	Cert. Authority
Alabama	40660	7/1/13	6/30/14	DW	WW, UST, RCRA,	Reciprocal	TN
Alaska	UST-080	4/30/14	4/30/13	UST	UST	AK	AK
Arizona	AZ0612	6/25/14	6/26/13	AIR, DW, WW, RCRA, UST		Audit	AZ
Arkansas	88-0469	1/21/15	1/21/14	WW, RCRA, UST, BIoassay		NELAP	NJ
California	01157CA	8/31/14	9/1/13	WW, RCRA, UST		NELAP	NJ
Colorado	None	3/31/15	4/1/14	DW	WW, UST, RCRA,	Reciprocal	TN
Connecticut	PH-0197	3/31/15	6/13/13	DW	WW, UST, RCRA,	Reciprocal	TN, NJ
Florida	E87487	6/30/14	7/2/13	AIR, DW, WW, RCRA, UST		NELAP	NJ
Georgia DW Chemistry	923	6/16/16	1/21/11	DW		Reciprocal	TN
Georgia DW Microbiology	923	10/12/15	6/16/16	DW		Reciprocal	TN
Georgia	None	6/30/14	7/1/13	WW, RCRA, UST		NELAP	NJ
Idaho	TN00003	7/16/14	7/16/13	DW	WW, UST, RCRA,	NELAP	NJ
Illinois	200008	11/30/14	11/7/13	DW, WW, RCRA, UST		NELAP	NJ
Indiana	C-TN-01	6/16/16	6/11/13	DW	WW, UST, RCRA,	Reciprocal	TN
Iowa	364	5/1/14	7/12/12	WW, RCRA, UST		NELAP	IA
Kansas	E-10277	10/31/14	11/1/13	DW, WW, RCRA, UST		NELAP	NJ
Kentucky DW	90010	12/31/14	1/15/14	DW	WW, RCRA	Reciprocal	TN
Kentucky UST	12	11/30/15	12/19/13	UST		Audit	A2LA
Louisiana	Agency ID 30792	6/30/14	7/1/13	WW, RCRA, UST, AIR		NELAP	NJ
Maine	TN0002	7/5/15	5/15/13	DW, WW	RCRA, UST	Reciprocal	TN, NJ
Maryland	324	12/31/14	10/10/13	DW		Reciprocal	TN

State/ Agency	Certificate Number	Expiration Date/ Status	Date Issued	Certified Programs	Approved Programs	Cert. Type	Cert. Authority
Massachusetts	M-TN003	6/30/14	7/1/13	DW,WW	RCRA, UST	Reciprocal	TN
Michigan	9958	6/16/16	6/14/13	DW	WW, UST, RCRA,	Reciprocal	TN
Minnesota	047-999-395	12/31/14	12/27/13	WW, RCRA, UST		Audit	MN
Mississippi	None	6/16/16	4/2/14	DW	WW, UST, RCRA,	NELAP	NJ
Missouri	340	6/16/16	9/5/13	DW	WW, UST, RCRA,	NELAP	NJ
Montana	CERT0086	1/1/15	11/4/13	DW	WW, UST, RCRA,	Reciprocal	TN
Nebraska	NA	6/30/14	8/9/13	DW	WW, UST, RCRA,	Reciprocal	TN
Nevada	TN-03-2002-34	7/31/14	7/26/13	WW, DW, RCRA, UST		NELAP	NJ
New Hampshire	2975	5/20/14	5/21/13	DW, WW	RCRA, UST	NELAP	NJ
New Jersey - NELAP	TN002	6/30/14	7/1/13	DW, WW, RCRA, UST, AIR		NELAP	NJ
New Mexico	None	Renewal	8/3/2011	DW	WW, UST, RCRA,	NELAP	NJ
New York	11742	4/1/15	4/1/14	WW, RCRA, UST, AIR		NELAP	NJ
North Carolina DW	DW21704	7/31/14	7/1/13	DW		Audit	NC
North Carolina	Env375	12/31/14	1/1/14	WW, RCRA, UST		Audit	NC
North C. Aquatic Tox	041	11/1/14	11/13/13	Aquatic Toxicity		Audit	NC
North Dakota	R-140	6/30/14	7/1/13	DW, WW, RCRA		Reciprocal	TN, WI
Ohio VAP	CL0069	10/15/15	12/16/13	WW, RCRA, UST, AIR		Audit	OH
Oklahoma	9915	8/31/14	9/1/13	WW, RCRA, UST, BIOASSAY		NELAP	NJ
Oregon	TN200002	1/15/15	1/16/14	DW, WW, RCRA, UST		NELAP	NJ
Pennsylvania	68-02979	12/31/14	1/24/14	DW, WW, RCRA, UST		NELAP	NJ

State/ Agency	Certificate Number	Expiration Date/ Status	Date Issued	Certified Programs	Approved Programs	Cert. Type	Cert. Authority
Rhode Island	221	12/30/14	1/9/13	DW, Env. Lead	WW, UST, RCRA,	Reciprocal	TN, AIHA
South Carolina	84004	6/30/14	11/26/13	WW, RCRA, UST		NELAP	NJ
South Dakota	Pending	Pending					
Tennessee DW	2006	6/16/16	8/12/13	DW	WW, UST, RCRA,	Audit	TN
Tennessee DW Micro	2006	10/12/15	7/10/13	DW Micro		Audit	TN
Texas Mold	LAB0152	3/10/15	2/13/13	MOLD		NA	TX
Texas - Env	T 104704245-07-TX	10/31/14	11/1/13	DW, WW, RCRA, AIR		Reciprocal	NJ
Utah	6157585858	7/31/14	7/1/13	DW, WW, RCRA, UST		NELAP	NJ
Vermont	VT2006	1/5/14	1/10/13	DW	WW, UST, RCRA,	Reciprocal	TN
Virginia VELAP	460132	6/14/14	2/1/14	DW, WW, RCRA, UST		NELAP	NJ
Washington	C1915	8/19/14	4/3/14	DW, WW, RCRA, UST, AIR		Audit	A2LA
West Virginia	233	2/28/15	2/26/14	WW, RCRA, UST		Audit	WV
West Virginia TO-15 Approval	233	2/28/15	1/27/14	AIR		Audit	WV
West Virginia Cryptosporidium	233	12/31/14	3/24/14	Cryptosporidium		Audit	WV
Wisconsin	998093910	8/31/14	2/28/14	WW, RCRA, UST		Audit	WI
Wyoming	A2LA	11/30/15	12/11/13	UST	WW, RCRA	Audit	A2LA
A2LA	1461.01	11/30/15	12/11/13	DW, WW, RCRA, UST, AIR, MICRO		Audit	A2LA
AIHA*	100789	6/1/14	4/16/13	IHLAP, ELLAP, EMLAP		Audit	AIHA
DOD	1461.01	11/30/15	12/11/13	RCRA, UST		Audit	A2LA
USDA	S-67674	9/27/15	12/11/12	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

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2.0 APPENDIX TABLE OF CONTENTS

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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

• Parameter Group	• Sample Source
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. 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] Purging	Tygon Tubing Teflon® Silastic Rubber	All parameter groups except organics All parameter groups 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%.
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

Type	Use	Materials	Allowable Parameter Groups[1]
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

Chemical	Method of Storage
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

TABLE 14.6: PRESERVATION, HOLDING TIME AND SAMPLE CONTAINERS

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Air Methods									
Volatiles in Ambient Air	Air	EPA TO-15	NA	Various	Canister	None	Ambient	14	Days
Volatiles in Ambient Air	Air	EPA TO-15	NA	Various	Tedlar	None	Ambient	5	Days
Volatiles in Ambient Air	Air	EPA Method 18	NA	Various	Canister	None	Ambient	14	Days
Volatiles in Ambient Air	Air	EPA Method 18	NA	Various	Tedlar	None	Ambient	5	Days
Ohio VAP EPA Method 8260B	Air	NA	EPA 8260B	Various	Canister	None	Ambient	14	Days
Ohio VAP EPA Method 8260B	Air	NA	EPA 8260B	Various	Tedlar	None	Ambient	5	Days
Methane, Ethane, Ethene, Propane	Air	RSK-175	NA	Various	Canister	None	Ambient	14	Days
Methane, Ethane, Ethene, Propane	Air	RSK-175	NA	Various	Tedlar	None	Ambient	5	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Fixed Gases - C2, CO2, CO, and CH4	Air	ASTM D1946/D5 314	NA	Various	Canister	None	Ambient	14	Days
Fixed Gases - C2, CO2, CO, and CH4	Air	ASTM D1946/D5 314	NA	Various	Tedlar	None	Ambient	5	Days
Arizona State Specific VOCs in Vapor - 8260B	Air	NA	EPA 8260B	Various	Canister	None	Ambient	30	Days
Arizona State Specific VOCs in Vapor - 8260B	Air	NA	EPA 8260B	Various	Tedlar	None	Ambient	72	Hours
Arizona State Specific VOCs in Vapor - 8015B	Air	NA	EPA 8015B	Various	Canister	None	Ambient	30	Days
Arizona State Specific VOCs in Vapor - 8015B	Air	NA	EPA 8015B	Various	Tedlar	None	Ambient	72	Hours
Aquatic Toxicity & Related									
C.dubia - Acute	NPW	2002	NA	1L/1Gal	HDPE	None	0 - 6oC	36	Hours
Minnow - Acute	NPW	2000	NA	1L/1Gal	HDPE	None	0 - 6oC	36	Hours
Toxicity C.dubia - Chronic	NPW	1002	NA	1L/1Gal	HDPE	None	0 - 6oC	36	Hours
Toxicity Minnow - Chronic	NPW	1000	NA	1L/1Gal	HDPE	None	0 - 6oC	36	Hours
Bacteria									
Chlorophyll A/Pheophytin A	NPW	SM10200 H	NA	1L	Amber Glass	None	0 - 6oC	72	Hours

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Coliform, Total	NPW	SM9222B	NA	110ml	Micro	Na2S2O3	0 - 6oC	8	Hours
E. Coli	NPW	SM9223B Colilert	NA	110ml	Micro	Na2S2O3	0 - 6oC	8	Hours
Enterococci	NPW	ASTM D6503-99, Enterolert	NA	110ml	Micro	Na2S2O3	0 - 6oC	8	Hours
Fecal Coliform	NPW	SM9222D	NA	110ml	Micro	Na2S2O3	0 - 6oC	6	Hours
Fecal Coliform	NPW	SM9221C /E	NA	110ml	Micro	Na2S2O3	0 - 6oC	6	Hours
Heterotropic Plate Count	NPW	9215B	NA	110ml	Micro	Na2S2O3	0 - 6oC	6	Hours
Salmonella	NPW	SM9260D	NA	110ml	Micro	Na2S2O3	0 - 6oC	8	Hours
Cryptosporidium	PW	1622, 1623	NA	10L	LDPE	None	<20oC	96	Hours
E. Coli	PW	SM9223B	NA	110ml	Micro	Na2S2O3	0 - 6oC	30	Hours
Fecal Coliform (MPN)	PW	9221E	NA	110ml	Micro	Na2S2O3	0 - 6oC	30	Hours
Fecal Coliform	PW	SM9222D	NA	110ml	Micro	Na2S2O3	0 - 6oC	30	Hours
Enterococci	PW	ASTM D6503-99	NA	110ml	Micro	Na2S2O3	0 - 6oC	30	Hours
Heterotropic Plate Count	PW	9215B	NA	110ml	Micro	Na2S2O3	0 - 6oC	6	Hours
Coliform, Total	PW	9222B, 9223B	NA	110ml	Plastic	Na2S2O3	0 - 6oC	30	Hours
Coliform, Total	SS	SM9221B 9222	NA	Sterile 125mL	Plastic	None	0 - 6oC	24	Hours
Fecal Coliform (MPN)	SS	9221E	NA	Sterile 125mL	Plastic	None	0 - 6oC	24	Hours
Fecal Coliform (Sludge)	SS	9222D	NA	Sterile 125mL	Plastic	None	0 - 6oC	24	Hours
Enterococci	SS	ASTM D6503-99	9230	Sterile 125mL	Plastic	None	0 - 6oC	6	Hours
Salmonella	SS	SM9260D	NA	110ml	Micro	None	0 - 6oC	6	Hours

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Heterotropic Plate Count	SS	SM9215B	NA	110ml	Micro	None	0 - 6oC	6	Hours
S.O.U.R.	SS	SM 2710B	NA	1L	HDPE	None	0 - 6oC	2	Hours
Inorganic Classic									
Acidity	NPW	SM2310B ASTM D1067	NA	250ml	HDPE	None	0 - 6oC	14	Days
Alkalinity	NPW	SM2320B	NA	500ml	HDPE	None	0 - 6oC	14	Days
Alkalinity	NPW	310.2	NA	500ml	HDPE	None	0 - 6oC	14	Days
Ammonia Nitrogen	NPW	350.1, SM4500N H3G	NA	500ml	HDPE	H2SO4+Na2S2O3	0 - 6oC	28	Days
Ammonia, distilled/titration (4500)	NPW	SM4500N H3C	NA	500ml	HDPE	H2SO4+Na2S2O4	0 - 6oC	28	Days
Asbestos	NPW	100.1	NA	1L	Glass	None	0 - 6oC	48	Hours
BOD/CBOD (Total & Soluble)	NPW	SM5210B	NA	1L	HDPE	None	0 - 6oC	48	Hours
Bromide	NPW	300.0, SM4110B	9056	125ml	HDPE	None	0 - 6oC	28	Days
Carbon Dioxide	NPW	SM4500CO2 D	NA	1L	HDPE	None	0 - 6oC	15	Min
Chemical Oxygen Demand (COD)	NPW	410.4, SM5220D	NA	250ml	HDPE	H2SO4	0 - 6oC	28	Days
Chemical Oxygen Demand (COD), Soluble	NPW	410.4, SM5220D	NA	250ml	HDPE	None	0 - 6oC	28	Days
Chloride	NPW	300.0, SM4110B	9056	125ml	HDPE	None	0 - 6oC	28	Days
Chlorine, residual	NPW	SM4500Cl-G	NA	250ml	HDPE	None	0 - 6oC	15	Min
Color	NPW	SM2120B	NA	250ml	HDPE	None	0 - 6oC	48	Hours
CTAS Surfactants	NPW	SM5540D	NA	1L	HDPE	None	0 - 6oC	48	Hours

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Cyanide - Total	NPW	335.4, SM4500C NE	9012	250ml	Amber HDPE	NaOH	0 - 6oC	14	Days
Cyanide - Total	NPW	Kelada-01	NA	250ml	Amber HDPE	NaOH	0 - 6oC	14	Days
Cyanide, Amenable	NPW	SM4500C NG	9012	250ml	Amber HDPE	NaOH	0 - 6oC	14	Days
Cyanide, Free	NPW	SM4500C NE	NA	250ml	Amber HDPE	NaOH	0 - 6oC	14	Days
Cyanide, Weak Acid Dissoc.	NPW	SM4500C N-I	NA	250ml	Amber HDPE	NaOH	0 - 6oC	14	Days
Dissolved Organic Carbon (DOC)	NPW	SM5310B	9060	250ml	Amber Glass	None	0 - 6oC	28	Days
Ferrous Iron	NPW	SM3500F eB	NA	250ml	Amber Glass	HCl	0 - 6oC	15	Min
Fluoride	NPW	300.0, SM4110B	9056	125ml	HDPE	None	0 - 6oC	28	Days
Hardness	NPW	200.7, SM2340B	NA	250ml	HDPE	HNO3	0 - 6oC	180	Days
Hardness	NPW	130.1	NA	500ml	HDPE	HNO3	0 - 6oC	180	Days
Hardness	NPW	SM2340C	NA	500ml	HDPE	HNO3	0 - 6oC	180	Days
Iodide	NPW	345.1	NA	250ml	HDPE	None	0 - 6oC	Immed	
Kjeldahl Nitrogen, TKN	NPW	351.2, SM4500N orgB/C	NA	250ml	HDPE	H2SO4	0 - 6oC	28	Days
Methylene Blue Active Subst. (MBAS)	NPW	SM5540C	NA	250ml	HDPE	None	0 - 6oC	48	Hours
Nitrate	NPW	300.0, SM4110B	9056	125ml	HDPE	None	0 - 6oC	48	Hours
Nitrate + Nitrite	NPW	353.2, SM4500N O3F	NA	250ml	HDPE	H2SO4	0 - 6oC	28	Days
Nitrite	NPW	300.0, SM4110B	9056	125ml	HDPE	None	0 - 6oC	48	Hours
Oil & Grease (Hexane Extr)	NPW	1664A, SM5520B	9070	1L	Glass	HCl	0 - 6oC	28	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Oil & Grease, Free	NPW	1664A	9070	1L	Amber Glass	None	0 - 6oC	28	Days
Organic Nitrogen	NPW	351.2 - 350.1	NA	500ml	HDPE	H2SO4	0 - 6oC	28	Days
Oxygen, dissolved (DO)	NPW	SM4500OC, SM4500OG	NA	125ml	HDPE	None	0 - 6oC	15	Min
pH	NPW	SM4500HB	9040	125ml	HDPE	None	0 - 6oC	15	Min
Phenols (Total) by 4AAP	NPW	420.1, 420.4	9066	250ml	Amber Glass	H2SO4	0 - 6oC	28	Days
Phosphate, Ortho	NPW	365.1, SM4500P-E	NA	250ml	HDPE	None	0 - 6oC	48	Hours
Phosphorus, Total	NPW	365.1, SM4500P-B.5	NA	250ml	HDPE	H2SO4	0 - 6oC	28	Days
Residue, Filterable (TDS)	NPW	SM2540C	NA	250ml	HDPE	None	0 - 6oC	7	days
Residue, non-Filterable (TSS)	NPW	SM2540D	NA	1L	HDPE	None	0 - 6oC	7	Days
Residue, Settleable (SS)	NPW	SM2540F	NA	1L	HDPE	None	0 - 6oC	48	Hours
Residue, Total (TS)	NPW	SM2540B	NA	250ml	HDPE	None	0 - 6oC	7	Days
Specific Conductance (Conductivity)	NPW	120.1, SM2510B	9050	250ml	HDPE	None	0 - 6oC	28	Days
Sulfate	NPW	300.0, SM4110B	9056	125ml	HDPE	None	0 - 6oC	28	Days
Sulfide	NPW	NA	9030, 9034	500ml	HDPE	NaOH +ZnAc	0 - 6oC	7	Days
Sulfide	NPW	SM4500S2D	NA	500ml	HDPE	NaOH +ZnAc	0 - 6oC	7	Days
Sulfide, Dissolved	NPW	SM4500S2D	NA	125ml	Amber Glass	NaOH +ZnAc	0 - 6oC	7	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Sulfite	NPW	SM4500S O3B	NA	250ml	HDPE	None	0 - 6oC	15	Min
Tannins and Lignins	NPW	SM5550B	NA	250ml	HDPE	None	0 - 6oC	NA	
Temperature	NPW	SM2550B	NA	onsite		None	0 - 6oC	15	Min
Total Organic Carbon (TOC)	NPW	SM53010 B	9060	250ml	Amber Glass	HCl	0 - 6oC	28	Days
Total Organic Halides (TOX)	NPW	450.1, SM5320B	NA	1L	Amber Glass	H2SO4	0 - 6oC	28	Days
Turbidity	NPW	180.1, SM2130B	NA	250ml	HDPE	None	0 - 6oC	48	Hours
Volatile Solids (VS)	NPW	160.4	NA	250ml	HDPE	None	0 - 6oC	7	Days
Volatile Susp. Solids (VSS)	NPW	SM2540E	NA	500ml	HDPE	None	0 - 6oC	7	Days
Alkalinity	PW	2320B	NA	500ml	HDPE	None	0 - 6oC	14	Days
Ammonia Nitrogen	PW	350.1, SM4500N H3G	NA	250ml	HDPE	H2SO4	0 - 6oC	28	Days
Ammonia, distilled/titration (4500)	PW	SM4500N H3C	NA	250ml	HDPE	H2SO4	0 - 6oC	28	Days
Asbestos	PW	100.1	NA	1L	Glass	None	0 - 6oC	48	Hours
Bromide	PW	300.0, SM4110B	NA	125ml	HDPE	None	0 - 6oC	28	Days
Calcium-hardness	PW	SM3500-Ca B	NA	250ml	Amber Glass	HNO3	0 - 6oC	180	Days
Carbon Dioxide	PW	SM4500C O2 D	NA	1L	HDPE	None	0 - 6oC	15	Min
Chloride	PW	300.0, SM4110B	NA	125ml	HDPE	None	0 - 6oC	28	Days
Chlorine, residual	PW	SM4500C l-G	NA	250ml	HDPE	None	0 - 6oC	15	Min
Color	PW	SM2120B	NA	250ml	HDPE	None	0 - 6oC	48	Hours
Corrosivity	PW	Calc	NA		Plastic	None	0 - 6oC	NA	
Cyanide - Total	PW	335.4, SM4500C NE	NA	250ml	HDPE Amber	NaOH	0 - 6oC	14	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Cyanide - Total	PW	Kelada-01	NA	250ml	HDPE Amber	NaOH	0 - 6oC	14	Days
Cyanide, Amenable	PW	SM4500C NG	NA	250ml	HDPE Amber	NaOH	0 - 6oC	14	Days
Cyanide, Free	PW	SM4500C NE	NA	250ml	HDPE Amber	NaOH	0 - 6oC	14	Days
Dissolved Organic Carbon (DOC)	PW	SM5310C	NA	250ml	Amber Glass	None	0 - 6oC	28	Days
Dissolved Solids (TDS)	PW	SM2540C	NA	250ml	HDPE	None	0 - 6oC	7	Days
Fluoride	PW	300.0, SM4110B	NA	125ml	HDPE	None	0 - 6oC	28	Days
Hardness	PW	200.7, SM2340B	NA	250ml	HDPE	HNO3	0 - 6oC	180	Days
Hardness	PW	130.1	NA	500ml	HDPE	HNO3	0 - 6oC	180	Days
Hardness	PW	SM2340C	NA	500ml	HDPE	HNO3	0 - 6oC	180	Days
Methylene Blue Active Subst. (MBAS)	PW	SM5540C	NA	1L	HDPE	None	0 - 6oC	48	Hours
Nitrate	PW	300.0, SM4110B	NA	125ml	HDPE	None	0 - 6oC	48	Hours
Nitrate + Nitrite	PW	353.2, SM4500N O3F	NA	250ml	HDPE	H2SO4	0 - 6oC	28	Days
Nitrite	PW	300.0, SM4110B	NA	125ml	HDPE	None	0 - 6oC	48	Hours
Odor	PW	SM2150B	NA	250ml	Amber Glass	None	0 - 6oC	24	Hours
Perchlorate	PW	314	NA	125ml	HDPE	None	0 - 6oC	28	Days
pH	PW	150.1, SM4500-H B	NA	125ml	HDPE	None	0 - 6oC	15	Min
Phosphate, Ortho	PW	SM4500P -E	NA	250ml	HDPE	None	0 - 6oC	48	Hours
Specific Conductance	PW	SM2510B	NA	250ml	HDPE	None	0 - 6oC	28	Days
Sulfate	PW	300.0, SM4110B	NA	125ml	HDPE	None	0 - 6oC	28	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Total Organic Carbon (TOC)	PW	SM5310C	NA	250ml	Amber Glass	H2SO4	0 - 6oC	28	Days
Total Organic Halides (TOX)	PW	SM5320B	NA	1L	Amber Glass	H2SO4	0 - 6oC	28	Days
Turbidity	PW	180.1, SM2130B	NA	250ml	HDPE	None	0 - 6oC	48	Hours
UV Absorbance at 254 nm	PW	SM5910B	NA	250ml	Amber Glass	None	0 - 6oC	48	Hours
Asbestos	SS	PLM	NA			None	0 - 6oC	NA	
Bromide	SS	NA	9056	4 oz.	Glass	None	0 - 6oC	28	Days
Chloride	SS	NA	9056	4 oz.	Glass	None	0 - 6oC	28	Days
Corrosivity	SS	NA	9045D	4 oz.	Glass	None	0 - 6oC	15	Min
Cyanide - Total	SS	NA	9010/9012	4 oz.	Glass	None	0 - 6oC	14	Days
Cyanide, Amenable	SS	NA	9010/9012	4 oz.	Glass	None	0 - 6oC	14	Days
Cyanide, Free	SS	NA	9010/9012	4 oz.	Glass	None	0 - 6oC	14	Days
Extractable Organic Halides (EOX)	SS	NA	9023	4 oz.	Glass	None	0 - 6oC	28	Days
Fluoride	SS	NA	9056	4 oz.	Glass	None	0 - 6oC	28	Days
Kjeldahl Nitrogen, TKN	SS	351.2	NA	2 oz.	Glass	None	0 - 6oC	28	Days
Nitrate	SS	NA	9056	4 oz.	Glass	None	0 - 6oC	28	Days
Nitrite	SS	NA	9056	4 oz.	Glass	None	0 - 6oC	28	Days
Oil & Grease	SS	NA	9071	4 oz.	Glass	None	0 - 6oC	28	Days
pH	SS	NA	9040, 9045	2 oz.	Glass	None	0 - 6oC	15	Min
Phenols by 4AAP	SS	NA	9066	4 oz.	Glass	None	0 - 6oC	28	Days
Phosphate, Ortho	SS	SM4500P -E	NA	4 oz.	Glass	None	0 - 6oC	48	Hours
Phosphorus, Total	SS	NA	9056	4 oz.	Glass	None	0 - 6oC	28	Days
Residue, Total	SS	SM2540G	NA	4 oz.	Glass	None	0 - 6oC	14	Days
Solids, Total	SS	SM2540B	NA	4 oz.	Glass	None	0 - 6oC	14	Days
Specific	SS	NA	9050	4 oz.	Glass	None	0 - 6oC	28	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Conductance									
Sulfate	SS	NA	9056	4 oz.	Glass	None	0 - 6oC	28	Days
Sulfide	SS	NA	9030, 9034	2 oz.	Glass	none	0 - 6oC	7	Days
Total Organic Carbon (TOC)	SS	NA	9060	2 oz.	Glass	None	0 - 6oC	28	Days
Total Organic Carbon (TOC)	SS	ASTM F1647-02A mod	NA	4 oz.	Glass	None	0 - 6oC	28	Days
Total Organic Carbon (TOC)	SS	USDA LOI	NA	4 oz.	Glass	None	0 - 6oC	28	Days
Inorganic Metals									
Chromium, Hexavalent - Cr+6	NPW	SM3500C rB	7196	250ml	HDPE	None	0 - 6oC	24	Hours
Chromium, Hexavalent - Cr+6	NPW	SM3500C rC	7199	250ml	HDPE	None	0 - 6oC	24	Hours
Chromium, Hexavalent - Cr+6	NPW	218.6, SM3500C rC	NA	125ml	HDPE	(NH4)2SO4	0 - 6oC	28 5	Days
Mercury (Dissolved)	NPW	245.1	7470	500ml	HDPE	None	0 - 6oC	28	Days
Mercury (Total)	NPW	245.1	7470	500ml	HDPE	HNO3	0 - 6oC	28	Days
Metals (Dissolved) ICP	NPW	200.7	6010	500ml	HDPE	None	NA	180	Days
Metals (Dissolved) ICPMS	NPW	200.8	6020	500nl	HDPE	None	NA	180	Days
Metals (Total) ICP	NPW	200.7	6010	500ml	HDPE	HNO3	NA	180	Days
Metals (Total) ICPMS	NPW	200.8	6020	500ml	HDPE	HNO3	NA	180	Days
Chromium, Hexavalent - Cr+6	PW	218.7	NA	125ml	HDPE	(NH4)2SO4 /(NH4)OH	0 - 6oC	14	Days
Mercury (Dissolved)	PW	245.1	NA	500ml	HDPE	None	0 - 6oC	28	Days
Mercury	PW	245.1	NA	500ml	HDPE	HNO3	0 - 6oC	28	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
(Total)									
Metals (Dissolved) ICP	PW	200.7	NA	500ml	HDPE	None	NA	180	Days
Metals (Dissolved) ICPMS	PW	200.8	NA	500ml	HDPE	None	NA	180	Days
Metals (Total) ICP	PW	200.7	NA	500ml	HDPE	HNO3	NA	180	Days
Metals (Total) ICPMS	PW	200.8	NA	500ml	HDPE	HNO3	NA	180	Days
Chromium, Hexavalent - Cr+6	SS	NA	3060/7196	4 oz.	Glass	None	0 - 6oC	30	Days
Chromium, Hexavalent - Cr+6	SS	NA	3060/7199	4 oz.	Glass	None	0 - 6oC	30	Days
Mercury (Total)	SS	NA	7471	2 oz.	Glass	<6 C	0 - 6oC	28	Days
Metals (Total) ICP	SS	NA	6010	2 oz.	Glass	None	NA	180	Days
Metals (Total) ICPMS	SS	NA	6020	4 oz.	Glass	None	NA	180	Days
Sodium Adsorption Ratio (SAR)	SS	NA	6010	250mL	Glass	None	0 - 6oC	180	Days
Michigan Fine/Coarse Soil Sieve for Lead	SS	NA	NA	250mL	Glass	None	0 - 6oC	180	Days
Physical									
Flashpoint/ ignitability (Closed Cup)	NPW	ASTM 93-07	1010	1L	Glass	None	0 - 6oC	14	Days
Flashpoint/ ignitability (Open Cup)	NPW	ASTM 92-05A	NA	1L	Glass	None	0 - 6oC	14	Days
Flashpoint/ ignitability (Closed Cup)	SS	ASTM 93-07	1010	4 oz.	Glass	None	0 - 6oC	14	Days
Flashpoint/ ignitability (Open Cup)	SS	ASTM 92-05A	NA	4 oz.	Glass	None	0 - 6oC	NA	

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Ash Content	SS	SM2540G , ASTM D2974	NA	4 oz.	Glass	None	0 - 6oC	14	Days
Cation Exchange Capacity	SS	NA	9081	4 oz.	Glass	None	0 - 6oC	180	Days
Paint Filter Test	SS	NA	9095	4 oz.	Glass	None	0 - 6oC	NA	
Permeability (Section 2.8)	SS	NA	9100	Various	Shelby Tube	None	0 - 6oC	28	Days
React. Sulf.(SW846 7.3.4.2)	SS	NA	Sec. 7.3	4 oz.	Glass	None	0 - 6oC	7	Days
Reactive CN (SW846 7.3.4.1)	SS	NA	Sec. 7.3	4 oz.	Glass	None	0 - 6oC	14	Days
Resistivity (ASTM)	SS	NA	NA	16 oz	Glass	None	0 - 6oC	28	Days
Specific Gravity	SS	NA	NA	Various	Plastic	None	0 - 6oC	14	Days
Leaching Methods									
Cal Wet (CACR Title22 Chap11 AppII)	SS	NA	NA	100g	Glass	None	0 - 6oC	14/28/180	Days
EP TOX	SS	NA	1310	100g	Glass	None	0 - 6oC	14/28/180	Days
MEP	SS	NA	1320	100g	Glass	None	0 - 6oC	14/28/180	Days
SPLP	SS	NA	1312	100g	Glass	None	0 - 6oC	14/28/180	Days
TCLP	SS	NA	1311	100g	Glass	None	0 - 6oC	14/28/180	Days
Organics - Semivolatiles									
Base/Neutral/ Acid (BNA)	NPW	NA	8270	1L or 100mL	Amber Glass	None	0 - 6oC	7	Days
Base/Neutral/ Acid (BNA)	NPW	625, SM6410B	NA	1L or 100mL	Amber Glass	Na2S2O3	0 - 6oC	7	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Diesel Range Organics	NPW	NA	8015	1L, 100mL, or 40mL	Amber Glass	HCl	0 - 6oC	7	Days
Dioxin	NPW	1613	NA	1L	Amber Glass	Na2S2O3	0 - 6oC	1	Year
EDB/DBCP	NPW	NA	8011	2 x 40 ml	Glass	Na2S2O3	0 - 6oC	7	Days
Formaldehyde	NPW	NA	8315	1L	Amber Glass	None	0 - 6oC	3	Days
Herbicides	NPW	1658, SM6640B	8151	1L	Amber Glass	None	0 - 6oC	7	Days
Polynuclear Aromatic Hydrocarbons (PAH)	NPW	625, SM640B	8270	1L, 100mL, or 40mL	Amber Glass	None	0 - 6oC	7	Days
Polynuclear Aromatic Hydrocarbons (PAH-SIM)	NPW	NA	8270	1L, 100mL, or 40mL	Amber Glass	None	0 - 6oC	7	Days
Polynuclear Aromatic Hydrocarbons (PAH)	NPW	610, SM6440B	8310	1L	Amber Glass	None	0 - 6oC	7	Days
Pesticides - Organophos Comp	NPW	614, 622, 1657	8141	1L	Amber Glass	None	0 - 6oC	7	Days
Pesticides & PCB's	NPW	608, SM6630B , SM6630C	8081, 8082	1L or 100mL	Amber Glass	None	0 - 6oC	7	Days
Base/Neutral/ Acid (BNA)	PW	525	NA	1L	Amber Glass	HCl + Na2S2O3	0 - 6oC	7	Days
Carbamates	PW	531.1	NA	2 x 60ml	Amber Glass	AcAcid + Na2S2O3	0 - 6oC	7	Days
Dioxin	PW	1613	NA	1L	Amber Glass	Na2S2O3	0 - 6oC	7	Days
Diquat	PW	549	NA	1L	PVC Amber	H2SO4 + Na2S2O3	0 - 6oC	7	Days
EDB/DBCP	PW	504.1	NA	2 x 40 ml	Glass	Na2S2O3	0 - 6oC	28	Days
Endothall	PW	548	NA	250ml	Amber Glass	Na2S2O3	0 - 6oC	7	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Glyphosate	PW	547	NA	2 x 60ml	Glass	Na2S2O3	0 - 6oC	7	Days
Herbicides	PW	515.1, SM6640B	NA	1L	Amber Glass	Na2S2O3	0 - 6oC	7	Days
Pesticides - Nitrogen/phosphorus Comp	PW	507	NA	1L	Amber Glass	Na2S2O3	0 - 6oC	14	Days
Pesticides - Organochlorine	PW	508	NA	1L	Amber Glass	Na2S2O3	0 - 6oC	7	Days
Haloacetic acids - HAAs	PW	552.2	NA	500ml	Amber Glass	NH4Cl	0 - 6oC	28	Days
Base/Neutral/ Acid (BNA)	SS	NA	8270	4 oz.	Glass	None	0 - 6oC	14	Days
Dioxin	SS	NA	8290	5 oz.	Glass	None	0 - 6oC	30	Days
Formaldehyde	SS	NA	8315	4 oz.	Glass	None	0 - 6oC	3	Days
Herbicides	SS	NA	8151	4 oz.	Glass	None	0 - 6oC	14	Days
Polynuclear Aromatic Hydrocarbons (PAH)	SS	NA	8270	4 oz.	Glass	None	0 - 6oC	14	Days
Polynuclear Aromatic Hydrocarbons (PAH-SIM)	SS	NA	8270	4 oz.	Glass	None	0 - 6oC	14	Days
Polynuclear Aromatic Hydrocarbons (PAH)	SS	NA	8310	4 oz.	Glass	None	0 - 6oC	14	Days
Pesticides - Organophos Comp	SS	NA	8141	4 oz.	Glass	None	0 - 6oC	14	Days
Pesticides & PCBs	SS	NA	8081, 8082	4 oz.	Glass	None	0 - 6oC	14	Days
Total Chlorine in Oil	SS	ASTM D808-00	NA	125ml	HDPE	None	0 - 6oC	24	Hours
Organic - Volatiles									
Meetac - Methanol and Ethanol	NPW	NA	EPA 8015 Mod	40ml	Amber Glass	HCl	0 - 6oC	14	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Methane, Ethane, Ethene, Propane	NPW	RSK-175	NA	40ml	Amber Glass	HCl	0 - 6oC	14	Days
BTEX (water)	NPW	602, SM6200C	8021	2 x 40 ml	Amber Glass	HCl	0 - 6oC	14	Days
BTEX (water)	NPW	602, SM6200C	8021	2 x 40 ml	Amber Glass	None	0 - 6oC	7	Days
Gasoline Range Organics (GRO)	NPW	NA	8015	2 x 40 ml	Amber Glass	HCl	0 - 6oC	14	Days
VOCs	NPW	624, SM6200B	8260	2 x 40 ml	Amber Glass	HCl	0 - 6oC	14	Days
VOCs	NPW	624, SM6200B	8260	2 x 40 ml	Amber Glass	none	0 - 6oC	7	Days
VOCs	PW	524.2	NA	2 x 40 ml	Amber Glass	Ascorbic Acid+HCl	0 - 6oC	14	Days
Meetac - Methanol and Ethanol	SS	NA	EPA 8015 Mod	2 oz.	Glass	None	0 - 6oC	14	Days
BTEX (soil)	SS	NA	8021	4 oz.	Glass	None	0 - 6oC	14	Days
VOCs	SS	NA	8260	2 oz.	Glass	none	0 - 6oC	14	Days
VOCs	SS	NA	8260	40ml	Amber Glass	MeOH	0 - 6oC	14	Days
VOCs	SS	NA	8260	40ml	Amber Glass	NaHSO4 or TSP(MO) or DI Water(FL)	0 - 6oC	14	Days
VOCs	SS	NA	8260	NA	Encore	none	0 - 6oC	48	Hours
Radiochemistry									
Gross alpha	NPW	900	na	1L	Plastic	HNO3	0 - 6oC	180	Days
Gross beta	NPW	900	na	1L	Plastic	HNO3	0 - 6oC	180	Days
Radium 226	NPW	903.1	na	1L	Plastic	HNO3	0 - 6oC	180	Days
Radium 228	NPW	904	na	1L	Plastic	HNO3	0 - 6oC	180	Days
Gross alpha	PW	900	na	1L	HDPE	HNO3	0 - 6oC	180	Days
Gross beta	PW	900	na	1L	HDPE	HNO3	0 - 6oC	180	Days
Radium 226	PW	903.1	na	1L	HDPE	HNO3	0 - 6oC	180	Days
Radium 228	PW	904	na	1L	HDPE	HNO3	0 - 6oC	180	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Tritium	PW	906	na	1L	HDPE	None	0 - 6oC	180	Days
Strontium-90	PW	905	na	1L	HDPE	HNO3	0 - 6oC	180	Days
State Specific Petroleum Methods									
Alaska DRO	NPW	NA	AK102	100ml	Amber Glass	HCl	0 - 6oC	14	Days
Alaska DRO	SS	NA	AK102	4 oz.	Glass	None	0 - 6oC	14	Days
Alaska GRO	NPW	NA	AK101	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Alaska GRO	SS	NA	AK101	60ml	Amber Glass	MeOH	0 - 6oC	28	Days
Alaska Motor Oil	NPW	NA	AK103	100ml	Glass	HCl	0 - 6oC	14	Days
Alaska Motor Oil	SS	NA	AK103	4 oz.	Glass	None	0 - 6oC	14	Days
Arizona GRO	SS	NA	AZ 8015	2 oz.	Glass	None	0 - 6oC	14 9	Days
Arizona TPH	SS	NA	AZ 8015	4 oz.	Glass	None	0 - 6oC	14	Days
California DRO	NPW	NA	8015	1L	Amber Glass	HCl	0 - 6oC	7	Days
California DRO	NPW	NA	8015	40ml	Amber Glass	HCl	0 - 6oC	7	Days
California DRO	SS	NA	8015	4 oz.	Glass	None	0 - 6oC	7	Days
Connecticut EPH	NPW	NA	8015	1L	Amber Glass	HCl	0 - 6oC	14	Days
Connecticut EPH	SS	NA	8015	4 oz.	Glass	None	0 - 6oC	14	Days
Florida TPH	NPW	NA	FL-Pro	1L	Amber Glass	HCl	0 - 6oC	7	Days
Florida TPH	SS	NA	FL-Pro	4 oz.	Glass	None	0 - 6oC	14	Days
Indiana DRO	NPW	NA	8015	1L	Amber Glass	HCl	0 - 6oC	7	Days
Indiana DRO	SS	NA	8015	4 oz.	Glass	None	0 - 6oC	14	Days
Indiana ERO	NPW	NA	8015	1L	Amber Glass	HCl	0 - 6oC	7	Days
Indiana ERO	SS	NA	8015	4 oz.	Glass	None	0 - 6oC	7	Days
Indiana GRO	NPW	NA	8015	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Indiana GRO	SS	NA	8015	40ml	Amber Glass	MeOH	0 - 6oC	14	Days
Indiana GRO	SS	NA	8015	40ml	Amber Glass	NaHSO4	0 - 6oC	14	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Iowa GRO	NPW	NA	OA-1	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Iowa GRO	SS	NA	OA-1	4 oz.	Glass	None	0 - 6oC	14	Days
Iowa DRO	NPW	NA	OA-2	1L	Amber Glass	None	0 - 6oC	7	Days
Iowa DRO	SS	NA	OA-2	4 oz.	Glass	None	0 - 6oC	14	Days
Louisiana EPH	NPW	NA	MADEP EPH	1L	Amber Glass	HCl	0 - 6oC	14	Days
Louisiana EPH	SS	NA	MADEP EPH	4 oz.	Amber Glass	None	0 - 6oC	14	Days
Louisiana VPH	NPW	NA	MADEP VPH	1L	Amber Glass	HCl	0 - 6oC	14	Days
Louisiana VPH	SS	NA	MADEP VPH	40ml	Amber Glass	MeOH	0 - 6oC	28	Days
Massachusetts EPH	NPW	NA	MADEP EPH	1L	Amber Glass	HCl	0 - 6oC	14	Days
Massachusetts EPH	SS	NA	MADEP EPH	4 oz.	Amber Glass	None	0 - 6oC	14	Days
Massachusetts VPH	NPW	NA	MADEP VPH	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Massachusetts VPH	SS	NA	MADEP VPH	40ml	Amber Glass	MeOH	0 - 6oC	28	Days
Minnesota DRO	NPW	NA	WI DRO	1L	Amber Glass	HCl	0 - 6oC	7	Days
Minnesota DRO	SS	NA	WI DRO	60ml	Amber Glass	CH3Cl	0 - 6oC	47 9	Days
Minnesota GRO	NPW	NA	WI GRO	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Minnesota GRO	SS	NA	WI GRO	60ml	Amber Glass	MeOH	0 - 6oC	21 7	Days
Missouri DRO	NPW	NA	8270	1L	Amber Glass	None	0 - 6oC	7	Days
Missouri DRO	SS	NA	8270	4 oz.	Glass	None	0 - 6oC	14	Days
Missouri GRO	NPW	NA	8260	40ml	Amber Glass	TSP	0 - 6oC	14	Days
Missouri GRO	SS	NA	8260	40ml	Amber Glass	TSP	0 - 6oC	14	Days
Missouri GRO	SS	NA	8260	40ml	Amber Glass	MeOH	0 - 6oC	14	Days
Montana EPH	NPW	NA	MT EPH	1L	Amber Glass	HCl	0 - 6oC	14	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Montana EPH	SS	NA	MT EPH	4 oz.	Amber Glass	None	0 - 6oC	14	Days
Montana VPH	NPW	NA	MT VPH	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Montana VPH	SS	NA	MT VPH	Encore	Amber Glass	None	0 - 6oC	7	Days
Montana VPH	SS	NA	MT VPH	40ml	Amber Glass	MeOH	0 - 6oC	28	Days
New Jersey EPH	NPW	NA	NJ EPH	1L	Amber Glass	HCl	0 - 6oC	14	Days
New Jersey EPH	SS	NA	NJ EPH	4 oz.	Amber Glass	None	0 - 6oC	14	Days
North Carolina EPH	NPW	NA	MADEP EPH	1L	Amber Glass	HCl	0 - 6oC	14	Days
North Carolina EPH	SS	NA	MADEP EPH	4 oz.	Amber Glass	None	0 - 6oC	14	Days
North Carolina VPH	NPW	NA	MADEP VPH	1L	Amber Glass	HCl	0 - 6oC	14	Days
North Carolina VPH	SS	NA	MADEP VPH	40ml	Amber Glass	MeOH	0 - 6oC	28	Days
Ohio DRO	NPW	NA	8015	1L	Amber Glass	None	0 - 6oC	7	Days
Ohio DRO	NPW	NA	8015	100ml	Amber Glass	None	0 - 6oC	7	Days
Ohio DRO	NPW	NA	8015	40ml	Amber Glass	None	0 - 6oC	7	Days
Ohio DRO	SS	NA	8015	4 oz.	Glass	None	0 - 6oC	14	Days
Ohio GRO	NPW	NA	8015	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Ohio GRO	SS	NA	8015	2 oz.	Glass	None	0 - 6oC	14	Days
Ohio GRO (VAP)	SS	NA	8015	Encore - Low Level	None	None	0 - 6oC	14 8	Days
Ohio GRO (VAP)	SS	NA	8015	Encore - High Level	None	MeOH	0 - 6oC	14	Days
Oklahoma DEQ GRO	NPW	NA	OK DEQ GRO	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Oklahoma DEQ GRO	SS	NA	OK DEQ GRO	4 oz.	Glass	None	0 - 6oC	14	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Oklahoma DEQ DRO	NPW	NA	OK DEQ DRO	1L	Amber Glass	HCl	0 - 6oC	7	Days
Oklahoma DEQ DRO	SS	NA	OK DEQ DRO	60ml	Amber Glass	CH3Cl	0 - 6oC	7 6	Days
Oregon TPH-Gx	NPW	NA	NWTP H-Gx	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Oregon TPH-Gx	SS	NA	NWTP H-Gx	4 oz.	Glass	None	0 - 6oC	14	Days
Oregon TPH-Dx	NPW	NA	NWTP H-Dx	1L	Amber Glass	HCl	0 - 6oC	14	Days
Oregon TPH-Dx	SS	NA	NWTP H-Dx	4 oz.	Glass	None	0 - 6oC	14	Days
Tenneessee DRO	NPW	NA	TN EPH	1L	Amber Glass	HCl	0 - 6oC	7	Days
Tenneessee DRO	NPW	NA	TN EPH	100 ml	Amber Glass	HCl	0 - 6oC	7	Days
Tenneessee DRO	SS	NA	TN EPH	4 oz.	Glass	None	0 - 6oC	14	Days
Tenneessee GRO	NPW	NA	TN GRO	40ml	Amber Glass	HCl	0 - 6oC	7	Days
Tenneessee GRO	SS	NA	TN GRO	2 oz.	Glass	None	0 - 6oC	14	Days
Texas TPH	NPW	NA	TX1005 /TX100 6	60ml	Amber Glass	HCl	0 - 6oC	14	Days
Texas TPH	SS	NA	TX1005 /TX100 6	4 oz.	Glass	None	0 - 6oC	14	Days
Washington TPH-Gx	NPW	NA	NWTP H-Gx	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Washington TPH-Gx	SS	NA	NWTP H-Gx	4 oz.	Glass	None	0 - 6oC	14	Days
Washington TPH-Dx	NPW	NA	NWTP H-Dx	1L	Amber Glass	HCl	0 - 6oC	14	Days
Washington TPH-Dx	SS	NA	NWTP H-Dx	4 oz.	Glass	None	0 - 6oC	14	Days
Wisconsin DRO	NPW	NA	WI DRO	1L	Amber Glass	HCl	0 - 6oC	7	Days
Wisconsin DRO	NPW	NA	WI DRO	100 ml	Amber Glass	HCl	0 - 6oC	7	Days
Wisconsin DRO	SS	NA	WI DRO	60ml	Amber Glass	CH3Cl	0 - 6oC	47 9	Days

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Wisconsin GRO	NPW	NA	WI GRO	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Wisconsin GRO	SS	NA	WI GRO	60ml	Amber Glass	MeOH	0 - 6oC	21 7	Days
Wyoming DRO	NPW	NA	8015	40ml	Amber Glass	HCl	0 - 6oC	7	Days
Wyoming DRO	NPW	NA	8015	1L	Amber Glass	HCl	0 - 6oC	7	Days
Wyoming DRO	SS	NA	8015	4 oz.	Glass	None	0 - 6oC	14	Days
Wyoming GRO	NPW	NA	8015	40ml	Amber Glass	HCl	0 - 6oC	14	Days
Wyoming GRO	SS	NA	8015	2 oz.	Glass	None	0 - 6oC	14	Days
Industry Hygiene (IH) Methods									
Particulates not otherwise regulated	Air	NIOSH 0500	NA	NA	2 piece 37mm PVC Pre-weighed filter	None	NA	NA	NA
Respirable Dust	Air	NIOSH 0600	NA	NA	3 piece 37mm PVC Pre-weighed filter	None	NA	NA	NA
Formaldehyde	Air	NIOSH 3500	NA	NA	PTFE Filter with 2 Impinger aliquots	None	0 - 6oC	28	Days
1,3-Butadiene	Air	NIOSH 1024	NA	NA	Sorbent Tube	Frozen	Frozen	NA	NA
Aromatic Hydrocarbons	Air	NIOSH 1501	NA	NA	Sorbent Tube	None	NA	NA	NA
Total Hydrocarbons	Air	NIOSH 1550	NA	NA	Sorbent Tube	None	NA	NA	NA
1,3-Butadiene	Air	OSHA 56	NA	NA	Sorbent Tube	None	NA	NA	NA
1,3-Butadiene	Air	NIOSH 1024	NA	NA	Diffusive Samplers	Frozen	Frozen	NA	NA

Parameter	Matrix 1	EPA Approved Method2	SW846 Method 3	Rec Vol	Bottle Type	Preserv 4	Temp	Holding Time	Holding Time Units
Aromatic Hydrocarbons	Air	NIOSH 1501	NA	NA	Diffusive Samplers	None	NA	NA	NA
Total Hydrocarbons	Air	NIOSH 1550	NA	NA	Diffusive Samplers	None	NA	NA	NA
1,3-Butadiene	Air	OSHA 56	NA	NA	Diffusive Samplers	None	NA	NA	NA
Metals	Air	NA	EPA 6010B	NA	0.8-µm MCE or 5.0-µm PVC cassette	None	NA	NA	NA
Metals	Air	NIOSH 7300	NA	NA	0.8-µm MCE or 5.0-µm PVC cassette	None	NA	NA	NA
Metals	Air	OSHA ID-125G	NA	NA	0.8-µm MCE or 5.0-µm PVC cassette	None	NA	NA	NA
Hexavalent Chromium	Air	NIOSH 7604	NA	NA	5.0-µm PVC cassette	None	NA	NA	NA
Hexavalent Chromium	Air	OSHA ID-215	NA	NA	5.0-µm PVC cassette	None	NA	NA	NA

Footnotes:

1) Matrix - NPW=Nonpotable Water, PW= Potable Water, SS=Solids

2) EPA Approved Method - Where applicable EPA methods are listed. Compounds/programs not regulated by EPA will have methods appropriate to their regulatory oversight.

3) SW846 Method - Where one exists, the appropriate Solid Waste method will be listed

4) Preservative Key

$(NH_4)_2SO_4$ = Ammonium Sulfate
AcAcid = Acetic Acid
CH_3Cl = Methylene Chloride
H_2SO_4 = Sulfuric Acid
HCl= Hydrochloric Acid
HNO_3 = Nitric Acid
MeOH = Methanol
$Na_2S_2O_3$ = Sodium Thiosulfate

NaHSO4 = Sodium Bisulfate
NH4Cl = Ammonium Chloride
TSP = Trisodium Phosphate
ZnAc = Zinc Acetate

5) Must be field filtered to achieve the extended holding time.
6) Must be received by lab within 7 days of sampling for solvent addition.
7) Must be received by lab within 4 days of sampling for solvent addition.
8) Must be received by lab within 48 hours of sampling for freezing.
9) Must be received by lab within 72 hours of sampling for solvent addition.

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

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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
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Prepared by

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3.0 SCOPE AND APPLICATION

This manual discusses specific Regulatory Affairs 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, including guidance and materials, 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 12.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kenneth W. Buckley, with a B.S. degree in General Science, is the Laboratory Operations Manager. Mr. Buckley reviews and approves all data reduction associated with analyses in this area and is responsible for the overall production of these laboratories; including the management of the staff and scheduling. Mr. Buckley has over 13 years of environmental laboratory experience.

In his absence, Chad Pfalmer assumes responsibility for departmental decisions in the Wet Lab. Mr. Pfalmer with a B.S. degree in Chemistry is the Primary Analyst for the Wet Lab. Mr. Pfalmer is proficient in wet chemistry analytical methods and is responsible for sample analysis, review and approval of all data associated with Wet Lab analyses.

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. 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 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 1	m26291	Wet Lab
Analytical Balance	Mettler	AG204 Delta Range	Balance 2	118420883	Wet Lab
Analytical Balance	Mettler	XP205	Balance 3	1129420141	Wet Lab
Autoanalyzer	Lachat	Quikchem 8000	Lachat 2	A83000-1027	Wet Lab
Autoanalyzer	Lachat	Quikchem 8000	Lachat 3	A83000-1638	Wet Lab
Autoanalyzer	Lachat	Quikchem 8500	Lachat 4	60900000341	Wet Lab
Autoanalyzer	Lachat	Quikchem 8500	Lachat 5	60900000342	Wet Lab
Autoanalyzer	Lachat	Quikchem 8500	Lachat 6	70500000452	Wet Lab
Autoanalyzer - digestor	Lachat	BD-46	DIG1	100700000-982	Wet Lab
Autoanalyzer - digestor	Lachat	BD-46	DIG2	1000700000-982	Wet Lab
Autoanalyzer - digestor	Lachat	BD-46	DIG1	1800-871	Wet Lab
Autoanalyzer - digestor	Lachat	BD-46	DIG2	1800-872	Wet Lab
Automated distiller	Skalar	SAN++ system	Kelada 1	9719	Wet Lab
Automated titrator	Metrohm	855 titrosampler	Titrando	3256	Wet Lab
Centrifuge	Thermo	Megafuge 40	Centrifuge	41123868	Wet Lab
Class “I” weights	Troemner	Serial #7944		7944	Wet Lab
COD Reactor	HACH	45600	COD1	10800	Wet Lab
COD Reactor	HACH	45600	COD2	10090C0036	Wet Lab
Conductivity Meter	ORION	MODEL 170	ATI Orion	32470007	Wet Lab
Distillation Unit - Cyanide	Environmental Express	Distillation 1	LMD1920-106	2270	Wet Lab
Distillation Unit - Cyanide	Environmental Express	Distillation 2	LMD1920-106	2271	Wet Lab
Distillation Unit - Cyanide	Environmental Express	Distillation 3	LMD1920-106	2272	Wet Lab
Distillation Unit - Phenol	Westco Scientific	Model EASY-DIST	Dist 1	1062	Wet Lab
Distillation Unit - Phenol	Westco Scientific	Model EASY-DIST	Dist 2	1198	Wet Lab
Flash Point Tester	Koehler	Pensky-Martens K16200	Manual	R07002693B	Wet Lab

LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Wet Lab

This table is subject to revision without notice

Item	*Manufacturer*	*Model*	*Instrument Name*	*Serial #*	*Location*
Flash Point Tester	Koehler	Pensky-Martens K16201	Manual	R07002510B	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	ICS-2000	IC5	6050731	Wet Lab
Ion Chromatograph	Metrohm	850 Professional	IC2	1850000003190	Wet Lab
Ion Chromatograph	Dionex	ICS 1500	IC6	8100010	Wet Lab
Ion Chromatograph	Dionex	ICS 1500	IC7	8100267	Wet Lab
Ion Chromatograph	Dionex	ICS 2000	IC8	8090820	Wet Lab
Ion Chromatograph	Dionex	ICS 2100	IC9	10060822	Wet Lab
Ion Chromatograph	Dionex	ICS 2100	IC10	10091285	Wet Lab
Ion Chromatograph	Dionex	ICS 2100	IC11	11012204	Wet Lab
Ion Chromatograph	Dionex	ICS 2100	IC12	12020460	Wet Lab
Ion Chromatograph	Thermo Fisher	ICS 1600	IC13	13031204	Wet Lab
Muffle Furnace	Thermolyne	(1) 30400	FURNACE	23231	Wet Lab
Autoanalyzer	OI Analytical	FS 3100	FS 3100-1	301831056 (NH3) 251833391 (CN)	Wet Lab
Autoanalyzer	OI Analytical	FS 3100	FS 3100-2	3168140781(NH3) 325833494 (CN)	Wet Lab
Autoanalyzer	OI Analytical	FS 3100	FS 3100-3	407831164 (NO2NO3) 403833925 (PHT)	Wet Lab
ORP Meter	YSI	ORP15	ORP	JC000114	Wet Lab
Oven - Drying	Blue M	Stabil-Therm	#1	NA	Wet Lab
Oven - Drying	Equatherm	D1576	#2	NA	Wet Lab
Oven - Drying	VWR	1305U	#3	4082804	Wet Lab
Oven - Drying	Equatherm	D1576	#4	10AW-3	Wet Lab
Oven - Drying	VWR	1305U	#5	4082104	Wet Lab
pH Meter	Fisher	AB15	AB15+	AB92329028	Wet Lab
pH Meter	Orion	410A	Orion	58074	Wet Lab
pH Meter	Fisher	AB15	AB15+	AB92325899	Wet Lab
pH Meter	Thermo Fisher	Orion Versa Star	Orion VS-1	V00659	Wet Lab
Refrigerated Recirculator	Polyscience	Recirculator	Recirculator1	1282	Wet Lab
Refrigerated Recirculator	Polyscience	Recirculator	Recirculator2	1608	Wet Lab
Spectrophotometer (UV/Vis)	Hach	DR 5000	DR5000-1	1381711	Wet Lab

LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Wet Lab ***This table is subject to revision without notice***					
Item	***Manufacturer***	***Model***	***Instrument Name***	***Serial #***	***Location***
Spectrophotometer (UV/Vis)	Hach	DR 5000	DR5000-2	1326829	Wet Lab
Total Organic Carbon Analyzer	Shimadzu	Model TOC-VWS	TOC2	39830572	Wet Lab
Total Organic Carbon Analyzer	Shimadzu	TOC-VCPH	TOC3	H51304435	Wet Lab
Total Organic Carbon Analyzer	OI-Analytical	Aurora 1030	TOC4	E141788082	Wet Lab
Total Organic Halogen Analyzer	Mitsubishi	TOX-100	TOX2	1035	Wet Lab
Total Organic Halogen Analyzer	Mitsubishi	AOX-200	AOX1	E7B00107	Wet Lab
Turbidimeter	Hach	2100N	Turbidimeter1	941100000903	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
Ion Chromatograph	•Replace guard and analytical columns	As needed
Ion Chromatograph	•Replace the end-line filter (P/N 045987)	As needed

INSTRUMENT	*P. M. DESCRIPTION*	*FREQUENCY*
Ion Chromatograph	• Replace the pump piston rinse seals and piston seals	Every 6 months or as needed
Ion Chromatograph	•Replace the sampling tip and the tubing between the tip and the injection valve.	As needed
Ion Chromatograph	•Replace lines throughout the instrument	As needed
Ion Chromatograph	•Perform Preventive Maintenance using PM kit (P/N 057954)	Annual

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

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
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.
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
pH Meter	Commercial Source	pH 1.0 Buffer	Room temp.	No prep required	NA	Annual/Expiration Date
pH Meter	Commercial Source	pH 13.0 Buffer	Room temp.	No prep required	NA	Annual/Expiration

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.
Bromide IC	Range –1.0, 5.0, 10, 50, 100, mg/L

TABLE 8.3B: WORKING STANDARD CALIBRATION	
Analysis	**Calibration Standard**
Chloride IC	Range –1.0, 5.0, 10, 50, 100, mg/L1
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, 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, 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, mg/L
Nitrogen-Nitrite – IC	Range –0.10, 0.50, 1.0, 5.0, 10.0, 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

<u>Total Organic Carbon Analyzer (TOC) – SOP Number 340356A</u>

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 recover 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 recover 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 recover within 10% of the expected value for each analyte, except during the analysis of groundwater and soil using EPA Method 9056 that must 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 recover within 10% 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, ammonia, total phosphorus, NO2NO3 and TKN 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, and 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 recover 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 Continuing	5 (buffers) 1 reference buffer 1 buffer (may be any certified buffer)	Log.	Third pH of a different value buffer must read within 0.05 units of true value Buffer solution must read within 0.05 units of true value	Daily as used Every 10th sample; Field**
Conductivity Meter*	Initial Continuing	1 1	1 point	Calculation of cell constant between 0.95 - 1.05 Must be within 5% of true value	Daily as used Every 10th sample; Field**
Turbidimeter *	Initial Continuing	5 1 reference of different value, 1 (high-level)	Linear	Formazin-confirmed Gelex standards in appropriate range. Check with second standard must be within 5% Must be within 5% of true value	Daily as used Every 10th sample; Field**
UV/VIS Spec.	Initial Continuing	At least 5 standards calibration standards 2 laboratory control standard 1 mid-level reference std.	Linear	Calibration Curve must have a correlation of 0.995 or better Must be within ± 15% of the calibration curve. Must be within 90 – 110%	Daily as used Daily as used Every 10th sample

Instrument (Analysis)	Calibration Type	Number of Standards	Type of Curve	Acceptance/Rejection Criteria	Frequency
Total Organic Halogen Analyzer	Initial	3 calibration standards	Linear	Calibration Curve must have a correlation of 0.995 or better	Daily as used
		1 laboratory control standard		Laboratory control standard must agree within ± 15% of calibration curve	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	Linear	Calibration Curve must have a correlation of 0.995 or better	Every 6 months or as needed
		2 laboratory control standard		Laboratory control standard must agree within ± 15% of calibration curve	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 SOPs associated with the Wet Lab can be found in the following table:

TABLE 10.1: WET LAB DEPARTMENT SOPs
This table is subject to revision without notice

SOP #	Title
340300	Acidity (SM 2310B)
340301	Alkalinity (Titrimetric)
340302A	Alkalinity - Lachat
340305	Chlorine, Total Residual DPD- 330.5 SM4500-CL-G
340306	Corrosivity, 9040B, 9045C
340307A	Cyanide- All Forms (Colorimetric Automated UV) - Lachat
340307C	Cyanide- OI Method
340309	Chemical Oxygen Demand
340310	Color by Visual Comparison (SM2120B, EPA 110.2)
340313	Density (Specific Gravity)
340317B	Total Hardness (mg/l as CaCO3) - (Titrando)
340317	Total Hardness (mg/l as CaCO3) - (Titrimetric)
340317A	Total Hardness by Lachat Method 130.1
340318B	Hexavalent Chromium (Colorimetric) Water 7196A
340318C	Hexavalent Chromium (Colorimetric) Soil 3060A/7196A
340319	Ion Chromatography - Anions by 300.0, 300.1, SM 4110B and 9056/9056A
340325	MBAS (Methylene Blue Active Substances)

SOP #	Title
340327B	Ammonia, Phenolate (OI)
340327A	Ammonia, Phenolate (Lachat)
340328	Organic Nitrogen
340331	Threshold Odor Test
340333	Nitrate/Nitrite (Lachat Autoanalyzer)
340334	Paint Filter Test
340335	pH
340336A	Phenol - 4AAP (Lachat Autoanalyzer)
340338B	Orthophosphate (365.2,4500P-E) Colorimetric
340338A	Total Phos.(361.2,4500P-B/F) Colorimetric
340338C	Total Phos GW/WW (365.4) Colorimetric
340339	Reactivity
340340	Reactive Cyanide/Sulfide Distillation
340341	Percent Sulfur in Petroleum Products (ASTM D129-00)
340342	Specific Conductance
340344B	Sulfide Acid-soluble,and acid-insoluble Method 9034
340344A	Sulfide (Colorimetric Methylene Blue)
340345	Sulfite (377.1)
340346	Settleable Solids
340347	Total Dissolved Solids
340348	Total Suspended Solids (Non-Filterable Residue)
340349	Total Solids/Percent Moisture
340350	Total Volatile Solids
340352A	Total Kjeldahl Nitrogen
340354	Turbidity
340356B	TOC for Drinking Water only
340356A	Total Organic Carbon (TOC) and Total Inorganic Carbon (TIC) using Shimadzu 5000A for GW and WW
340356C	Total Organic Carbon In Soils (loss of weight on ignit.
340357	Ignitability
340359	UV254
340360	TOX (total organic halides)
340361	Ferrous Iron, SM-3500-Fe-B
340362	Heat of Combustion
340365	Particles Not Otherwise Regulated, Total (PNOR) NIOSH 0500
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 (ASTM D808-00)
340372A	Hexavalent Chromium in Water by IC (218.7/SM 3500Cr)
340372	Hexavalent Chromium in Soil by IC (3060A/7199)
340373	Organic Matter (FOM) and Fractional Organic Carbon (FOC)
340374	Total Volatile Dissolved Solids (TVDS)

SOP #	Title
340375	Hexavalent Chromium in Air by IC
340376	Total Organic Halides in Oil (EPA 9076)
340377	Manual Nitrocellulose Analysis
340378	Volatile Suspended Solids
340379	Guanidine Nitrate by IC
340381	Ash in Petroleum Products (ASTM D482-07)

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 (PTs) in support of various laboratory accreditations/recognitions. Environmental samples are purchased from Phenova. The WS, WP and solid matrix studies are completed every 6 months.

11.2 Initial Demonstrations of Capability (IDOCs) are performed during new analyst training and/or prior to acceptance and use of any new method/instrumentation. Continuing Demonstration of Capability (CDOCs) 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	$\frac{\text{mL titrant x normality titrant x 50,000}}{\text{mL sample}}$
BOD, 5-day	$\frac{\text{Initial D.O. - Final D.O. - CF}}{\text{\% Dilution Sample}}$ *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	$\frac{\text{µg from standard curve x mL total volume absorbing solution}}{\text{mL volume sample x mL volume of absorbing solution colored}}$ *Calculated by software as provided by Lachat Corp.*
Solids, Total and Total Dissolved	$\frac{\text{((mg wt of dried residue + dish) - mg wt of dish) x 1000}}{\text{mL sample}}$
Solids, Total Suspended	$\frac{\text{((mg wt of dried residue + filter) - mg wt of filter) x 1000}}{\text{mL sample}}$

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 ± 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 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 RLs
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	–90-110	<20	100
Ammonia	350.1 (mod.)	s	Certified Values	<20	500
Ash	ASTM D482-07	s	90-110	<20	n/a
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 CU
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	w/s	±3 degrees C	<20	n/a
Methylene Blue Active Substances	5540C SM20th	w	85 - 115	<20	100

Table 12.3: QC Targets for Wet Lab Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Analyte	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppb)
Nitrate-Nitrite	300	w	90 - 110	<20	100
Nitrate-Nitrite	SM 4110B	w	85 - 115	<20	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	<20	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	w/s	n/a	<20	n/a
pH	SM 4500-H, 9040B	w	n/a	<1	n/a
pH	9045C	s	n/a	<1	n/a
Phosphate (ortho)	SM 4500-P	w	85 - 115	<20	25
Phosphorous/Total	365.4, SM 4500-P	w	90-110	<20	100
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	–90-110	<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

Table 12.3: QC Targets for Wet Lab Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Analyte	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppb)
EOX	9023	s	85 - 115	<20	20000
Total Phenol	420.2	w	85 - 115	<20	50
Total Phenol	9066	w/s	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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs Department will be consulted for further action.

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103, *Document Control and Distribution*, SOP #030230, *Standards Logger, SOP #030227, Data Review* 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 12*.0.

1.0 SIGNATORY APPROVALS

Metals Department
QUALITY ASSURANCE MANUAL

APPENDIX V TO THE ESC
QUALITY ASSURANCE MANUAL

for

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

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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 12.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kenneth W. Buckley, with a B.S. degree in General Science, is the Laboratory Operations Manager. 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 13 years of environmental laboratory experience.

In his absence, Andrew Holt assumes responsibility for departmental decisions in the Metals Lab. Mr. Holt with a B.S. degree in Plant and Soil Science is proficient in metals analytical methods and is responsible for sample analysis, review and approval of all data associated with Metals Lab analyses.

5.2 TRAINING

Senior Analysts or the Manager train 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 $4 \pm 2^{o}C$ 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	Trobal	AGN100		1	701001026	Metals Prep Lab
Balance - Top Loading	Mettler Toledo	PB3002-5		1	1119070828	Metals Prep Lab
Balance - Top Loading	Mettler Toledo	PB3002-5		1	71242213216	Mercury Lab
Balance - Top Loading	Mettler Toledo	PB3002-5		1	1121462199	Metals Prep Lab
Hot Block	Env. Express	SC154	C	1	3994CEC1880	Metals Prep Lab
ICPMS with autosampler	Perkin Elmer	ELAN DRC-e ASX-520	ICPMS4	1	AH13650804	Metals Lab
ICPMS with autosampler	Perkin Elmer	ELAN DRC-e ASX-520	ICPMS3	1	AH00110504H	Metals Lab
ICPMS with autosampler	Perkin Elmer	ELAN 9000 ASX-520	ICPMS5	1	AJ12270805	Metals Lab
ICPMS with autosampler	Perkin Elmer	ELAN DRC II ASX-520	ICPMS6	1	AI13820805H	Metals Lab
ICP - Simultaneous with autosampler	Perkin Elmer	Optima 8300DV ASX-520	ICP9	1	078N2042101	Metals Lab
ICP - Simultaneous with autosampler	Perkin Elmer	Optima 8300DV ASX-520	ICP10	1	078S1310044	Metals Lab
ICP - Simultaneous with autosampler	Perkin Elmer	Optima 8300DV ASX-520	ICP11	1	078S1402113	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-520	ICP7	1	077C6110602	Metals Lab
ICP - Simultaneous with autosampler	Perkin Elmer	Optima 7300	ICP8	1	077C0111203	Metals Lab
Hot Block	CPI	Mod Block	HGA	1	004412	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***
Hot Block	CPI	Mod Block	HGB	1	604443	Mercury Lab
Hot Block	CPI	Mod Block	MPA	1	4430	Metals Prep Lab
Hot Block	CPI	Mod Block	MPB	1	4434	Metals Prep Lab
Mercury Auto Analyzer	Perkin Elmer	(1) FIMS 400	I	1	4545	Mercury Lab
Mercury Auto Analyzer	Perkin Elmer	(1) FIMS 100	III	1	110156051101	Mercury Lab
Mercury Auto Sampler	Perkin Elmer	(1) AS-91, (1) AS-93, (1) S10	NA	1	NA	Mercury Lab
Mercury Auto Analyzer	Perkin Elmer	FIMS 100	IV	1	101S11061403	Mercury Lab
Microwave	CEM	MARS 5	NA	1	DS-8025	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
Microwave	CEM	MARS Xpress	NA	1	MD-4692	Metals Prep Lab
Prep Station	Env. Express	Automated prep station	Autoblock 3	1	AB1002-0708-001	Metals Prep Lab
Prep Station	Env. Express	Automated prep station	Autoblock 4	1	AB1001-1211-0035	Metals Prep Lab
TCLP Extraction Unit	Env. Express	6 Position	NA	1	NA	TCLP Lab
TCLP Extraction Unit	Env. Express	12 Position	NA	5	4803-12-542	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	2	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	22	NA	TCLP Lab
Turbidimeter	HACH	2100N		1	05090C020685	Metals Prep Lab
Water Purification - Nanopure	Barnstead	D11951		1	1372051120948	Metals Prep Lab
PH Meter	Orion	410A	NA	1	015683	TCLP Lab
Balance	Mettler Toledo			1	B246522879	TCLP Lab
Auto pipetters 1000µl to 20 µl	Oxford	Varies	NA		NA	Metals Lab
Auto pipetters	Eppendorf, Oxford	Varies	NA		NA	Metals Prep Lab
Drying Oven	VWR Scientific	1305U	NA	a	1000594	Metals Prep Lab
MAX/MIN Thermometer	Fischer Scientific	MAX/MIN	TCLP #1		122376671	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
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 manufacturer's 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, Fe, 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/CCVLL	Env. Express	2ppm-Al, Mg, Fe 10ppm-Ca, K, Na 4ppm- B, Si, 0.04ppm-Be 0.1ppm-Pb, Mo, Cd, Ba 0.2ppm-Cr, Co, Ag, Ti, Mn, Sr, V 0.4ppm-Tl, Sb, Ni, Sn, Cu, As, Se 0.6ppm-Zn 0.3ppm- Li	Room temp.	2% HNO3 w/ Tr HF	Annual/Expiration Date
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 20ppm- Sr 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
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- all others 1000ppm- Al, Mg, K, Ca, Fe, Na	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

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, Fe, Mn, Mo, Ni, Pb, Sb, Se, Sn, Tl, V, Zn

Instrument Group/Standard	*Standard Source**	*How Received**	*Source/ Storage*	*Lab Stock Storage*	*Receipt Frequency*
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
ICPMS/ICSB	Env. Express	2ppm – Sb, As, Be, Cd, 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, Fe, 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 - Sr1ppm- Sc 5ppm – All others	Room temp.	1 month
ICP/Calibration Standard	Std 7- 0.5mL of Std. 6 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 7- 0.5ppm 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 and 1mL of Scandium stock adjusted to 1000mL with 5% HNO3	50ppm – Al, Ca, Fe, K, Mg, Na 0.5ppm – Ag 1ppm- Sc5ppm – 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

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, Fe, Mn, Mo, Ni, Pb, Sb, Se, Sn, Tl, V, Zn***

Instrument Group/Standard	***How Prepared***	***Final Concentration***	***Source/ Storage***	***Expiration***
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, 0.50 of 10ppm Scandiumand 0.5mL of Fe stock adjusted to 100mL with 5% HNO3	5ppm-Fe0.05 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 and 0.225mL of Fe stock adjusted to 100mL with 5% HNO3.	0.050 ppm 5ppm-Fe	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
Hg/Calibration Standard	Soils: 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 Waters: Std 6 - 50µL of 3ppm Intermediate Std 5 - 200µL of 300ppb Intermediate Std 4 - 100µL of 300ppb Intermediate Std 3 - 40µL of 300ppb Intermediate Std 2 - 20µL of 300ppb Intermediate Std 1 - 10µL 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 Std 6 – 0.005ppm Std 5 – 0.002ppm Std 4 – 0.001ppm Std 3 – 0.0004ppm Std 2 – 0.0002ppm Std 1 – 0.0001ppm	Room temp.	4 days

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, Fe, Mn, Mo, Ni, Pb, Sb, Se, Sn, Tl, V, Zn**				
Instrument Group/Standard	***How Prepared***	***Final Concentration***	***Source/ Storage***	***Expiration***
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 ≥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 ±10% for Methods 7470A/7471A/7471B and within ±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 ±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, 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

TABLE 8.4: CALIBRATION STANDARD CONCENTRATIONS *This table is subject to revision without notice*		
HIGH LEVEL	ICP (mg/L)	ICP/MS (mg/L)
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
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	6010C, 6020A, 6010B, 6020, 200.7 200.8: 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	< 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	< 1/2 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	Continuing	1 Continuing Calibration Blank	< 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 SOPs associated with the metals laboratory can be found in the following table.

TABLE 10.1: METALS DEPARTMENT SOPS

This table is subject to revision without notice

SOP #	Title
	TCLP SOPs
340358	TCLP
340704	SPLP
340363	EP TOX
340364	MEP
340705	California Waste Extraction Test
	Mercury SOPs
340384A	Mercury in Liquid Waste (Cold-Vapor Technique) 7470A/245.1
340384B	Mercury in Solid Waste (Cold-Vapor Technique) 7471A
	Metals Prep SOPs
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
340354A	Turbidity-Metals Drinking Water Screen Only (EPA Method 180.1)
340392	Sodium Absorption Ratio
340707	Fine, Coarse Soil Sieve Preparation for Lead Analysis for Michigan DEQ
	Metals Analysis SOPs
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 (PTs) in support of various laboratory accreditations/recognitions. Environmental samples are purchased from Phenova. 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 by NIOSH 7300/7301/7303, including lead in air, is completed every quarter. Soil, wipes and paint PTs are also completed quarterly 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 (IDOCs) are performed during new analyst training and/or prior to acceptance and use of any new method/instrumentation. Continuing Demonstration of Capability (CDOCs) 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 Data Review 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 RLs
(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 RLs
(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	150
(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 RLs
(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 RLs
(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 RLs
(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 RLs
(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 RLs
(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 RLs
(subject to revision without notice)

Class	Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range (%)	Precision (% RPD)	RL
(ICP-AES)	Lead	3050B (mod.)	NIOSH 7300/ 7301/7303	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
(ICP-AES)	Arsenic	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Barium	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample

Table 12.3B: QC Targets for IH Metals Accuracy (LCS), Precision and RLs
(subject to revision without notice)

Class	Analyte	Prep Method	Analysis Method	Matrix	Accuracy Range (%)	Precision (% RPD)	RL
(ICP-AES)	Beryllium	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Cadmium	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Chromium	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Cobalt	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Copper	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Iron	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	5.0 ug/sample
(ICP-AES)	Manganese	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Molybdenum	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Nickel	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Selenium	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Silver	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Thallium	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Tin	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Titanium	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Vanadium	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 ug/sample
(ICP-AES)	Zinc	3050B (mod.)	NIOSH 7300/ 7301/7303	Filters	85-115	<20	2.5 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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs department is 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 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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs 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
- Regulatory Affairs Department
- Department Manager
- Technical Service Representative

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103, *Document Control and Distribution,* SOP #030230, *Standards Logger, SOP #030227, Data Review* 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 12.0

1.0 SIGNATORY APPROVALS

VOLATILES QUALITY ASSURANCE MANUAL

APPENDIX VI TO THE ESC QUALITY ASSURANCE MANUAL

for

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Prepared by

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

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2.0 APPENDIX TABLE OF CONTENTS

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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 12.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kenneth W. Buckley, with a B.S. degree in General Science, is the Laboratory Operations Manager. 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 13 years of environmental laboratory experience.

In his absence, Heidi Ferrell assumes responsibility for departmental decisions in the Volatiles Lab. Ms. Ferrell, with a B.S. degree in Chemistry, is the Primary Analyst for the Volatiles Lab. She is proficient in volatile organic analytical methods and is responsible for sample analysis, review and approval of all data associated with Volatiles Department analyses.

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	Agilent	6890 GC/ 5975 MSD	VOCMS	2	GCCN10641044 MSUS63234371	Volatiles
Gas Chromatograph/ Mass Spectrometer	Hewlett Packard	6890 GC/ 5973 MSD	VOCMS	6	CN10343037 US44647141	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
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	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

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/ 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
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	28	GCUS000034135 MSUS94240103	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	29	GCUS00033898 MSUS94240096	Volatiles
Gas Chromatograph/ Mass Spectrometer	Agilent	6890 GC/ 5973MSD	VOCMS	30	GCUS10208101 MSUS10442360	Volatiles
Centurion Autosampler	(8) PTS/EST	Centurion				Volatiles
Autosampler	(23) Varian	Archon				Volatiles
Autosampler	(2) CDS	7400				Volatiles
Purge and Trap	CDS	7000E				Volatiles
Purge and Trap	(15) OI Analytical	Eclipse				Volatiles
Purge and Trap	(15) PTS/EST	Encon				Volatiles
Purge and Trap	(2)PTS/EST	Evolution				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
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

8.2 EQUIPMENT PREVENTIVE MAINTENANCE, EQUIPMENT CALIBRATION		
INSTRUMENT	P. M. DESCRIPTION	FREQUENCY
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	Ultra	Gases Mix	Primary	-30°C to 4°C	1 week
	NSI	Custom VOC Mix1	Primary	< -10°C	6 months
	NSI	Mix 2	Primary	2°C to 8°C	6 months
	Absolute Stds	n-Hexane/n-Heptane	Primary		6 months
	NSI	iso-octane	Primary	2°C to 8°C	6 months
	Ultra	Custom Std (1,2-MNP)	Primary	15°C to 30°C	6 months
	Restek	Acrolein	Primary	<0°C	3 months
	SPEX	Custom (AZ analytes)	Primary	<0°C	6 months
	Restek	TX TPH Mix (GRO)	Primary	<10°C	6 months
	SPEX	Custom (AZ analytes)	Secondary	<0°C	6 months
	NSI	Custom VOC Mix 2	Secondary	2°C to 8°C	6 months
	Ultra	Custom Std (1,2-MNP)	Secondary	15°C to 30°C	6 months
	Restek	Custom VOA LCS Mix 1	Secondary	<0°C	6 months
	Absolute Stds	n-Hexane/n-Heptane	Secondary	4°C	6 months
	Restek	Acrolein	Secondary	<0°C	3 months
	Ultra	Petroleum Products Solution (GRO)	Secondary	15°C to 30°C	6 months
8015 (GRO)	Restek	Certified BTEX in Unleaded Gas Composite Standard	Secondary	<0°C	6 months
	NSI	Gas Composite	Primary	2°C to 8°C	6 months
8021	Restek	WISC PVOC/GRO Mix	Secondary	<0°C	6 months
	NSI	PVOC/GRO Mix WI	Primary	4° ± 2°C	6 months
VPH	NSI	Primary VPH Dilution Std	Primary	15°C to 30°C	6 months
	NSI	Custom VPH LCS 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**
VOCs by GC/MS	524.2, 624, SM6200B 20th, 8260B	GW/WW0.25, 0.5, 1, 2, 5, 10, 25, 40, 75, 100, 200 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 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 and SM6200B,
≤20% RSD for method 524.2, 8260C and
≤35% RSD for method 624.

The calibration checks compounds (CCCs) for method 8260B 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 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 CCCs in EPA 8260B 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%.

8260B 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

8260B 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. Sample 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/C, 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). For 8260B,each SPCC in the calibration verification standard must meet the minimum response factors listed above. The CCC must achieve the criteria of +/- 20% RSD. For 8260C, 524.2 & SM6200B, each target analyte must achieve a drift or difference of +/-20% of the expected concentration. 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:

Propene	2-Chloroethylvinyl Ether
Dichlorodifluoromethane	Acrolein
Carbon Disulfide	Vinyl acetate
Bromomethane	trans-1, 4-dichloro-2-butene
Chloroethane	Alcohols (Ethanol, TBA, TAA, ETBA, TBF, Butanol)
1,3-Butadiene	Iodomethane.
2,2-Dibromo-3-chloropropane	Naphthalene
1- Methylnaphthalene	2-Butanone
2- Methylnaphthalene	2-Hexanone
Acetone	4-Methyl-2-pentanone
Pentachloroethane	Cyclohexanone

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	External	+/- 20% of true value	With each calibration
	Daily / Cont.	1/10	Internal	Must be within 15% of the initial calibration curve Must be within 15% of the initial calibration curve	Beginning, every 10 and ending 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 CCCs. 8260C - Must be ≤20 %RSD for all target analytes and ≤30% for CCCs. If Linear regression is used, an MRL check must pass +/-30%.	As needed
	Second Source	1 Second Source		8260B - 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. 8260C – Should recover within 30% for all compounds, with the exception of analytes known to perform poorly	With each calibration
	Daily / Cont.	Tune & CCV every 12 hours		8260B/C - 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. 8260C – All targets meet designated minimum response factor, and all compounds ≤20% difference, however 20% of target compounds can fail. If any failures, an MRL check is analyzed.	Every 12 hours

Instrument (Analysis)	Calibration Type	Minimum Number of Standards	Type of Curve	Acceptance/ Rejection Criteria	Frequency
GC/MS VOC 624	Initial	3 –600 series	Avg. RF	624 - Must be ≤35 %RSD for all target analytes and ≤30% for CCCs	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 analyses.

10.0 ANALYTICAL PROCEDURES

10.1 A list of laboratory SOPs associated with the volatiles laboratory can be found in the following table:

TABLE 10.1: VOLATILE DEPARTMENT SOPS
This table is subject to revision without notice

SOP #	Title
330351	BTEX and Gasoline Range Organics by Gas Chromatography (8015B)
330351A	TNGRO
330351	BTEXM (8021B)
330354	NC - Volatile Petroleum Hydrocarbons
330357	Volatile Organic Compounds (GRO by GCMS)
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
330374	VOCs in Vapor by EPA 8260B (AZ)
330375	Gasoline Range Organics in Air by 8015B (AZ)
330751	5035 Closed System Purge and Trap and Extraction for VOCs in Soil and Waste
330752	5030B Purge and Trap for Aqueous 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 (PTs) in support of various laboratory accreditations/recognitions. Environmental samples are purchased from Phenova. 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 (IDOCs) are performed during new analyst training and/or prior to acceptance and use of any new method/instrumentation. Continuing Demonstration of Capability (CDOCs) 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 (LCSD) 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 Exceedance – 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 exceedance (ME) limits are established as the mean of at least 20 data points ± four times their standard deviations. The number of allowable marginal exceedances per event is based on the number of analytes spiked in the LCS.

Allowable Marginal Exceedance 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 RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	1,1,1,2-Tetrachloroethane	8260B/C, 624, 6200B	GW, WW	74.2-124	20	0.0025	mg/L
Volatiles	1,1,1-Trichloroethane	8260B/C, 624, 6200B	GW, WW	73.2-123	20	0.001	mg/L
Volatiles	1,1,2,2-Tetrachloroethane	8260B/C, 624, 6200B	GW, WW	70.7-122	20.0	0.001	mg/L
Volatiles	1,1,2-Trichloro-1,2,2-trifluoroethane	8260B/C, 624, 6200B	GW, WW	67.2-143	20.0	0.001	mg/L
Volatiles	1,1,2-Trichloroethane	8260B/C, 624, 6200B	GW, WW	77.7-118	20.0	0.001	mg/L
Volatiles	1,1-Dichloroethane	8260B/C, 624, 6200B	GW, WW	70.7-126	20.0	0.001	mg/L
Volatiles	1,1-Dichloroethene	8260B/C, 624, 6200B	GW, WW	67.8-129	20.0	0.001	mg/L
Volatiles	1,1-Dichloropropene	8260B/C, 624, 6200B	GW, WW	73.1-125	20.0	0.001	mg/L
Volatiles	1,2,3-Trichlorobenzene	8260B/C, 624, 6200B	GW, WW	64.9-135	20.0	0.001	mg/L
Volatiles	1,2,3-Trichloropropane	8260B/C, 624, 6200B	GW, WW	71.8-121	20.0	0.001	mg/L
Volatiles	1,2,3-Trimethylbenzene	8260B/C, 624, 6200B	GW, WW	72.3-116	20.0	0.001	mg/L
Volatiles	1,2,4-Trichlorobenzene	8260B/C, 624, 6200B	GW, WW	69.7-136	20.0	0.050	mg/L
Volatiles	1,2,4-Trimethylbenzene	8260B/C, 624, 6200B	GW, WW	75.0-123	20.0	0.001	mg/L
Volatiles	1,2-Dibromo-3-Chloropropane	8260B/C, 624, 6200B	GW, WW	65.4-128	20.0	0.001	mg/L
Volatiles	1,2-Dibromoethane	8260B/C, 624, 6200B	GW, WW	76.6-121	20.0	0.050	mg/L
Volatiles	1,2-Dichlorobenzene	8260B/C, 624, 6200B	GW, WW	78.4-117	20.0	0.050	mg/L
Volatiles	1,2-Dichloroethane	8260B/C, 624, 6200B	GW, WW	68.8-124	20.0	0.001	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	1,2-Dichloropropane	8260B/C, 624, 6200B	GW, WW	76.5-119	20.0	0.005	mg/L
Volatiles	1,3,5-Trimethylbenzene	8260B/C, 624, 6200B	GW, WW	75.6-124	20.0	0.050	mg/L
Volatiles	1,3-Butadiene	8260B/C, 624, 6200B	GW, WW	44.6-147	20.0	0.001	mg/L
Volatiles	1,3-Dichlorobenzene	8260B/C, 624, 6200B	GW, WW	70.8-128	20.0	0.001	mg/L
Volatiles	1,3-Dichloropropane	8260B/C, 624, 6200B	GW, WW	77.4-117	20.0	0.001	mg/L
Volatiles	1,4-Dichlorobenzene	8260B/C, 624, 6200B	GW, WW	78.8-115	20.0	0.050	mg/L
Volatiles	1,4-Dioxane	8260B/C, 624, 6200B	GW, WW	76.2-132	25.0	0.001	mg/L
Volatiles	2,2-Dichloropropane	8260B/C, 624, 6200B	GW, WW	62.4-133	20.0	0.001	mg/L
Volatiles	2-Butanol	8260B/C, 624, 6200B	GW, WW	64.8-140	25.0	0.001	mg/L
Volatiles	2-Butanone (MEK)	8260B/C, 624, 6200B	GW, WW	55.0-149	20.0	0.050	mg/L
Volatiles	2-Chloroethylvinyl Ether	8260B/C, 624, 6200B	GW, WW	43.8-150	20.0	0.001	mg/L
Volatiles	2-Chlorotoluene	8260B/C, 624, 6200B	GW, WW	74.7-122	20.0	0.001	mg/L
Volatiles	2-Hexanone	8260B/C, 624, 6200B	GW, WW	65.6-144	20.0	0.005	mg/L
Volatiles	2-Propanol	8260B/C, 624, 6200B	GW, WW	70.0-130	20.0	0.001	mg/L
Volatiles	4-Chlorotoluene	8260B/C, 624, 6200B	GW, WW	77.5-120	20.0	0.001	mg/L
Volatiles	4-Ethyltoluene	8260B/C, 624, 6200B	GW, WW	76.2-129	20.0	0.001	mg/L
Volatiles	4-Methyl-2-Pentanone (MIBK)	8260B/C, 624, 6200B	GW, WW	70.5-133	20.0	0.001	mg/L
Volatiles	Acetone	8260B/C, 624, 6200B	GW, WW	35.6-163	23.9	0.001	mg/L
Volatiles	Acetonitrile	8260B/C, 624, 6200B	GW, WW	61.3-134	25.0	0.001	mg/L
Volatiles	Acrolein	8260B/C, 624, 6200B	GW, WW	88.0-118	28.1	0.001	mg/L
Volatiles	Acrylonitrile	8260B/C, 624, 6200B	GW, WW	71.0-135	20.0	0.001	mg/L
Volatiles	Allyl Chloride	8260B/C, 624, 6200B	GW, WW	77.9-127	25.0	0.001	mg/L
Volatiles	Benzene	8260B/C, 624, 6200B	GW, WW	74.8-121	20.0	0.050	mg/L
Volatiles	Bromobenzene	8260B/C, 624, 6200B	GW, WW	77.5-116	20.0	0.001	mg/L
Volatiles	Bromochloromethane	8260B/C, 624, 6200B	GW, WW	77.6-119	20.0	0.050	mg/L
Volatiles	Bromodichloromethane	8260B/C, 624, 6200B	GW, WW	75.1-116	20.0	0.005	mg/L
Volatiles	Bromoethane	8260B/C, 624, 6200B	GW, WW	74.3-136	25.0	0.001	mg/L
Volatiles	Bromoform	8260B/C, 624, 6200B	GW, WW	67.5-130	20.0	0.001	mg/L
Volatiles	Bromomethane	8260B/C, 624, 6200B	GW, WW	49.9-162	20.0	0.001	mg/L
Volatiles	Carbon Disulfide	8260B/C, 624, 6200B	GW, WW	64.6-140	20.0	0.001	mg/L
Volatiles	Carbon Tetrachloride	8260B/C, 624, 6200B	GW, WW	70.2-123	20.0	0.050	mg/L
Volatiles	Chlorobenzene	8260B/C, 624, 6200B	GW, WW	78.1-119	20.0	0.001	mg/L
Volatiles	Chlorodibromomethane	8260B/C, 624, 6200B	GW, WW	74.0-121	20.0	0.001	mg/L
Volatiles	Chloroethane	8260B/C, 624, 6200B	GW, WW	61.7-135	20.0	0.001	mg/L
Volatiles	Chloroform	8260B/C, 624, 6200B	GW, WW	76.0-121	20.0	0.001	mg/L
Volatiles	Chloromethane	8260B/C, 624, 6200B	GW, WW	61.5-129	20.0	0.001	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	Chloroprene	8260B/C, 624, 6200B	GW, WW	49.4-142	25.0	0.003	mg/L
Volatiles	cis-1,2-Dichloroethene	8260B/C, 624, 6200B	GW, WW	76.0-119	20.0	0.001	mg/L
Volatiles	cis-1,3-Dichloropropene	8260B/C, 624, 6200B	GW, WW	78.2-120	20.0	0.001	mg/L
Volatiles	Cyclohexanone	8260B/C, 624, 6200B	GW, WW	36.5-138	25.0	0.001	mg/L
Volatiles	Dibromomethane	8260B/C, 624, 6200B	GW, WW	79.5-118	20.0	0.001	mg/L
Volatiles	Dichlorodifluoromethane	8260B/C, 624, 6200B	GW, WW	54.8-135	20.0	0.001	mg/L
Volatiles	Dicyclopentadiene	8260B/C, 624, 6200B	GW, WW	72.7-132	20.0	0.001	mg/L
Volatiles	Di-isopropyl ether	8260B/C, 624, 6200B	GW, WW	65.6-132	20.0	0.001	mg/L
Volatiles	Ethanol	8260B/C, 624, 6200B	GW, WW	51.8-153	25.0	0.001	mg/L
Volatiles	Ethyl Ether	8260B/C, 624, 6200B	GW, WW	62.4-134	20.0	0.001	mg/L
Volatiles	Ethyl methacrylate	8260B/C, 624, 6200B	GW, WW	55.4-126	25.0	0.001	mg/L
Volatiles	Ethyl tert-butyl ether	8260B/C, 624, 6200B	GW, WW	63.5-131	25.0	0.001	mg/L
Volatiles	Ethylbenzene	8260B/C, 624, 6200B	GW, WW	78.8-122	20.0	0.001	mg/L
Volatiles	Hexachlorobutadiene	8260B/C, 624, 6200B	GW, WW	64.7-129	20.0	0.001	mg/L
Volatiles	Hexane	8260B/C, 624, 6200B	GW, WW	33.0-167	20.0	0.001	mg/L
Volatiles	Iodomethane	8260B/C, 624, 6200B	GW, WW	61.0-130	20.0	0.001	mg/L
Volatiles	Isobutanol	8260B/C, 624, 6200B	GW, WW	59.3-137	25.0	0.001	mg/L
Volatiles	Isopropylbenzene	8260B/C, 624, 6200B	GW, WW	78.6-132	20.0	0.001	mg/L
Volatiles	Methacrylonitrile	8260B/C, 624, 6200B	GW, WW	74.7-126	25.0	0.001	mg/L
Volatiles	Methyl Methacrylate	8260B/C, 624, 6200B	GW, WW	62.0-142	25.0	0.001	mg/L
Volatiles	Methyl Tert Butyl Ether	8260B/C, 624, 6200B	GW, WW	71.2-126	20.0	0.001	mg/L
Volatiles	Methylene Chloride	8260B/C, 624, 6200B	GW, WW	70.3-120	20.0	0.001	mg/L
Volatiles	Naphthalene	8260B/C, 624, 6200B	GW, WW	68.4-128	20.0	0.005	mg/L
Volatiles	n-Butylbenzene	8260B/C, 624, 6200B	GW, WW	76.2-126	20.0	0.001	mg/L
Volatiles	n-Propylbenzene	8260B/C, 624, 6200B	GW, WW	78.2-122	20.0	0.010	mg/L
Volatiles	Pentachloroethane	8260B/C, 624, 6200B	GW, WW	10.0-200	25.0	0.050	mg/L
Volatiles	p-Isopropyltoluene	8260B/C, 624, 6200B	GW, WW	74.0-131	20.0	0.005	mg/L
Volatiles	Propene	8260B/C, 624, 6200B	GW, WW	19.5-180	20.0	0.050	mg/L
Volatiles	Propionitrile	8260B/C, 624, 6200B	GW, WW	53.7-143	25.0	0.100	mg/L
Volatiles	sec-Butylbenzene	8260B/C, 624, 6200B	GW, WW	74.4-127	20.0	0.100	mg/L
Volatiles	Styrene	8260B/C, 624, 6200B	GW, WW	80.4-126	20.0	0.050	mg/L
Volatiles	Tert-Amyl Methyl Ether	8260B/C, 624, 6200B	GW, WW	69.3-125	25.0	0.005	mg/L
Volatiles	Tert-Butyl alcohol	8260B/C, 624, 6200B	GW, WW	44.2-173	25.0	0.005	mg/L
Volatiles	tert-Butylbenzene	8260B/C, 624, 6200B	GW,WW	75.3-126	20.0	.05	mg/L
Volatiles	Tetrachloroethene	8260B/C, 624, 6200B	GW, WW	72.6-126	20.0	0.050	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	Tetrahydrofuran	8260B/C, 624, 6200B	GW, WW	54.4-137	20.0	0.005	mg/L
Volatiles	Toluene	8260B/C, 624, 6200B	GW, WW	79.7-116	20.0	0.010	mg/L
Volatiles	Total-Xylene	8260B/C, 624, 6200B	GW, WW	78.7-121	20.0	0.001	mg/L
Volatiles	trans-1,2-Dichloroethene	8260B/C, 624, 6200B	GW, WW	72.6-121	20.0	0.050	mg/L
Volatiles	trans-1,3-Dichloropropene	8260B/C, 624, 6200B	GW, WW	74.3-123	20.0	0.050	mg/L
Volatiles	trans-1,4-Dichloro-2-Butene	8260B/C, 624, 6200B	GW, WW	65.1-123	20.0	0.001	mg/L
Volatiles	Trichloroethene	8260B/C, 624, 6200B	GW, WW	77.7-118	20.0	0.001	mg/L
Volatiles	Trichlorofluoromethane	8260B/C, 624, 6200B	GW, WW	63.5-135	20.0	0.001	mg/L
Volatiles	Vinyl Acetate	8260B/C, 624, 6200B	GW, WW	65.0-138	20.0	0.050	mg/L
Volatiles	Vinyl Chloride	8260B/C, 624, 6200B	GW, WW	65.9-128	20.0	0.001	mg/L
Volatiles	Propene	8260B/C	Solid	16.3-187	20.0	0.0025	mg/kg
Volatiles	1,3-Butadiene	8260B/C	Solid	53.2-141	20.0	0.001	mg/kg
Volatiles	4-Ethyltoluene	8260B/C	Solid	76.5-130	20.0	0.001	mg/kg
Volatiles	Dicyclopentadiene	8260B/C	Solid	72.7-137	20.0	0.001	mg/kg
Volatiles	Dichlorodifluoromethane	8260B/C	Solid	67.5-126	20.0	0.001	mg/kg
Volatiles	Chloromethane	8260B/C	Solid	63.4-131	20.0	0.001	mg/kg
Volatiles	Vinyl Chloride	8260B/C	Solid	66.7-130	20.0	0.001	mg/kg
Volatiles	Bromomethane	8260B/C	Solid	48.7-165	20.0	0.001	mg/kg
Volatiles	Chloroethane	8260B/C	Solid	66.2-132	20.0	0.001	mg/kg
Volatiles	Trichlorofluoromethane	8260B/C	Solid	67.7-131	20.0	0.001	mg/kg
Volatiles	Ethyl Ether	8260B/C	Solid	66.4-134	20.0	0.001	mg/kg
Volatiles	Acrolein	8260B/C	Solid	10.0-200	28.8	0.050	mg/kg
Volatiles	1,1-Dichloroethene	8260B/C	Solid	70.4-129	20.0	0.001	mg/kg
Volatiles	1,1,2-Trichloro-1,2,2-trifluoroethane	8260B/C	Solid	70.0-146	20.0	0.001	mg/kg
Volatiles	Acetone	8260B/C	Solid	35.1-175	26.1	0.050	mg/kg
Volatiles	Iodomethane	8260B/C	Solid	65.3-124	20.0	0.050	mg/kg
Volatiles	Carbon Disulfide	8260B/C	Solid	66.9-145	20.0	0.001	mg/kg
Volatiles	Methylene Chloride	8260B/C	Solid	72.6-120	20.0	0.005	mg/kg
Volatiles	Acrylonitrile	8260B/C	Solid	56.4-128	20.0	0.050	mg/kg
Volatiles	trans-1,2-Dichloroethene	8260B/C	Solid	73.8-122	20.0	0.001	mg/kg
Volatiles	Methyl Tert Butyl Ether	8260B/C	Solid	73.0-129	20.0	0.001	mg/kg
Volatiles	1,1-Dichloroethane	8260B/C	Solid	75.0-124	20.0	0.001	mg/kg
Volatiles	Vinyl Acetate	8260B/C	Solid	65.4-138	20.0	0.050	mg/kg
Volatiles	Di Isopropyl Ether	8260B/C	Solid	70.4-133	20.0	0.001	mg/kg
Volatiles	2,2-Dichloropropane	8260B/C	Solid	61.3-136	20.0	0.001	mg/kg
Volatiles	cis-1,2-Dichloroethene	8260B/C	Solid	78.2-119	20.0	0.001	mg/kg

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	2-Butanone (MEK)	8260B/C	Solid	53.7-153	21.2	0.050	mg/kg
Volatiles	Bromochloromethane	8260B/C	Solid	78.4-119	20.0	0.001	mg/kg
Volatiles	Tetrahydrofuran	8260B/C	Solid	53.6-145	20.1	0.001	mg/kg
Volatiles	Chloroform	8260B/C	Solid	76.7-122	20.0	0.005	mg/kg
Volatiles	1,1,1-Trichloroethane	8260B/C	Solid	73.7-124	20.0	0.001	mg/kg
Volatiles	Carbon Tetrachloride	8260B/C	Solid	70.0-124	20.0	0.001	mg/kg
Volatiles	1,1-Dichloropropene	8260B/C	Solid	74.9-124	20.0	0.001	mg/kg
Volatiles	Benzene	8260B/C	Solid	77.1-121	20.0	0.001	mg/kg
Volatiles	1,2-Dichloroethane	8260B/C	Solid	70.1-124	20.0	0.001	mg/kg
Volatiles	Trichloroethene	8260B/C	Solid	77.9-118	20.0	0.001	mg/kg
Volatiles	1,2-Dichloropropane	8260B/C	Solid	77.9-119	20.0	0.001	mg/kg
Volatiles	Dibromomethane	8260B/C	Solid	78.9-120	20.0	0.001	mg/kg
Volatiles	Bromodichloromethane	8260B/C	Solid	74.9-115	20.0	0.001	mg/kg
Volatiles	2-Chloroethylvinyl Ether	8260B/C	Solid	37.7-157	20.0	0.050	mg/kg
Volatiles	cis-1,3-Dichloropropene	8260B/C	Solid	79.6-120	20.0	0.001	mg/kg
Volatiles	4-Methyl-2-Pentanone (MIBK)	8260B/C	Solid	70.4-137	20.0	0.050	mg/kg
Volatiles	Toluene	8260B/C	Solid	79.7-118	20.0	0.005	mg/kg
Volatiles	trans-1,3-Dichloropropene	8260B/C	Solid	75.9-124	20.0	0.001	mg/kg
Volatiles	1,1,2-Trichloroethane	8260B/C	Solid	79.1-118	20.0	0.001	mg/kg
Volatiles	Tetrachloroethene	8260B/C	Solid	73.9-125	20.0	0.001	mg/kg
Volatiles	1,3-Dichloropropane	8260B/C	Solid	79.1-117	20.0	0.001	mg/kg
Volatiles	2-Hexanone	8260B/C	Solid	66.7-148	20.0	0.050	mg/kg
Volatiles	Chlorodibromomethane	8260B/C	Solid	73.5-121	20.0	0.001	mg/kg
Volatiles	1,2-Dibromoethane	8260B/C	Solid	78.6-120	20.0	0.001	mg/kg
Volatiles	Chlorobenzene	8260B/C	Solid	79.1-119	20.0	0.001	mg/kg
Volatiles	1,1,1,2-Tetrachloroethane	8260B/C	Solid	72.9-124	20.0	0.001	mg/kg
Volatiles	Ethylbenzene	8260B/C	Solid	79.7-122	20.0	0.001	mg/kg
Volatiles	m,p-Xylene	8260B/C	Solid	79.0-120	20.0	0.003	mg/kg
Volatiles	o-Xylene	8260B/C	Solid	77.8-122	20.0	0.003	mg/kg
Volatiles	Styrene	8260B/C	Solid	82.4-126	20.0	0.001	mg/kg
Volatiles	Bromoform	8260B/C	Solid	65.9-132	20.0	0.001	mg/kg
Volatiles	Isopropylbenzene	8260B/C	Solid	80.0-135	20.0	0.001	mg/kg
Volatiles	Bromobenzene	8260B/C	Solid	78.2-115	20.0	0.001	mg/kg
Volatiles	1,1,2,2-Tetrachloroethane	8260B/C	Solid	69.4-122	20.0	0.001	mg/kg
Volatiles	1,2,3-Trichloropropane	8260B/C	Solid	69.3-131	20.0	0.001	mg/kg
Volatiles	trans-1,4-Dichloro-2-Butene	8260B/C	Solid	63.0-125	20.0	0.001	mg/kg

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RLs
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Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	n-Propylbenzene	8260B/C	Solid	77.9-123	20.0	0.001	mg/kg
Volatiles	2-Chlorotoluene	8260B/C	Solid	75.6-121	20.0	0.001	mg/kg
Volatiles	4-Chlorotoluene	8260B/C	Solid	77.3-120	20.0	0.001	mg/kg
Volatiles	1,3,5-Trimethylbenzene	8260B/C	Solid	75.9-124	20.0	0.001	mg/kg
Volatiles	tert-Butylbenzene	8260B/C	Solid	76.4-126	20.0	0.001	mg/kg
Volatiles	1,2,4-Trimethylbenzene	8260B/C	Solid	75.5-122	20.0	0.001	mg/kg
Volatiles	sec-Butylbenzene	8260B/C	Solid	75.8-126	20.0	0.001	mg/kg
Volatiles	1,3-Dichlorobenzene	8260B/C	Solid	72.0-126	20.0	0.001	mg/kg
Volatiles	p-Isopropyltoluene	8260B/C	Solid	75.8-129	20.0	0.001	mg/kg
Volatiles	1,4-Dichlorobenzene	8260B/C	Solid	78.3-117	20.0	0.001	mg/kg
Volatiles	1,2,3-Trimethylbenzene	8260B/C	Solid	73.6-113	20.0	0.001	mg/kg
Volatiles	1,2-Dichlorobenzene	8260B/C	Solid	78.3-118	20.0	0.001	mg/kg
Volatiles	n-Butylbenzene	8260B/C	Solid	77.5-126	20.0	0.001	mg/kg
Volatiles	1,2-Dibromo-3-Chloropropane	8260B/C	Solid	62.8-133	20.0	0.001	mg/kg
Volatiles	1,2,4-Trichlorobenzene	8260B/C	Solid	71.9-137	20.0	0.001	mg/kg
Volatiles	Hexachlorobutadiene	8260B/C	Solid	68.2-123	20.0	0.001	mg/kg
Volatiles	Naphthalene	8260B/C	Solid	69.8-128	20.0	0.005	mg/kg
Volatiles	1,2,3-Trichlorobenzene	8260B/C	Solid	71.4-123	20.0	0.001	mg/kg
Volatiles	Hexane	8260B/C	Solid	28.0-169	20.0	0.010	mg/kg
Volatiles	Acetonitrile	8260B/C	Solid	59.6-170	25.0	0.050	mg/kg
Volatiles	Allyl Chloride	8260B/C	Solid	66.7-106	25.0	0.005	mg/kg
Volatiles	Chloroprene	8260B/C	Solid	61.0-114	25.0	0.050	mg/kg
Volatiles	Isobutanol	8260B/C	Solid	80.4-130	25.0	0.100	mg/kg
Volatiles	1,4-Dioxane	8260B/C	Solid	78.4-148	25.0	0.100	mg/kg
Volatiles	Methacrylonitrile	8260B/C	Solid	87.1-108	25.0	0.050	mg/kg
Volatiles	Methyl Methacrylate	8260B/C	Solid	90.4-141	25.0	0.005	mg/kg
Volatiles	Ethyl methacrylate	8260B/C	Solid	41.6-159	25.0	0.005	mg/kg
Volatiles	Propionitrile	8260B/C	Solid	77.8-136	25.0	0.050	mg/kg
Volatiles	Pentachloroethane	8260B/C	Solid	63.5-179	25.0	0.005	mg/kg
Volatiles	Cyclohexanone	8260B/C	Solid	21.3-170	25.0	0.010	mg/kg
Volatiles	Bromoethane	8260B/C	Solid	61.7-123	25.0	0.001	mg/kg
Volatiles	2Butanol	8260B/C	Solid	82.5-138	25.0	0.050	mg/kg
Volatiles	Ethanol	8260B/C	Solid	65.6-136	25.0	0.050	mg/kg
Volatiles	Di-isopropyl ether	8260B/C	Solid	70.4-133	20.0	0.001	mg/kg
Volatiles	Ethyl tert-butyl ether	8260B/C	Solid	81.4-110	25.0	0.001	mg/kg

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RLs
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Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	Methyl-tert-butyl ether	8260B/C	Solid	73.0-129	20.0	0.001	mg/kg
Volatiles	Tert-Butyl alcohol	8260B/C	Solid	59.5-170	25.0	0.050	mg/kg
Volatiles	Tert-Amyl Methyl Ether	8260B/C	Solid	82-115	25.0	0.001	mg/kg
Volatiles	2-Propanol	8260B/C	Solid	70.0-130	25.0	0.05	mg/kg
Volatiles	GRO	8015B/C/D	GW, WW	66.3-133	20.0	0.100	mg/L
Volatiles	Benzene	8021B, 602, 6200C	GW, WW	70.0-130	20.0	0.0005	mg/L
Volatiles	Toluene	8021B, 602, 6200C	GW, WW	70.0-130	20.0	0.005	mg/L
Volatiles	Ethylbenzene	8021B, 602, 6200C	GW, WW	70.0-130	20.0	0.0005	mg/L
Volatiles	m&p-Xylene	8021B, 602, 6200C	GW, WW	70.0-130	20.0	0.001	mg/L
Volatiles	o-Xylene	8021B, 602, 6200C	GW, WW	70.0-130	20.0	0.0005	mg/L
Volatiles	MTBE	8021B, 602, 6200C	GW, WW	70.0-130	20.0	0.001	mg/L
Volatiles	Benzene	502.2	DW	70.0 - 130	25.0	0.0005	mg/L
Volatiles	Toluene	502.2	DW	70.0 - 130	25.0	0.005	mg/L
Volatiles	Ethylbenzene	502.2	DW	70.0 - 130	25.0	0.0005	mg/L
Volatiles	m&p-Xylene	502.2	DW	70.0 - 130	25.0	0.001	mg/L
Volatiles	o-Xylene	502.2	DW	70.0 - 130	25.0	0.0005	mg/L
Volatiles	MTBE	502.2	DW	70.0 - 130	25.0	0.001	mg/L
Volatiles	GRO	8015B	Solid	63.6-136	20.0	0.500	mg/kg
Volatiles	Benzene	8021B	Solid	70.0 - 130	20.0	0.0025	mg/kg
Volatiles	Toluene	8021B	Solid	70.0 - 130	20.0	0.025	mg/kg
Volatiles	Ethylbenzene	8021B	Solid	70.0 - 130	20.0	0.0025	mg/kg
Volatiles	m&p-Xylene	8021B	Solid	70.0 - 130	20.0	0.005	mg/kg
Volatiles	o-Xylene	8021B	Solid	70.0 - 130	20.0	0.0025	mg/kg
Volatiles	MTBE	8021B	Solid	70.0 - 130	20.0	0.005	mg/kg
Volatiles	1,1,1,2-Tetrachloroethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,1,1-Trichloroethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,1,2,2-Tetrachloroethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,1,2-Trichloroethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,1-Dichloroethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,1-Dichloroethene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,1-Dichloropropanone	524.2	DW	70.0-130	25.0		mg/L
Volatiles	1,1-Dichloropropene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,2,3-Trichlorobenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,2,3-Trichloropropane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,2,4-Trichlorobenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RLs
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Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	1,2,4-Trimethylbenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,2-Dibromo-3-chloropropane	524.2	DW	70.0-130	25.0	0.0010	mg/L
Volatiles	1,2-Dibromoethane	524.2	DW	70.0-130	25.0	0.0010	mg/L
Volatiles	1,2-Dichlorobenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,2-Dichloroethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,2-Dichloropropane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,3,5-Trimethylbenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,3-Dichlorobenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,3-Dichloropropane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1,4-Dichlorobenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	1-Chlorobutane	524.2	DW	70.0-130	25.0		mg/L
Volatiles	2,2-Dichloropropane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	2-Butanone	524.2	DW	70.0-130	25.0		mg/L
Volatiles	2-Chlorotoluene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	2-Hexanone	524.2	DW	70.0-130	25.0		mg/L
Volatiles	2-Nitropropane	524.2	DW	70.0-130	25.0		mg/L
Volatiles	4-Chlorotoluene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	4-Isopropyltoluene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	4-Methyl-2-pentanone	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Acetone	524.2	DW	70.0-130	25.0	0.01	mg/L
Volatiles	Acrylonitrile	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Allyl Chloride	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Benzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Bromobenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Bromochloromethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Bromodichloromethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Bromoform	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Bromomethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Carbon Disulfide	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Carbon Tetrachloride	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Chloroacetonitrile	524.2	DW	70.0-130	25.0		mg/L
Volatiles	THMs	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Chlorobenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Chloroethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Chloroform	524.2	DW	70.0-130	25.0	0.0005	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	Chloromethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Cis-1,2-dichloroethene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Cis-1,3-dichloropropene	524.2	DW	70.0-130	25.0	0.0010	mg/L
Volatiles	Dibromochloromethane	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Dibromomethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Dichlorodifluoromethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Diethyl ether	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Ethyl Methacrylate	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Ethylbenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Hexachlorobutadiene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Hexachloroethane	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Isopropylbenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Meta-xylene	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Methacrylonitrile	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Methyl Iodide	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Methylacrylate	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Methylene Chloride	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Methylmethacrylate	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Methyl-t-butyl ether	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Naphthalene	524.2	DW	70.0-130	25.0	0.0050	mg/L
Volatiles	N-butylbenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Nitrobenzene	524.2	DW	70.0-130	25.0		mg/L
Volatiles	N-propylbenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Ortho-xylene	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Para-xylene	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Pentachloroethane	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Propionitrile	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Sec-butylbenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Styrene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Tert-butylbenzene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Tetrachloroethene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Tetrahydrofuran	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Toluene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Trans-1,2-dichloroethene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Trans-1,3-dichloropropene	524.2	DW	70.0-130	25.0	0.0010	mg/L

Table 12.3: QC Targets for Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)**	Prec.** (RPD)	RL	Unit
Volatiles	Trans-1,4-dichloro-2-butene	524.2	DW	70.0-130	25.0		mg/L
Volatiles	Trichloroethene	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Trichlorofluoromethane	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Vinyl Chloride	524.2	DW	70.0-130	25.0	0.0005	mg/L
Volatiles	Xylenes – total	524.2	DW	70.0-130	25.0		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 Regulatory Affairs 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

<u>Rejection Criteria</u> - 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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs Department is consulted for further action.

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103, *Document Control and Distribution*, SOP #030230, *Standards Logger, SOP #030227, Data Review* 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. PDF 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 12.0.

1.0 SIGNATORY APPROVALS

Semi-Volatile
QUALITY ASSURANCE MANUAL

APPENDIX VII TO THE ESC QUALITY ASSURANCE MANUAL

for

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Prepared by

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

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3.0 SCOPE AND APPLICATION

This appendix discusses specific Regulatory Affairs 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 12.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kenneth W. Buckley, with a B.S. degree in General Science, is the Laboratory Operations Manager. 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 13 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 13 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 26	Agilent	7890	Svcompar	26	CN11501138	SVOC
Gas Chromatograph 27	Agilent	7890	Svcompas	27	CN11501139	SVOC
Gas Chromatograph 28	Agilent	7890	Svcompat	28	US11521018	SVOC
Gas Chromatograph 29	Agilent	7890	Svcompau	29	CN11521077	SVOC
Gas Chromatograph 30	Agilent	7890	svcompav	30	US11521020	SVOC
Gas Chromatograph 31	Agilent	7890	svcompba	30	CN13503096	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

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 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
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 Detectors 26	Detectors	FID	svcompar	26	N/A	SVOC
Gas Chromatograph Detectors 27	Detectors	FID	svcompas	27	N/A	SVOC
Gas Chromatograph Detectors 28	Detectors	ECD/ECD	Svcompat	28	F) U20406 B) U20407	SVOC
Gas Chromatograph Detectors 29	Detectors	ECD/ECD	Svcompat	29	F) U20277 B) U20299	SVOC
Gas Chromatograph Detectors 30	Detectors	ECD/ECD	svcompat	30	F) U20425 B) U20424	SVOC
Gas Chromatograph Detectors 31	Detectors	FID	svcompba	31	N/A	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

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/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
Gas Chromatograph/Mass Spectrometer 14	Agilent	7890 GC/5975MSD	Svcompal	14	GC: CN11031022 MS: US11093726	SVOC
Gas Chromatograph/Mass Spectrometer 15	Agilent	7890 GC/5975MSD	Svcompam	15	GC: CN10301081 MS: US10313621	SVOC
Gas Chromatograph/Mass Spectrometer 16	Agilent	7890 GC/5975MSD	Svcompan	16	GC: CN10301152 MS: US10313616	SVOC
Gas Chromatograph/Mass Spectrometer 17	Agilent	7890 GC/5975MSD	Svcompao	17	GC: CN11191064 MS: US11363807	SVOC
Gas Chromatograph/Mass Spectrometer 18	Agilent	7890 GC/5975MSD	Svcompap	18	GC: CN11401093 MS: US11403903	SVOC
Gas Chromatograph/Mass Spectrometer 19	Agilent	7890 GC/5975MSD	Svcompaq	19	GC: CN11391051 MS: US11383838	SVOC
Gas Chromatograph/Mass Spectrometer 20	Agilent	7890 GC/5975MSD	Svcompaw	20	GC: CN12031161 MS: US11503941	SVOC
Gas Chromatograph/Mass Spectrometer 21	Agilent	7890 GC/5975MSD	Svcompax	21	GC: CN12031160 MS: US11513903	SVOC
Gas Chromatograph/Mass Spectrometer 22	Agilent	7890 GC/5975MSD	Svcompay	22	GC: CN11521157 MS: US12023909	SVOC
Gas Chromatograph/Mass Spectrometer 23	Agilent	7890 GC/5975MSD	Svcompaz	23	GC: CN12031114 MS: US11433926	SVOC
High Performance Liquid Chromatography	Agilent	1100 Series DAD/FLD	hplc1	1	DAD de01608402 FLD de23904489	SVOC
High Performance Liquid Chromatography	Agilent	1100 Series DAD/FLD	hplc2	2	DAD de30518420 FLD	SVOC
High Performance Liquid Chromatography (HPLC3)	Agilent	1100 Series DAD	hplc3	3	DAD us64400711	SVOC
High Performance Liquid Chromatography (HPLC4)	Agilent	1100 Series DAD/FLD	hplc4	4	DAD de43623013	SVOC
Analytical Balance	Mettler Toledo	PB1502-S		1	1126193668	Ext. Lab
Analytical Balance	Mettler Toledo	MS1602S		2	B243464732	Ext.Lab
Analytical Balance	Mettler Toledo	MS1602S		3	B115130112	Ext.Lab
Analytical Balance	Ohaus	ARA520		3	1202120618	Ext. Lab
Analytical Balance	Ohaus	ARA520		4	1202120814	Ext. Lab
Analytical Balance	Ohaus	Scout Pro			7132101108	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*
Automatic Concentrators	Buchi	Syncore	Buchi	1	2302	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	2	2304	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	3	2303	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	4	0400000940	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	5	406583020005	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	6	1469	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	7	1461	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	8	417004020002	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	9	416870050003	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	10	1466	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	11	1463	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	12	1462	Ext. Lab
Automatic Concentrators	Buchi	Syncore	Buchi	13	1468	Ext. Lab
Capping station	Horizon	MARS X			snxc2225	Ext. Lab
Capping station	Horizon	MARS X			snxc2215	Ext. Lab
Centrifuge	Sorvall	ST-40		2	2224	Ext. Lab
Centrifuge	Sorvall	ST-40		3	2225	Ext. Lab
Centrifuge	Sorvall	ST-40		4	2226	Ext. Lab
Centrifuge	Sorvall	ST-40		5	2227	Ext. Lab
Concentration Chiller	Lauda	WKL 3200			2031	Ext. Lab
Concentration Chiller	Lauda	WKL 3200			2039	Ext. Lab
Furnace	Thermo Scientific				1882	Ext. Lab
Oven	Fisher	6556			166	Ext. Lab
Oven	VWR	1305U			0520	Ext. Lab
HAA Shaker	Eberbach				2159	Ext. Lab
RV shaker	Eberbach	F6010.00			041242	Ext. Lab
RV shaker	Eberbach	F6010.00			041250	Ext. Lab
LVI Shaker	Eberbach	6010-04			1834	Ext. Lab
HAA water Bath	Thermo Scientific	280 series			2033602-102	Ext. Lab
High Intensity Ultrasonic Processor	Misonix			1	2193	Ext. Lab
High Intensity Ultrasonic Processor	Misonix			2	1382	Ext. Lab
High Intensity Ultrasonic Processor	Misonix			3	1888	Ext. Lab
High Intensity Ultrasonic Processor	Misonix			4	1381	Ext. Lab
Microwave	CEM	MARS 6		3	2296	Ext. Lab
Microwave	CEM	MARS 6			MJ2518	Ext. Lab
OG concentrator	Horizon	SpeedVap III		1	1534	Ext. Lab
OG concentrator	Horizon	SpeedVap III		2	SN04-2020	Ext. Lab
OG concentrator	Horizon	SpeedVap III		3	2186	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***
OG SPE extractor	Horizon	SPE-DEX 3000		1	2222	Ext. Lab
OG SPE extractor	Horizon	SPE-DEX 3000		2	2223	Ext. Lab
OG SPE extractor	Horizon	SPE-DEX 3000		3	2221	Ext. Lab
OG SPE extractor	Horizon	SPE-DEX 3000		4	2220	Ext. Lab
OG SPE Controllers	Horizon	1000/3000XL		1	2125	Ext. Lab
OG SPE Controllers	Horizon	1000/3000XL		2	2126	Ext. Lab
OG SPE Controllers	Horizon	1000/3000XL		3	2127	Ext. Lab
OG SPE Controllers	Horizon	1000/3000XL		4	2128	Ext. Lab
Separatory funnel rotators	ATR				1514	Ext. Lab
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
Speed Vap	FMS				2471	Ext. Lab
Water Bath Sonicator	Branson	8510			RPA040384175E	Ext. Lab
Vacuum Pump	Gast				0908605639	Ext. Lab
Vacuum Pump	Gast				0913008139	Ext. Lab
Vacuum Pump	Gast			3	0311000841	Ext. Lab

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: ECD	•Bake off or Replace •Perform wipe leakage test	GC/detector maintenance is routinely completed as needed for each instrument. Analysts are responsible for performing and documenting maintenance on each component of the instrumentation based on daily performance of the instrument and its ability to meet certain method requirements. Senior analyst team is available to help with major maintenance issues.
Gas Chromatograph Detectors: FID	•Change Quartz jet; clean; replace flame tip	
Gas Chromatograph/Mass Spectrometer	•Autotune Report	
Gas Chromatograph/Mass Spectrometer	•Clean ion source	
Gas Chromatograph/Mass Spectrometer	•Replace vacuum pump oil	
Gas Chromatographs/Mass Spectrometer & Gas Chromatographs	•Replace septa and liner	
Gas Chromatographs/Mass	•Replace column	

INSTRUMENT	P. M. DESCRIPTION	FREQUENCY
Spectrometer & Gas Chromatographs		
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
8141 OP Pest	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
Sulfolane, 8270C	Sigma Aldrich	Calibration Mix	Primary	4° ± 2°C	6 months
	Restek	Spike Mix	Second source	4° ± 2°C	6 months
Glycol, 8015	Chemservice	Calibration Mix	Primary	4° ± 2°C	6 months

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
	Chemservice	Spike Mix	Second source	4° ± 2°C	6 months
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/D	1,2,4,8,12,16,20,30,40,50,80 (low level and regular)	4° ± 2°C	6 months
Semi-Volatiles: RV/LVI	625, SM6410B 20th, 8270C/D	10,20,50,100,200,500,1000,2000 ug/L	4° ± 2°C	6 months
PCBs 1016/1260	608, SM6431B 20th, 8082	0.05, 0.1, 0.25, 0.5, 0.75, 1.0 µg/mL	4° ± 2°C	6 months
PCBs: RV	608, SM6431B 20th, 8082	2.0,4.0,5.0,10,20,50 µg/L	4° ± 2°C	6 months
Pesticides	608, SM 6630C, 8081A	0.05, 0.10, 0.20, 0.40, 0.60, 0.80 µg/mL	4° ± 2°C	6 months
Pesticides: RV	608, SM 6630C, 8081A,	0.5,1.0,2.0,5.0,10,15,20 µg/L	4° ± 2°C	6 months
Chlordane and/or Toxaphene	608, SM 6630C, 8081A	0.1, 0.5, 1.0, 2.5, 5.0, 10.0 µg/mL	4° ± 2°C	6 months
Chlordane and/or Toxaphene RV	608, SM 6630C, 8081A,	10,20,50,100,150,200 µg/L	4° ± 2°C	6 months
Sulfolane	8270C/D	4,8,10,20,50,100,200,500 ug/L	4° ± 2°C	6 months
PCB Arochlors 1221, 1232, 1242, 1248, 1254	8082	5.0 µg/mL	4° ± 2°C	6 months
Herbicides	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/D 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

TABLE 8.3B: Working Standard Concentrations
This table is subject to revision without notice

Organic Compounds	Method #	Standard Concentrations	Storage Requirements	Expiration
PAHs: RV/LVI	8270C/D SIM	4.0,20,40,100,160,400,600,800 ug/L 1.0,5.0,10,20,40,80,200 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*
Diesel/M.O: RV/LVI	EPH TN OA2 , 8015Mod, LA TPH D, LA TPH O, OHIO DRO	2.0,4.0,8.0,20,40,80,100,200 mg/L	NA*	NA*
DRO	DRO/CA LUFT/CO	2.0,4.0,10,20,40,60,100,200 mg/L	NA*	NA*
DROMO: LVI PAHMO: LVI	MO DRO/PAH by 8270	5.0,10,20,40,80,120,160,200 mg/L 4.0,20,40,100,160,400,600,800 ug/L	4° ± 2°C	6 months
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	NA*	NA*
THAAs	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*
Glycols	8015B/C/D - Modified	1.5,7.5,15,30,45,60 ppm	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*

* 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.

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.

Degradation if DDT and Endrin are also verified at least every 12hr window. Breakdown should recover less 20% of the total injection.

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 $\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.

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.

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 $\pm$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 $\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.

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.

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 either the internal or external standard calibration model. A minimum of five concentration levels is necessary for methods 8141A and 1657A. 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 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 20th sample 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 50% for other analytes of interest for 8270C. All analytes must recover +/- 30% for 8270D.. 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. 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 - PAHs 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 ±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, or per state method, 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 or 20th sample depending on method 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 $\pm$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 $\pm$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.

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 10th or 20th 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 (Pest/PCB, Herbicides, Organophos/ Organonitrogen Pesticides)	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
	Second Source	1 Second Source		+/- 20% of true value	With each calibration
	Daily / Continuing	OPPEST/HERB1/10 P/PCB 1/20		Must be within 15% of the initial calibration curve, 20% for 6640C.	Beginning, every 10 and ending for external cal. Every 20 samples for internal cal
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.

TABLE 8.5: INSTRUMENT CALIBRATION

Instrument (Analysis)	Calibration Type	Minimum Number of Standards	Type of Curve	Acceptance/ Rejection Criteria	Frequency
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		8270C: Should recover within 20% for all CCC compounds and within 50% for other analytes of interest, with the exception of analytes known to perform poorly 8270D: Should recover w/in 30% for all	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 50% 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	Extracted with each batch
	Daily / Continuing	1/10		CCV must be ≤30% difference for all compounds,	Beginning, every 10 and ending
Pesticides 507	Initial	5 cal.stds	Avg. RF or Linear	≤20% RSD all compounds	As needed
	Second Source(QCS)	1 Second Source		±20% of true value	Extracted with each batch
	Daily / Continuing	1/10		CCV must be ≤20% difference for all compounds,	Beginning, every 10 and ending
DRO –8015, State Programs* * Or per state requirement	Initial	5 cal.stds	Avg. RF or Linear	8015B/C/D - ≤20% RSD all compounds	As needed
	Second Source	1 Second Source		±20% of true value	With each calibration
	Daily / Continuing	1/10		CCV must be ≤15% difference for all compounds,	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: 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 SOPs associated with the semi-volatile laboratory can be found in the following table:

TABLE 10.1: SEMI-VOLATILE DEPARTMENT SOPS
This table is subject to revision without notice

SOP #	Title
	Preparatory SOPs
330702	Separatory Funnel Liquid-Liquid Extraction 3510C
330702A	Separatory Funnel Liquid-Liquid Extraction 3510C for Minnesota Samples
330702B	Reduced Volume Separatory Funnel Liquid-Liquid Extraction 3510C
330705	Ultrasonic Extraction 3550B
330707	Microwave Extraction 3546
330708	Buchi Syncore Concentration System
330709	Microextraction Procedure 3511
330743	Solid Phase Extraction
330754	Waste Dilution for SVOCs 3580A
330755	PCB in Oil Waste Dilution
	Extract Cleanup SOPs
330739	Silica Gel Cleanup 3630C
330740	Acid Cleanup 3665A
330741	Sulfur Cleanup 3660C
330742	Florisil Cleanup 3620B
	Semi-Volatiles Analysis SOPs
330317	Sulfolane
330318	Organophosphorus Pesticides 8141A/ 1657A/ 614/ 622
330319	THAAs 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

SOP #	Title
330343	PCBs 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
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/MA/NJ/MT - 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
330361	Glycols

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 (IDOCs) are performed during new analyst training and/or prior to acceptance and use of any new method/instrumentation. Continuing Demonstration of Capability (CDOCs) 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 provided that sufficient volume is provided by the client.

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.

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 Exceedance 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 RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
Pesticides	AZINPHOS-METHYL	8141A, 1657A	GW	51.2-132	20.0	0.001	mg/L
Pesticides	BOLSTAR (SULPROFOS)	8141A, 1657A	GW	50.1-125	20.0	0.001	mg/L
Pesticides	CHLORPYRIFOS	8141A, 1657A	GW	52.8-127	20.0	0.001	mg/L
Pesticides	COUMAPHOS	8141A, 1657A	GW	47.8-131	20.0	0.001	mg/L
Pesticides	DEMETON,-O AND -S	8141A, 1657A	GW	10.0-109	20.0	0.002	mg/L
Pesticides	DIAZINON	8141A, 1657A	GW	57.9-153	20.0	0.001	mg/L
Pesticides	DICHLORVOS	8141A, 1657A	GW	42.8-123	20.0	0.002	mg/L
Pesticides	DIMETHOATE	8141A, 1657A	GW	21.7-114	24.3	0.001	mg/L
Pesticides	DISULFOTON	8141A, 1657A	GW	52.9-127	20.0	0.001	mg/L
Pesticides	EPN	8141A, 1657A	GW	46.4-127	20.0	0.001	mg/L
Pesticides	ETHOPROP	8141A, 1657A	GW	52.9-128	20.0	0.001	mg/L
Pesticides	ETHYL PARATHION	8141A, 1657A	GW	52.2-125	20.0	0.001	mg/L
Pesticides	FENSULFOTHION	8141A, 1657A	GW	50.9-120	20.0	0.001	mg/L
Pesticides	FENTHION	8141A, 1657A	GW	51.8-130	20.0	0.001	mg/L
Pesticides	MALATHION	8141A, 1657A	GW	52.8-128	20.0	0.001	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
Pesticides	MERPHOS	8141A, 1657A	GW	45.7-119	20.0	0.001	mg/L
Pesticides	METHYL PARATHION	8141A, 1657A	GW	51.2-129	20.0	0.001	mg/L
Pesticides	MEVINPHOS	8141A, 1657A	GW	46.5-125	20.0	0.001	mg/L
Pesticides	NALED	8141A, 1657A	GW	32.0-130	20.0	0.001	mg/L
Pesticides	PHORATE	8141A, 1657A	GW	51.6-129	20.0	0.001	mg/L
Pesticides	RONNEL	8141A, 1657A	GW	50.1-125	20.0	0.001	mg/L
Pesticides	STIROPHOS	8141A, 1657A	GW	51.2-129	20.0	0.001	mg/L
Pesticides	SULFOTEP	8141A, 1657A	GW	51.7-127	20.0	0.001	mg/L
Pesticides	TEPP	8141A, 1657A	GW	0.00-138	29.1	0.020	mg/L
Pesticides	TOKUTHION (PROTHIOFOS)	8141A, 1657A	GW	49.4-124	20.0	0.001	mg/L
Pesticides	TRICHLORONATE	8141A, 1657A	GW	48.6-125	20.0	0.001	mg/L
Pesticides	AZINPHOS-METHYL	8141A	SS	54.7-124	21.8	0.1	mg/Kg
Pesticides	BOLSTAR (SULPROFOS)	8141A	SS	55.5-120	23.0	0.1	mg/Kg
Pesticides	CHLORPYRIFOS	8141A	SS	59.2-118	21.0	0.1	mg/Kg
Pesticides	COUMAPHOS	8141A	SS	52.4-127	22.0	0.1	mg/Kg
Pesticides	DEMETON,-O AND -S	8141A	SS	50.4-117	24.1	0.1	mg/Kg
Pesticides	DIAZINON	8141A	SS	57.2-137	20.4	0.1	mg/Kg
Pesticides	DICHLORVOS	8141A	SS	39.2-114	20.0	0.1	mg/Kg
Pesticides	DIMETHOATE	8141A	SS	21.5-124	39.1	0.1	mg/Kg
Pesticides	DISULFOTON	8141A	SS	55.3-118	21.8	0.1	mg/Kg
Pesticides	EPN	8141A	SS	36.7-136	22.1	0.1	mg/Kg
Pesticides	ETHOPROP	8141A	SS	59.4-116	20.0	0.1	mg/Kg
Pesticides	ETHYL PARATHION	8141A	SS	49.9-123	21.9	0.1	mg/Kg
Pesticides	FENSULFOTHION	8141A	SS	40.3-116	27.6	0.1	mg/Kg
Pesticides	FENTHION	8141A	SS	57.0-123	22.5	0.1	mg/Kg
Pesticides	MALATHION	8141A	SS	54.7-120	20.8	0.1	mg/Kg
Pesticides	MERPHOS	8141A	SS	54.2-110	24.2	0.1	mg/Kg
Pesticides	METHYL PARATHION	8141A	SS	52.9-124	20.7	0.1	mg/Kg
Pesticides	MEVINPHOS	8141A	SS	49.8-114	24.2	0.1	mg/Kg
Pesticides	NALED	8141A	SS	10.0-127	28.2	0.1	mg/Kg
Pesticides	PHORATE	8141A	SS	58.3-115	20.0	0.1	mg/Kg
Pesticides	RONNEL	8141A	SS	58.6-114	20.0	0.1	mg/Kg
Pesticides	STIROPHOS	8141A	SS	46.7-120	21.4	0.1	mg/Kg
Pesticides	SULFOTEP	8141A	SS	55.7-116	20.0	0.1	mg/Kg
Pesticides	TEPP	8141A	SS	0.00-100	40.0	1.0	mg/Kg
Pesticides	TOKUTHION (PROTHIOFOS)	8141A	SS	57.0-116	21.6	0.1	mg/Kg
Pesticides	TRICHLORONATE	8141A	SS	57.0-116	23.0	0.1	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
Pesticides	ALACHLOR	507	DW	70.0-130	25.0	0.0002	mg/L
Pesticides	ATRAZINE	507	DW	70.0-130	25.0	0.0001	mg/L
Pesticides	BUTACHLOR	507	DW	70.0-130	25.0	0.0001	mg/L
Pesticides	METOLACHLOR	507	DW	70.0-130	25.0	0.0002	mg/L
Pesticides	METRIBUZIN	507	DW	70.0-130	25.0	0.0002	mg/L
Pesticides	SIMAZINE	507	DW	70.0-130	25.0	7.00E-05	mg/L
Pesticides	4,4-DDD	608/8081A/B, 6630C	GW, WW	50.7-129	20.0	0.00005	mg/L
Pesticides	4,4-DDE	608/8081A/B, 6630C	GW, WW	37.1-131	20.0	0.00005	mg/L
Pesticides	4,4-DDT	608/8081A/B, 6630C	GW, WW	43.9-131	20.0	0.00005	mg/L
Pesticides	ALDRIN	608/8081A/B, 6630C	GW, WW	10.0-124	31.5	0.00005	mg/L
Pesticides	ALPHA BHC	608/8081A/B, 6630C	GW, WW	60.6-106	20.0	0.00005	mg/L
Pesticides	BETA BHC	608/8081A/B, 6630C	GW, WW	64.9-111	20.0	0.00005	mg/L
Pesticides	ALPHA CHLORDANE	608/8081A/B, 6630C	GW, WW	51.0-117	21.0	0.005	mg/L
Pesticides	DELTA BHC	608/8081A/B, 6630C	GW, WW	61.1-115	20.0	0.00005	mg/L
Pesticides	DIELDRIN	608/8081A/B, 6630C	GW, WW	57.2-119	20.0	0.00005	mg/L
Pesticides	ENDOSULFAN I	608/8081A/B, 6630C	GW, WW	57.2-118	20.0	0.00005	mg/L
Pesticides	ENDOSULFAN II	608/8081A/B, 6630C	GW, WW	59.1-120	20.0	0.00005	mg/L
Pesticides	ENDOSULFAN SULFATE	608/8081A/B, 6630C	GW, WW	49.7-132	20.0	0.00005	mg/L
Pesticides	ENDRIN	608/8081A/B, 6630C	GW, WW	55.8-124	20.0	0.00005	mg/L
Pesticides	ENDRIN ALDEHYDE	608/8081A/B, 6630C	GW, WW	46.7-122	20.0	0.00005	mg/L
Pesticides	ENDRIN KETONE	608/8081A/B, 6630C	GW, WW	59.2-126	20.0	0.00005	mg/L
Pesticides	GAMMA BHC	608/8081A/B, 6630C	GW, WW	62.1-109	20.0	0.00005	mg/L
Pesticides	HEPTACHLOR	608/8081A/B, 6630C	GW, WW	15.4-116	20.0	0.00005	mg/L
Pesticides	HEPTACHLOR EPOXIDE	608/8081A/B, 6630C	GW, WW	57.3-117	25.1	0.00005	mg/L
Pesticides	HEXACHLOROBENZENE	608/8081A/B, 6630C	GW, WW	28.7-108	20.0	0.00005	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
Pesticides	METHOXYCHLOR	608/8081A/B, 6630C	GW, WW	55.7-121	20.0	0.00005	mg/L
PCBs	PCB 1016	608, 6431B, 8082/A	GW, WW	48.4-116	20.0	0.0005	mg/L
PCBs	PCB 1260	608, 6431B, 8082/A	GW, WW	53.6-122	22.0	0.0005	mg/L
PCBs	PCB 1016	8082/A	SS	63.2-118	20.0	0.017	mg/Kg
PCBs	PCB 1260	8082/A	SS	64.6-123	20.8	0.017	mg/Kg
Pesticides	4,4-DDD	8081A/B	SS	70.3-111	20.0	0.02	mg/Kg
Pesticides	4,4-DDE	8081A/B	SS	69.9-113	20.0	0.02	mg/Kg
Pesticides	4,4-DDT	8081A/B	SS	68.1-111	20.0	0.02	mg/Kg
Pesticides	ALDRIN	8081A/B	SS	66.9-111	20.0	0.02	mg/Kg
Pesticides	ALPHA BHC	8081A/B	SS	65.1-111	20.0	0.02	mg/Kg
Pesticides	BETA BHC	8081A/B	SS	69.6-112	20.0	0.02	mg/Kg
Pesticides	DELTA BHC	8081A/B	SS	68.3-114	20.0	0.02	mg/Kg
Pesticides	DIELDRIN	8081A/B	SS	70.2-112	20.0	0.02	mg/Kg
Pesticides	ENDOSULFAN I	8081A/B	SS	69.8-113	20.0	0.02	mg/Kg
Pesticides	ENDOSULFAN II	8081A/B	SS	69.2-113	20.0	0.02	mg/Kg
Pesticides	ENDOSULFAN SULFATE	8081A/B	SS	62.0-123	20.0	0.02	mg/Kg
Pesticides	ENDRIN	8081A/B	SS	65.9-115	20.0	0.02	mg/Kg
Pesticides	ENDRIN ALDEHYDE	8081A/B	SS	47.6-124	20.0	0.02	mg/Kg
Pesticides	ENDRIN KETONE	8081A/B	SS	69.0-120	20.0	0.02	mg/Kg
Pesticides	GAMMA BHC	8081A/B	SS	68.2-111	20.0	0.02	mg/Kg
Pesticides	HEPTACHLOR	8081A/B	SS	65.9-111	20.0	0.02	mg/Kg
Pesticides	HEPTACHLOR EPOXIDE	8081A/B	SS	69.7-113	20.0	0.02	mg/Kg
Pesticides	HEXACHLOROBENZENE	8081A/B	SS	59.6-113	20.0	0.02	mg/Kg
Pesticides	METHOXYCHLOR	8081A/B	SS	66.2-114	20.0	0.02	mg/Kg
Herbicides	2,4,5-T	1658, 8151A, 6640C	GW, WW	53.9-119	20.0	0.002	mg/L
Herbicides	2,4,5-TP (SILVEX)	1658, 8151A, 6640C	GW, WW	60.8-121	20.0	0.002	mg/L
Herbicides	2,4-D	1658, 8151A, 6640C	GW, WW	52.4-110	20.0	0.002	mg/L
Herbicides	2,4-DB	1658, 8151A, 6640C	GW, WW	33.9-123	20.0	0.002	mg/L
Herbicides	DALAPON	1658, 8151A, 6640C	GW, WW	41.8-105	20.0	0.002	mg/L
Herbicides	DICAMBA	1658, 8151A, 6640C	GW, WW	61.9-114	20.0	0.002	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
Herbicides	DICHLOROPROP	1658, 8151A, 6640C	GW, WW	63.0-129	20.0	0.002	mg/L
Herbicides	DINOSEB	1658, 8151A, 6640C	GW, WW	43.7-121	23.1	0.002	mg/L
Herbicides	MCPA	1658, 8151A, 6640C	GW, WW	10.0-184	38.1	0.1	mg/L
Herbicides	MCPP	1658, 8151A, 6640C	GW, WW	55.3-188	20.0	0.1	mg/L
Herbicides	2,4,5-T	8151A	SS	38.1-115	23.2	0.07	mg/Kg
Herbicides	2,4,5-TP (SILVEX)	8151A	SS	49.0-119	20.2	0.07	mg/Kg
Herbicides	2,4-D	8151A	SS	38.9-103	24.7	0.07	mg/Kg
Herbicides	2,4-DB	8151A	SS	29.1-111	27.6	0.07	mg/Kg
Herbicides	DALAPON	8151A	SS	28.4-114	28.0	0.07	mg/Kg
Herbicides	DICAMBA	8151A	SS	48.3-115	22.1	0.07	mg/Kg
Herbicides	DICHLOROPROP	8151A	SS	42.4-128	23.6	0.07	mg/Kg
Herbicides	DINOSEB	8151A	SS	10.0-113	40.0	0.07	mg/Kg
Herbicides	MCPA	8151A	SS	10.0-149	40.0	6.5	mg/Kg
Herbicides	MCPP	8151A	SS	47.9-173	32.4	6.5	mg/Kg
PAH	1-METHYLNAPHTHALENE	8310, 610, 6440B	GW, WW	49.7-93.4	20.0	0.0001	mg/L
PAH	2-METHYLNAPHTHALENE	8310, 610, 6440B	GW, WW	44.3-84.1	20.0	0.0001	mg/L
PAH	ACENAPHTHENE	8310, 610, 6440B	GW, WW	52.6-88.0	20.0	0.0001	mg/L
PAH	ACENAPHTHYLENE	8310, 610, 6440B	GW, WW	57.1-90.4	20.0	0.0001	mg/L
PAH	ANTHRACENE	8310, 610, 6440B	GW, WW	61.0-96.6	20.0	0.0001	mg/L
PAH	BENZO(A)ANTHRACENE	8310, 610, 6440B	GW, WW	64.4-103	20.0	0.0001	mg/L
PAH	BENZO(A)PYRENE	8310, 610, 6440B	GW, WW	53.0-110	20.0	0.0001	mg/L
PAH	BENZO(B)FLUORANTHENE	8310, 610, 6440B	GW, WW	66.0-102	20.0	0.0001	mg/L
PAH	BENZO(G,H,I)PERYLENE	8310, 610, 6440B	GW, WW	40.8-119	20.0	0.0001	mg/L
PAH	BENZO(K)FLUORANTHENE	8310, 610, 6440B	GW, WW	63.9-96.0	20.0	0.0001	mg/L
PAH	CHRYSENE	8310, 610, 6440B	GW, WW	66.9-104	20.0	0.0001	mg/L
PAH	DIBENZ(A,H)ANTHRACENE	8310, 610, 6440B	GW, WW	37.2-103	22.2	0.0001	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
PAH	FLUORANTHENE	8310, 610, 6440B	GW, WW	67.7-108	20.0	0.0001	mg/L
PAH	FLUORENE	8310, 610, 6440B	GW, WW	56.7-94.0	20.0	0.0001	mg/L
PAH	INDENO(1,2,3-CD)PYRENE	8310, 610, 6440B	GW, WW	58.7-97.0	20.0	0.0001	mg/L
PAH	NAPHTHALENE	8310, 610, 6440B	GW, WW	42.6-85.1	20.2	0.0001	mg/L
PAH	PHENANTHRENE	8310, 610, 6440B	GW, WW	60.4-95.4	20.0	0.0001	mg/L
PAH	PYRENE	8310, 610, 6440B	GW, WW	63.7-103	20.0	0.0001	mg/L
PAH	1-METHYLNAPHTHALENE	8310	SS	50.9-112	20.0	0.02	mg/Kg
PAH	2-METHYLNAPHTHALENE	8310	SS	47.2-92.0	20.0	0.02	mg/Kg
PAH	ACENAPHTHENE	8310	SS	51.8-100	20.0	0.02	mg/Kg
PAH	ACENAPHTHYLENE	8310	SS	53.8-104	20.0	0.02	mg/Kg
PAH	ANTHRACENE	8310	SS	68.3-97.0	20.0	0.02	mg/Kg
PAH	BENZO(A)ANTHRACENE	8310	SS	77.9-101	20.0	0.02	mg/Kg
PAH	BENZO(A)PYRENE	8310	SS	68.5-107	20.0	0.02	mg/Kg
PAH	BENZO(B)FLUORANTHENE	8310	SS	75.6-100	20.0	0.02	mg/Kg
PAH	BENZO(G,H,I)PERYLENE	8310	SS	73.6-123	20.0	0.02	mg/Kg
PAH	BENZO(K)FLUORANTHENE	8310	SS	74.9-95.0	20.0	0.02	mg/Kg
PAH	CHRYSENE	8310	SS	78.7-99.0	20.0	0.02	mg/Kg
PAH	DIBENZ(A,H)ANTHRACENE	8310	SS	74.7-97.0	20.0	0.02	mg/Kg
PAH	FLUORANTHENE	8310	SS	79.7-104	20.0	0.02	mg/Kg
PAH	FLUORENE	8310	SS	57.9-102	20.0	0.02	mg/Kg
PAH	INDENO(1,2,3-CD)PYRENE	8310	SS	71.0-99.0	20.0	0.02	mg/Kg
PAH	NAPHTHALENE	8310	SS	44.7-97.0	20.0	0.02	mg/Kg
PAH	PHENANTHRENE	8310	SS	65.1-96.0	20.0	0.02	mg/Kg
PAH	PYRENE	8310	SS	74.3-100	20.0	0.02	mg/Kg
BNA	PYRIDINE	8270C/D 625	GW,WW	13.0-54.0	32.8	0.01	mg/L
BNA	PYRENE	8270C/D 625	GW,WW	40.2-135	20.0	0.001	mg/L
BNA	PHENOL	8270C/D 625	GW,WW	10.0-77.3	24.6	0.01	mg/L
BNA	PHENANTHRENE	8270C/D 625	GW,WW	41.4-134	20.0	0.001	mg/L
BNA	PENTACHLOROPHENOL	8270C/D 625	GW,WW	17.0-117	34.3	0.01	mg/L
BNA	N-OCTADECANE	8270C/D 625	GW,WW	28.3-151	20.0	0.01	mg/L
BNA	N-NITROSODIPHENYLAMINE	8270C/D 625	GW,WW	41.1-134	20.0	0.01	mg/L
BNA	N-NITRODIPHENYLAMINE	8270C/D 625	GW,WW	40.1-157	20.0	0.01	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	N-NITROSODI-N-PROPYLAMINE	8270C/D 625	GW,WW	35.6-125	20.0	0.01	mg/L
BNA	N-NITROSODIMETHYLAMINE	8270C/D 625	GW,WW	12.3-70.5	33.0	.01	mg/L
BNA	NITROBENZENE	8270C/D 625	GW,WW	34.4-121	21.2	.01	mg/L
BNA	N-DECANE	8270C/D 625	GW,WW	10.0-118	32.3	0.01	mg/L
BNA	NAPHTHALENE	8270C/D 625	GW,WW	33.0-117	20.0	0.001	mg/L
BNA	ISOPHORONE	8270C/D 625	GW,WW	30.5-109	20.0	0.01	mg/L
BNA	INDENO(1,2,3-CD)PYRENE	8270C/D 625	GW,WW	41.0-140	20.0	0.01	mg/L
BNA	HEXACHLOROETHANE	8270C/D 625	GW,WW	22.2-109	25.8	0.01	mg/L
BNA	HEXACHLOROCYCLOPENTADIENE	8270C/D 625	GW,WW	13.5-122	21.6	0.00	mg/L
BNA	HEXACHLOROBENZENE	8270C/D 625	GW,WW	34.1-125	20.0	0.001	mg/L
BNA	HEXACHLORO-1,3-BUTADIENE	8270C/D 625	GW,WW	24.9-121	22.0	0.01	mg/L
BNA	FLUORENE	8270C/D 625	GW,WW	39.9-132	20.0	0.001	mg/L
BNA	FLUORANTHENE	8270C/D 625	GW,WW	41.4-141	20.0	0.001	mg/L
BNA	DI-N-OCTYL PHTHALATE	8270C/D 625	GW,WW	39.8-146	20.0	0.003	mg/L
BNA	DI-N-BUTYL PHTHALATE	8270C/D 625	GW,WW	33.0-151	20.0	0.003	mg/L
BNA	DIMETHYL PHTHALATE	8270C/D 625	GW,WW	23.4-138	20.2	0.003	mg/L
BNA	DIETHYL PHTHALATE	8270C/D 625	GW,WW	36.0-140	20.0	0.003	mg/L
BNA	DIBENZOFURAN	8270C/D 625	GW,WW	37.9-128	20.0	0.01	mg/L
BNA	DIBENZ(A,H)ANTHRACENE	8270C/D 625	GW,WW	39.9-141	20.0	0.001	mg/L
BNA	CHRYSENE	8270C/D 625	GW,WW	40.5-140	20.0	0.001	mg/L
BNA	CARBAZOLE	8270C/D 625	GW,WW	41.0-137	20.0	0.01	mg/L
BNA	CAPROLACTAM	8270C/D 625	GW,WW	10.0-45.6	25.2	0.01	mg/L
BNA	BIS(2-ETHYLHEXYL)PHTHALATE	8270C/D 625	GW,WW	41.4-150	20.0	0.003	mg/L
BNA	BIS(2-CHLOROISOPROPYL)ETHER	8270C/D 625	GW,WW	33.6-115	21.3	0.01	mg/L
BNA	BIS(2-CHLOROETHYL)ETHER	8270C/D 625	GW,WW	29.8-114	25.3	0.01	mg/L
BNA	BIS(2-CHLORETHOXY)METHANE	8270C/D 625	GW,WW	36.7-123	20.0	0.01	mg/L
BNA	BIPHENYL	8270C/D 625	GW,WW	36.9-126	20.0	0.01	mg/L
BNA	BENZYLBUTYL PHTHALATE	8270C/D 625	GW,WW	29.2-146	20.7	0.003	mg/L
BNA	BENZYL ALCOHOL	8270C/D 625	GW,WW	26.0-104	21.0	0.01	mg/L
BNA	BENZOIC ACID	8270C/D 625	GW,WW	10.0-54.3	40.0	0.01	mg/L
BNA	BENZO(K)FLUORANTHENE	8270C/D 625	GW,WW	41.5-140	20.0	0.001	mg/L
BNA	BENZO(G,H,I)PERYLENE	8270C/D 625	GW,WW	38.8-137	20.0	0.001	mg/L
BNA	BENZO(B)FLUORANTHENE	8270C/D 625	GW,WW	40.5-137	20.0	0.001	mg/L
BNA	BENZO(A)PYRENE	8270C/D 625	GW,WW	41.7-138	20.0	0.001	mg/L
BNA	BENZO(A)ANTHRACENE	8270C/D 625	GW,WW	42.3-137	20.0	0.001	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	BENZIDINE	8270C/D 625	GW,WW	10.0-75.5	40.0	0.01	mg/L
BNA	BENZALDEHYDE	8270C/D 625	GW,WW	10.0-93.4	27.8	0.01	mg/L
BNA	AZOBENZENE	8270C/D 625	GW,WW	37.2-129	20.0	0.01	mg/L
BNA	ATRAZINE	8270C/D 625	GW,WW	40.6-154	20.0	0.01	mg/L
BNA	ANTHRACENE	8270C/D 625	GW,WW	42.9-138	20.0	0.001	mg/L
BNA	ANILINE	8270C/D 625	GW,WW	22.5-99.1	28.3	0.01	mg/L
BNA	ACETOPHENONE	8270C/D 625	GW,WW	35.6-122	20.0	0.01	mg/L
BNA	ACENAPHTHYLENE	8270C/D 625	GW,WW	41.0-135	20.0	0.001	mg/L
BNA	ACENAPHTHENE	8270C/D 625	GW,WW	39.0-128	20.0	0.001	mg/L
BNA	4-NITROPHENOL	8270C/D 625	GW,WW	10.0-65.4	33.6	0.01	mg/L
BNA	4-NITROANILINE	8270C/D 625	GW,WW	37.3-159	20.0	0.01	mg/L
BNA	4-CHLOROPHENYL-PHENYLETHER	8270C/D 625	GW,WW	37.3-130	20.0	0.01	mg/L
BNA	4-CHLOROANILINE	8270C/D 625	GW,WW	29.8-128	20.9	0.01	mg/L
BNA	4-CHLORO-3-METHYLPHENOL	8270C/D 625	GW,WW	34.6-130	20.0	0.01	mg/L
BNA	4-BROMOPHENYL-PHENYLETHER	8270C/D 625	GW,WW	39.0-137	20.0	0.01	mg/L
BNA	4,6-DINITRO-2-METHYLPHENOL	8270C/D 625	GW,WW	28.2-134	29.2	0.01	mg/L
BNA	3-NITROANILINE	8270C/D 625	GW,WW	34.8-132	20.0	0.01	mg/L
BNA	3,3-DICHLOROBENZIDINE	8270C/D 625	GW,WW	33.1-134	20.0	0.01	mg/L
BNA	3&4-METHYLPHENOL	8270C/D 625	GW,WW	23.1-107	20.7	0.01	mg/L
BNA	2-NITROPHENOL	8270C/D 625	GW,WW	38.3-125	20.0	0.01	mg/L
BNA	2-NITROANILINE	8270C/D 625	GW,WW	41.9-143	20.0	0.01	mg/L
BNA	2-METHYLPHENOL	8270C/D 625	GW,WW	23.9-97	20.0	0.01	mg/L
BNA	2-METHYLNAPHTHALENE	8270C/D 625	GW,WW	35.6-124	20.0	0.001	mg/L
BNA	2-CHLOROPHENOL	8270C/D 625	GW,WW	31.2-103	20.0	0.01	mg/L
BNA	2-CHLORONAPHTHALENE	8270C/D 625	GW,WW	35.1-123	20.0	0.001	mg/L
BNA	2,6-DINITROTOLUENE	8270C/D 625	GW,WW	41.0-139	20.0	0.01	mg/L
BNA	2,4-DINITROTOLUENE	8270C/D 625	GW,WW	42.3-143	20.0	0.01	mg/L
BNA	2,4-DINITROPHENOL	8270C/D 625	GW,WW	10.0-108	40.0	0.01	mg/L
BNA	2,4-DIMETHYLPHENOL	8270C/D 625	GW,WW	33.8-126	20.0	0.01	mg/L
BNA	2,4-DICHLOROPHENOL	8270C/D 625	GW,WW	39.6-121	20.0	0.01	mg/L
BNA	2,4,6-TRICHLOROPHENOL	8270C/D 625	GW,WW	35.9-129	22.4	0.01	mg/L
BNA	2,4,5-TRICHLOROPHENOL	8270C/D 625	GW,WW	35.4-136	20.0	0.01	mg/L
BNA	1-METHYLNAPHTHALENE	8270C/D 625	GW,WW	34.3-123	20.0	0.001	mg/L
BNA	1,4-DICHLOROBENZENE	8270C/D 625	GW,WW	24.8-105	25.2	0.01	mg/L
BNA	1,3-DICHLOROBENZENE	8270C/D 625	GW,WW	23.9-103	25.2	0.01	mg/L
BNA	1,2-DICHLOROBENZENE	8270C/D 625	GW,WW	26.1-107	25.4	0.01	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	1,2,4-TRICHLOROBENZENE	8270C/D 625	GW,WW	26.6-109	20.0	0.01	mg/L
BNA	1,2,4,5-TETRACHLOROBENZENE	8270C/D 625	GW,WW	30.8-124	20.7	0.01	mg/L
BNA	PYRIDINE	8270C/D	SS	10.0-90.0	38.3	0.33	mg/Kg
BNA	PYRENE	8270C/D	SS	47.1-108	20.0	0.33	mg/Kg
BNA	PHENOL	8270C/D	SS	41.5-106	20.0	0.33	mg/Kg
BNA	PHENANTHRENE	8270C/D	SS	51.6-107	20.0	0.33	mg/Kg
BNA	PENTACHLOROPHENOL	8270C/D	SS	16.2-102	22.9	0.33	mg/Kg
BNA	N-OCTADECANE	8270C/D	SS	40.7-122	20.0	0.33	mg/Kg
BNA	N-NITROSODIPHENYLAMINE	8270C/D	SS	48.8-107	20.0	0.33	mg/Kg
BNA	N-NITROSODI-N-PROPYLAMINE	8270C/D	SS	43.3-109	20.0	0.33	mg/Kg
BNA	N-NITROSODIMETHYLAMINE	8270C/D	SS	18.1-1422	23.5	0.33	mg/Kg
BNA	NITROBENZENE	8270C/D	SS	40.7-109	21.0	0.33	mg/Kg
BNA	N-DECANE	8270C/D	SS	38.1-116	20.0	0.33	mg/Kg
BNA	NAPHTHALENE	8270C/D	SS	43.4-103	20.0	0.33	mg/Kg
BNA	ISOPHORONE	8270C/D	SS	28.8-104	20.0	0.033	mg/Kg
BNA	INDENO(1,2,3-CD)PYRENE	8270C/D	SS	47.5-109	20.0	0.33	mg/Kg
BNA	HEXACHLOROETHANE	8270C/D	SS	36.2-103	22.7	0.033	mg/Kg
BNA	HEXACHLOROCYCLOPENTADIENE	8270C/D	SS	13.5-123	20.7	0.33	mg/Kg
BNA	HEXACHLOROBENZENE	8270C/D	SS	43.2-104	20.1	0.33	mg/Kg
BNA	HEXACHLORO-1,3-BUTADIENE	8270C/D	SS	41.5-112	20.0	0.33	mg/Kg
BNA	FLUORENE	8270C/D	SS	51.1-109	20.0	0.33	mg/Kg
BNA	FLUORANTHENE	8270C/D	SS	53.7-110	20.0	0.33	mg/Kg
BNA	DI-N-OCTYL PHTHALATE	8270C/D	SS	49.6-112	20.0	0.33	mg/Kg
BNA	DI-N-BUTYL PHTHALATE	8270C/D	SS	49.7-113	20.0	0.33	mg/Kg
BNA	DIMETHYL PHTHALATE	8270C/D	SS	51.4-108	20.0	0.33	mg/Kg
BNA	DIETHYL PHTHALATE	8270C/D	SS	52.0-112	20.0	0.33	mg/Kg
BNA	DIBENZOFURAN	8270C/D	SS	48.6-104	20.0	0.33	mg/Kg
BNA	DIBENZ(A,H)ANTHRACENE	8270C/D	SS	45.7-111	20.0	0.33	mg/Kg
BNA	CHRYSENE	8270C/D	SS	54.4-110	20.0	0.33	mg/Kg
BNA	CARBAZOLE	8270C/D	SS	52.4-102	21.1	0.33	mg/Kg
BNA	CAPROLACTAM	8270C/D	SS	42.2-107	21.9	0.33	mg/Kg
BNA	BIS(2-ETHYLHEXYL)PHTHALATE	8270C/D	SS	48.1-116	20.5	0.33	mg/Kg
BNA	BIS(2-CHLOROISOPROPYL)ETHER	8270C/D	SS	40.4-99.0	20.7	0.33	mg/Kg
BNA	BIS(2-CHLOROETHYL)ETHER	8270C/D	SS	32.5-112	26.0	0.33	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	BIS(2-CHLORETHOXY)METHANE	8270C/D	SS	44.9-108	20.0	0.33	mg/Kg
BNA	BIPHENYL	8270C/D	SS	45.6-103	20.0	0.33	mg/Kg
BNA	BENZYLBUTYL PHTHALATE	8270C/D	SS	47.5-115	20.0	0.33	mg/Kg
BNA	BENZYL ALCOHOL	8270C/D	SS	49.1-105	20.0	0.033	mg/Kg
BNA	BENZOIC ACID	8270C/D	SS	0.00-82.0	32.5	0.033	mg/Kg
BNA	BENZO(K)FLUORANTHENE	8270C/D	SS	52.9-107	20.0	0.33	mg/Kg
BNA	BENZO(G,H,I)PERYLENE	8270C/D	SS	45.8-108	20.0	0.33	mg/Kg
BNA	BENZO(B)FLUORANTHENE	8270C/D	SS	51.3-106	20.0	0.33	mg/Kg
BNA	BENZO(A)PYRENE	8270C/D	SS	51.9-106	20.0	0.33	mg/Kg
BNA	BENZO(A)ANTHRACENE	8270C/D	SS	52.3-106	20.0	0.33	mg/Kg
BNA	BENZIDINE	8270C/D	SS	0.00-48.0	40.0	0.033	mg/Kg
BNA	BENZALDEHYDE	8270C/D	SS	46.4-109	24.8	0.33	mg/Kg
BNA	AZOBENZENE	8270C/D	SS	45.0-131	20.0	0.33	mg/Kg
BNA	ATRAZINE	8270C/D	SS	45.0-131	20.0	0.33	mg/Kg
BNA	ANTHRACENE	8270C/D	SS	52.0-112	20.0	0.33	mg/Kg
BNA	ANILINE	8270C/D	SS	10.0-94.0	24.2	0.33	mg/Kg
BNA	ACETOPHENONE	8270C/D	SS	47.1-99.0	22.1	0.33	mg/Kg
BNA	ACENAPHTHYLENE	8270C/D	SS	49.2-111	20.0	0.033	mg/Kg
BNA	ACENAPHTHENE	8270C/D	SS	48.9-107	20.0	0.033	mg/Kg
BNA	4-NITROPHENOL	8270C/D	SS	34.8-109	20.0	0.033	mg/Kg
BNA	4-NITROANILINE	8270C/D	SS	38.6-133	21.7	0.033	mg/Kg
BNA	4-CHLOROPHENYL-PHENYLETHER	8270C/D	SS	48.1-108	20.0	0.033	mg/Kg
BNA	4-CHLOROANILINE	8270C/D	SS	24.5-101	24.5	0.33	mg/Kg
BNA	4-CHLORO-3-METHYLPHENOL	8270C/D	SS	51.1-113	20.0	0.33	mg/Kg
BNA	4-BROMOPHENYL-PHENYLETHER	8270C/D	SS	51.4-110	20.0	0.33	mg/Kg
BNA	4,6-DINITRO-2-METHYLPHENOL	8270C/D	SS	23.1-119	23.7	0.33	mg/Kg
BNA	3-NITROANILINE	8270C/D	SS	34.7-103	20.7	0.33	mg/Kg
BNA	3,3-DICHLOROBENZIDINE	8270C/D	SS	21.0-101	22.0	0.33	mg/Kg
BNA	3&4-METHYLPHENOL	8270C/D	SS	50.5-115	20.0	0.33	mg/Kg
BNA	2-NITROPHENOL	8270C/D	SS	44.2-113	20.9	0.33	mg/Kg
BNA	2-NITROANILINE	8270C/D	SS	56.2-117	20.0	0.33	mg/Kg
BNA	2-METHYLPHENOL	8270C/D	SS	53.8-107	20.0	0.33	mg/Kg
BNA	2-METHYLNAPHTHALENE	8270C/D	SS	42.4-100	20.0	0.033	mg/Kg
BNA	2-CHLOROPHENOL	8270C/D	SS	48.0-101	20.0	0.33	mg/Kg
BNA	2-CHLORONAPHTHALENE	8270C/D	SS	40.8-103	20.0	0.33	mg/Kg
BNA	2,6-DINITROTOLUENE	8270C/D	SS	47.1-105	20.0	0.33	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	2,4-DINITROTOLUENE	8270C/D	SS	51.6-110	20.0	0.033	mg/Kg
BNA	2,4-DINITROPHENOL	8270C/D	SS	53.0-112	36.5	0.33	mg/Kg
BNA	2,4-DIMETHYLPHENOL	8270C/D	SS	10.0-105	20.0	0.33	mg/Kg
BNA	2,4-DICHLOROPHENOL	8270C/D	SS	42.2-109	20.0	0.33	mg/Kg
BNA	2,4,6-TRICHLOROPHENOL	8270C/D	SS	44.4-108	20.0	0.33	mg/Kg
BNA	2,4,5-TRICHLOROPHENOL	8270C/D	SS	43.3-110	20.0	0.33	mg/Kg
BNA	1-METHYLNAPHTHALENE	8270C/D	SS	49.8-104	20.0	0.33	mg/Kg
BNA	1,4-DICHLOROBENZENE	8270C/D	SS	36.5-97.0	20.0	0.33	mg/Kg
BNA	1,3-DICHLOROBENZENE	8270C/D	SS	35.0-94.0	20.0	0.33	mg/Kg
BNA	1,2-DICHLOROBENZENE	8270C/D	SS	37.2-98.0	20.0	0.33	mg/Kg
BNA	1,2,4-TRICHLOROBENZENE	8270C/D	SS	39.8-100	20.0	0.33	mg/Kg
BNA	1,2,4,5-TETRACHLOROBENZENE	8270C/D	SS	47.6-107	20.0	0.33	mg/Kg
BNA	PYRIDINE	8270C/D RV	GW,WW	13.5-58.9	32.5	0.01	mg/L
BNA	PYRENE	8270C/D RV	GW,WW	463-117	20.0	0.001	mg/L
BNA	PHENOL	8270C/D RV	GW,WW	10.0-57.9	35.0	0.01	mg/L
BNA	PHENANTHRENE	8270C/D RV	GW,WW	46.4-113	20.0	0.001	mg/L
BNA	PENTACHLOROPHENOL	8270C/D RV	GW,WW	10.9-97.4	35.1	0.01	mg/L
BNA	N-OCTADECANE	8270C/D RV	GW,WW	15.8-132	21.1	0.01	mg/L
BNA	N-NITROSODIPHENYLAMINE	8270C/D RV	GW,WW	44.4-113	20.0	0.01/ .05ug/L SIM	mg/L
BNA	N-NITROSODI-N-PROPYLAMINE	8270C/D RV	GW,WW	33.2-106	23.7	0.01	mg/L
BNA	N-NITROSODIMETHYLAMINE	8270C/D RV	GW,WW	33.2-106	37.5	0.01	mg/L
BNA	NITROBENZENE	8270C/D RV	GW,WW	31.4-106	25.7	0.01	mg/L
BNA	N-DECANE	8270C/D RV	GW,WW	10.0-95.2	40.0	0.01	mg/L
BNA	NAPHTHALENE	8270C/D RV	GW,WW	32.2-101	23.8	0.001	mg/L
BNA	ISOPHORONE	8270C/D RV	GW,WW	35.4-112	21.5	0.01	mg/L
BNA	INDENO(1,2,3-CD)PYRENE	8270C/D RV	GW,WW	45.0-116	20.0	0.01	mg/L
BNA	HEXACHLOROETHANE	8270C/D RV	GW,WW	16.5-89.8	30.7	0.01	mg/L
BNA	HEXACHLOROCYCLOPENTADIENE	8270C/D RV	GW,WW	10.0-121	27.9	0.00	mg/L
BNA	HEXACHLOROBENZENE	8270C/D RV	GW,WW	38.5-116	20.1	0.001	mg/L
BNA	HEXACHLORO-1,3-BUTADIENE	8270C/D RV	GW,WW	16.1-104	31.2	0.01	mg/L
BNA	FLUORENE	8270C/D RV	GW,WW	41.0-112	20.2	0.001	mg/L
BNA	FLUORANTHENE	8270C/D RV	GW,WW	45.9-115	20.0	0.001	mg/L
BNA	DI-N-OCTYL PHTHALATE	8270C/D RV	GW,WW	39.7-112	21.1	0.003	mg/L
BNA	DI-N-BUTYL PHTHALATE	8270C/D RV	GW,WW	41.8-120	20.2	0.003	mg/L
BNA	DIMETHYL PHTHALATE	8270C/D RV	GW,WW	35.3-128	20.8	0.003	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	DIETHYL PHTHALATE	8270C/D RV	GW,WW	36.5-129	20.0	0.003	mg/L
BNA	DIBENZOFURAN	8270C/D RV	GW,WW	42.4-105	20.0	0.01	mg/L
BNA	DIBENZ(A,H)ANTHRACENE	8270C/D RV	GW,WW	42.8-118	20.0	0.001	mg/L
BNA	CHRYSENE	8270C/D RV	GW,WW	54.6-120	20.0	0.001	mg/L
BNA	CARBAZOLE	8270C/D RV	GW,WW	49.0-110	20.0	0.01	mg/L
BNA	CAPROLACTAM	8270C/D RV	GW,WW	10.0-40.4	40.0	0.01	mg/L
BNA	BIS(2-ETHYLHEXYL)PHTHALATE	8270C/D RV	GW,WW	36.9-134	23.6	0.003	mg/L
BNA	BIS(2-CHLOROISOPROPYL)ETHER	8270C/D RV	GW,WW	32.9-100	25.1	0.01	mg/L
BNA	BIS(2-CHLOROETHYL)ETHER	8270C/D RV	GW,WW	22.6-108	27.9	0.01	mg/L
BNA	BIS(2-CHLORETHOXY)METHANE	8270C/D RV	GW,WW	37.2-111	24.1	0.01	mg/L
BNA	BIPHENYL	8270C/D RV	GW,WW	38.0-103	20.1	0.01	mg/L
BNA	BENZYLBUTYL PHTHALATE	8270C/D RV	GW,WW	31.8-123	20.7	0.003	mg/L
BNA	BENZYL ALCOHOL	8270C/D RV	GW,WW	30.1-89.2	24.8	0.01	mg/L
BNA	BENZOIC ACID	8270C/D RV	GW,WW	0.00-79.4	31.1	0.01	mg/L
BNA	BENZO(K)FLUORANTHENE	8270C/D RV	GW,WW	49.4-114	20.0	0.001	mg/L
BNA	BENZO(G,H,I)PERYLENE	8270C/D RV	GW,WW	45.2-117	20.0	0.001	mg/L
BNA	BENZO(B)FLUORANTHENE	8270C/D RV	GW,WW	47.6-110	20.0	0.001	mg/L
BNA	BENZO(A)PYRENE	8270C/D RV	GW,WW	45.6-106	20.0	0.001	mg/L
BNA	BENZO(A)ANTHRACENE	8270C/D RV	GW,WW	51.2-112	20.0	0.001	mg/L
BNA	BENZIDINE	8270C/D RV	GW,WW	10.0-165	40.0	0.01	mg/L
BNA	BENZALDEHYDE	8270C/D RV	GW,WW	11.7-132	25.2	0.01	mg/L
BNA	AZOBENZENE	8270C/D RV	GW,WW	37.6-111	21.1	0.01	mg/L
BNA	ATRAZINE	8270C/D RV	GW,WW	50.0-123	21.5	0.01	mg/L
BNA	ANTHRACENE	8270C/D RV	GW,WW	43.6-113	18.7	0.001	mg/L
BNA	ANILINE	8270C/D RV	GW,WW	25.8-88.1	26.3	0.01	mg/L
BNA	ACETOPHENONE	8270C/D RV	GW,WW	41.6-104	24.8	0.01	mg/L
BNA	ACENAPHTHYLENE	8270C/D RV	GW,WW	36.0-106	21.0	0.001	mg/L
BNA	ACENAPHTHENE	8270C/D RV	GW,WW	38.7-109	21.5	0.001	mg/L
BNA	4-NITROPHENOL	8270C/D RV	GW,WW	10.0-52.7	40.0	0.01	mg/L
BNA	4-NITROANILINE	8270C/D RV	GW,WW	35.4-124	23.1	0.01	mg/L
BNA	4-CHLOROPHENYL-PHENYLETHER	8270C/D RV	GW,WW	39.0-113	20.9	0.01	mg/L
BNA	4-CHLOROANILINE	8270C/D RV	GW,WW	32.0-104	26.4	0.01	mg/L
BNA	4-CHLORO-3-METHYLPHENOL	8270C/D RV	GW,WW	35.7-100	22.9	0.01	mg/L
BNA	4-BROMOPHENYL-PHENYLETHER	8270C/D RV	GW,WW	40.7-116	21.0	0.01	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
BNA	4,6-DINITRO-2-METHYLPHENOL	8270C/D RV	GW,WW	18.4-148	24.4	0.01	mg/L
BNA	3-NITROANILINE	8270C/D RV	GW,WW	33.6-103	21.8	0.01	mg/L
BNA	3,3-DICHLOROBENZIDINE	8270C/D RV	GW,WW	27.2-142	22.3	0.01	mg/L
BNA	3&4-METHYLPHENOL	8270C/D RV	GW,WW	27.9-92	27.0	0.01	mg/L
BNA	2-NITROPHENOL	8270C/D RV	GW,WW	25.9-106	26.9	0.01	mg/L
BNA	2-NITROANILINE	8270C/D RV	GW,WW	56.4-173	20.0	0.01	mg/L
BNA	2-METHYLPHENOL	8270C/D RV	GW,WW	35.6-113	20.9	0.01	mg/L
BNA	2-METHYLNAPHTHALENE	8270C/D RV	GW,WW	26.4-86.9	26.5	0.001	mg/L
BNA	2-CHLOROPHENOL	8270C/D RV	GW,WW	33.8-98.6	24.2	0.01	mg/L
BNA	2-CHLORONAPHTHALENE	8270C/D RV	GW,WW	26.2-91.5	26.5	0.001	mg/L
BNA	2,6-DINITROTOLUENE	8270C/D RV	GW,WW	33.6-105	23.0	0.01	mg/L
BNA	2,4-DINITROTOLUENE	8270C/D RV	GW,WW	30.6-106	23.1	0.01	mg/L
BNA	2,4-DINITROPHENOL	8270C/D RV	GW,WW	31.2-105	22.0	0.01	mg/L
BNA	2,4-DIMETHYLPHENOL	8270C/D RV	GW,WW	24.2-128	20.5	0.01	mg/L
BNA	2,4-DICHLOROPHENOL	8270C/D RV	GW,WW	31.9-107	25.7	0.01	mg/L
BNA	2,4,6-TRICHLOROPHENOL	8270C/D RV	GW,WW	31.4-103	24.9	0.01	mg/L
BNA	2,4,5-TRICHLOROPHENOL	8270C/D RV	GW,WW	29.8-107	24.1	0.01	mg/L
BNA	2,3,4,6-TETRACHLOROPHENOL	8270C/D RV	GW,WW	34.9-112	23.9	0.001	mg/L
BNA	1-METHYLNAPHTHALENE	8270C/D RV	GW,WW	34.7-102	24.9	0.01	mg/L
BNA	1,4-DICHLOROBENZENE	8270C/D RV	GW,WW	21.0-89.4	32.6	0.01	mg/L
BNA	1,3-DICHLOROBENZENE	8270C/D RV	GW,WW	20.9-86.7	32.4	0.01	mg/L
BNA	1,2-DICHLOROBENZENE	8270C/D RV	GW,WW	23.7-91.9	31.9	0.01	mg/L
BNA	1,2,4-TRICHLOROBENZENE	8270C/D RV	GW,WW	22.9-96.1	27.5	0.01	mg/L
BNA	1,2,4,5-TETRACHLOROBENZENE	8270C/D RV	GW,WW	30.7-102	27.7	0.01	mg/L
BNA	SULFOLANE	8270C/D	GW, WW	70.0-130	20.0	0.2	ug/L
BNA	SULFOLANE	8270C/D	SS	70.0-130	20.0	0.33	ug/kg
Glycols	ETHYLENE GLYCOL	8015	SS	70.0-130	20.0	5.0	mg/L
Glycols	PROPYLENE GLYCOL	8015	SS	70.0-130	20.0	5.0	mg/L
Glycols	ETHYLENE GLYCOL	8015	GW,WW	70.0-130	20.0	5.0	mg/L
Glycols	PROPYLENE GLYCOL	8015	GW,WW	70.0-130	20.0	5.0	mg/L
Explosives	1,3,5-TRINITROBENZENE	8330A/B	SS	70.0-130	20.0	0.5	mg/Kg
Explosives	1,3-DINITROBENZENE	8330A/B	SS	70.0-130	20.0	0.5	mg/Kg
Explosives	2,4,6-TRINITROTOLUENE	8330A/B	SS	70.0-130	20.0	0.5	mg/Kg
Explosives	2,4-DINITROTOLUENE	8330A/B	SS	70.0-130	20.0	0.5	mg/Kg
Explosives	2,6-DINITROTOLUENE	8330A/B	SS	70.0-130	20.0	0.5	mg/Kg
Explosives	2-NITROTOLUENE	8330A/B	SS	70.0-130	20.0	0.5	mg/Kg
Explosives	3-NITROTOLUENE	8330A/B	SS	70.0-130	20.0	0.5	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
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Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
Explosives	4-NITROTOLUENE (4-NT)	8330A/B	SS	70.0-130	20.0	0.5	mg/Kg
Explosives	HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE	8330A/B	SS	70.0-130	20.0	0.5	mg/Kg
Explosives	METHYL-2,4,6-TRINITROPHENYLNITRAMINE	8330A/B	SS	70.0-130	20.0	0.5	mg/Kg
Explosives	NITROBENZENE	8330A/B	SS	70.0-130	20.0	0.5	mg/Kg
Explosives	OCTAHYDRO - 1,3,5,7 - TETRANITRO-1,3,5,7-TETRAZOCINE (HMX)	8330A/B	SS	70.0-130	20.0	0.0005	mg/Kg
Explosives	PENTAERYTHRITOL TETRANITRATE (PETN)	8330A/B	SS	70.0-130	20.0	2	mg/Kg
Explosives	NITROGLYCERINE	8330A/B	SS	70.0-130	20.0	2	mg/Kg
Explosives	NITROGUANIDINE	8330A/B	SS	70.0-130	20.0	8	mg/Kg
Explosives	1,3,5-TRINITROBENZENE	8330A/B	GW	70.1-98.5	20.0	0.0005	mg/L
Explosives	1,3-DINITROBENZENE	8330A/B	GW	50.8-88.7	24.2	0.0005	mg/L
Explosives	2,4,6-TRINITROTOLUENE	8330A/B	GW	61.4-102	20.0	0.0005	mg/L
Explosives	2,4-DINITROTOLUENE	8330A/B	GW	40.2-91.7	36.2	0.0005	mg/L
Explosives	2,6-DINITROTOLUENE	8330A/B	GW	47.0-94.4	29.4	0.0005	mg/L
Explosives	2-NITROTOLUENE	8330A/B	GW	43.3-93.9	30.4	0.0005	mg/L
Explosives	3-NITROTOLUENE	8330A/B	GW	36.8-89.5	37.3	0.0005	mg/L
Explosives	4-NITROTOLUENE (4-NT)	8330A/B	GW	41.1-93.1	34.4	0.0005	mg/L
Explosives	HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE	8330A/B	GW	63.1-94.2	20.0	0.0005	mg/L
Explosives	METHYL-2,4,6-TRINITROPHENYLNITRAMINE	8330A/B	GW	57.6-104	20.0	0.0005	mg/L
Explosives	NITROBENZENE	8330A/B	GW	56.0-99.0	20.4	0.0005	mg/L
Explosives	OCTAHYDRO - 1,3,5,7 - TETRANITRO-1,3,5,7-TETRAZOCINE (HMX)	8330A/B	GW	58.1-100	20.0	0.0005	mg/L
Explosives	PENTAERYTHRITOL TETRANITRATE (PETN)	8330A/B	GW	67.1-110	20.0	0.0005	mg/L
Explosives	NITROGLYCERINE	8330A/B	GW	65.0-126	20.0	0.0005	mg/L
GC	1, 2 DIBROMOETHANE (EDB)	504/8011	DW,GW, WW	70.0-130	30	0.00002	mg/L
GC	1, 2 DIBROMO-3-CHLOROPROPANE	504/8011	DW,GW, WW	70.0-130	30	0.00002	mg/L
GC	1,2,3-TRICHLOROPROPANE	504/8011	DW,GW, WW	70.0-130	30	0.0005	mg/L
THAA	BROMOACETIC ACID	552.2	DW	70.0-130	30	0.001	mg/L
THAA	CHLOROACETIC ACID	552.2	DW	70.0-130	30	0.002	mg/L
THAA	DIBROMOACETIC ACID	552.2	DW	70.0-130	30	0.001	mg/L
THAA	DICHLOROACETIC ACID	552.2	DW	70.0-130	30	0.001	mg/L
THAA	TRICHLOROACETIC ACID	552.2	DW	70.0-130	30	0.001	mg/L

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
TPH	PETROLEUM RANGE ORGANICS (TRPH)	FL-PRO	GW,	50.0-150	20.0	0.1	mg/L
TPH	PETROLEUM RANGE ORGANICS (TRPH)	FL-PRO	SS	50.0-150	20.0	4.0	mg/Kg
TPH	PETROLEUM RANGE ORGANICS (TRPH)	EPH TN	GW	50.0-150	20.0	0.1	mg/L
TPH	PETROLEUM RANGE ORGANICS (TRPH)	EPH TN	SS	50.0-150	20.0	4.0	mg/Kg
TPH	PETROLEUM RANGE ORGANICS (TRPH) - C9-C18, C19-C36, C11-C22	MADEP EPH	GW, WW	50.0-150	20.0	0.1	mg/L
TPH	PETROLEUM RANGE ORGANICS (TRPH) - C9-C18, C19-C36, C11-C22	MADEP EPH	SS	50.0-150	20.0	5.5	mg/Kg
TPH	PETROLEUM RANGE ORGANICS (TRPH) - C10-C28	DRO, 8015Mod	GW, WW	50.0-150	20.0	0.1	mg/L
TPH	PETROLEUM RANGE ORGANICS (TRPH) - C10-C28	DRO, 8015Mod	SS	50.0-150	20.0	4.0	mg/Kg
TPH	PETROLEUM RANGE ORGANICS (TRPH) – C10-C20, C20-C34	OHIO DRO	GW, WW	50.0-150	20.0	0.1	mg/L
TPH	PETROLEUM RANGE ORGANICS (TRPH) – C10-C20, C20-C34	OHIO DRO	SS	50.0-150	20.0	4.0	mg/Kg
TPH	PETROLEUM RANGE ORGANICS (TRPH) – GAS, DIESEL, MOTOR OIL, ETC.	OA2	GW, WW	50.0-150	20.0	0.1	mg/L
TPH	PETROLEUM RANGE ORGANICS (TRPH) – GAS, DIESEL, MOTOR OIL, ETC.	OA2	SS	50.0-150	20.0	4.0	mg/Kg
TPH	PETROLEUM RANGE ORGANICS - C10-C28, C28-C40	DRORLA	GW, WW	50.0-150	20.0	0.1	mg/L
TPH	PETROLEUM RANGE ORGANICS - C10-C28, C28-C40	DRORLA	SS	50.0-150	20.0	4.0	mg/Kg
TPH	PETROLEUM RANGE ORGANICS – C10-C32	DROWY	GW, WW	50.0-150	20.0	0.1	mg/L
TPH	PETROLEUM RANGE ORGANICS – C10-C32	DROWY	SS	50.0-150	20.0	4.0	mg/Kg
TPH	PETROLEUM RANGE ORGANICS – GAS, DIESEL, MOTOR OIL, ETC.	NWTPH-Dx	GW, WW	50.0-150	20.0	0.25	mg/L
TPH	PETROLEUM RANGE ORGANICS – GAS, DIESEL, MOTOR OIL, ETC.	NWTPH-Dx	SS	50.0-150	20.0	25	mg/Kg
TPH	PETROLEUM RANGE ORGANICS – C10-C28	DROWM	GW, WW	75.0-115	20.0	0.1	mg/L
TPH	PETROLEUM RANGE ORGANICS – C10-C28	DROWM	SS	70.0-120	20.0	10	mg/Kg

Table 12.3: QC Targets for Semi-Volatiles Accuracy (LCS), Precision and RLs
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Class	Analyte	Method	Matrix	Accuracy (%)	Prec. (RPD)	RL	Unit
TPH	PETROLEUM RANGE ORGANICS – C10-C22	TPHAZ	SS	70.0-130	20.0	30	mg/Kg
TPH	PETROLEUM RANGE ORGANICS – C22-C32	TPHAZ	SS	70.0-130	20.0	100.	mg/Kg
TPH	PETROLEUM RANGE ORGANICS – C10-C32	TPHAZ	SS	70.0-130	20.0	130.	mg/Kg
TPH	PETROLEUM RANGE ORGANICS - C6-C12, C12-C28, C28-C35, C6-C35	TX TPH	SS	75.0-125	20.0	50	mg/Kg
TPH	PETROLEUM RANGE ORGANICS - C10-C21, C21-C35	DROMO	GW, WW	75.0-125	20.0	1.0	mg/L
TPH	PETROLEUM RANGE ORGANICS - C10-C21, C21-C35	DROMO	SS	75.0-125	20.0	20	mg/Kg

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 Regulatory Affairs 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 ESCs 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 Regulatory Affairs 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 $\pm$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 Regulatory Affairs 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 $\pm$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 Regulatory Affairs 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 Regulatory Affairs 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 Regulatory Affairs Department will be consulted for further action.

14.0 RECORD KEEPING

Record keeping is outlined in SOP #010103, *Document Control and Distribution*, SOP #030230, *Standards Logger, SOP #030227, Data Review* 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 12.0.

1.0 SIGNATORY APPROVALS

Air Laboratory
QUALITY ASSURANCE MANUAL

APPENDIX VIII TO THE ESC QUALITY ASSURANCE MANUAL

for

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2.0 APPENDIX TABLE OF CONTENTS

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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 guidance and equipment, 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 12.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Kenneth W. Buckley, with a B.S. degree in General Science, is the Laboratory Operations Manager. Mr. Buckley is responsible for the overall production of the Air Laboratory; including the management of the staff and scheduling. Mr. Buckley has 13 years of environmental laboratory experience.

In his absence, Derek Ramey, with studies in math and engineering and 11 years of environmental laboratory experience, assumes responsibility for Air Department decisions. Mr. Ramey is the Primary Analyst for the Air Laboratory and is proficient in air analytical methods. He is responsible for sample analysis, review and approval of all data associated with Air Lab analyses.

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). On-going acceptable capability in Air Laboratory is also demonstrated by acceptable participation in the Phenova 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 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	AIRGC3	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
Gas Chromatograph/Mass Spectrometer	Agilent	6890/5973	AIRMS4	4	US00024695 US82311265	Air Lab
Preconcentrator	Entech	7200			0197	Air Lab
Canister Autosampler	Entech	7016C			0203	Air Lab
Preconcentrator	Entech	7100A			1089	Air Lab
Preconcentrator	Entech	7200			1005	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

LABORATORY EQUIPMENT LIST: MAJOR ITEMS - Air Analysis
This table is subject to revision without notice

Item	*Manufacturer*	*Model*	*Instrument Name*	*#*	*Serial #*	*Location*
GC/FID	Agilent	6890N	AIRGC2	2	US10137006	Air Lab
Headspace Autosampler	Tekmar	7000			9507018	Air Lab
TO Canister	Restek/Entech	TO-Can/ SiloniteCan	1800 cans owned		N/A	Air Lab
Passive Sampling Kit	Restek		800 owned		N/A	Air Lab
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, 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, Propane, Acetylene) 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
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	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	8.0-40.0% of mass 95
75	30.0-66.0% of mass 95
95	base peak, 100% relative abundance
96	5.0-9.0% of mass 95
173	< 2.0% of mass 174
174	50.0-120% of mass 95
175	4.0-9.0% of mass 174
176	> 93.0%, 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(OH VAP only).

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.

Fixed Gases (Carbon Dioxide, Carbon Monoxide, Methane, Oxygen) – SOP Number 330372

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 PC-based D.01 ChemStation software and a calibration factor or linear regression model. The calibration must meet 15% RSD or a 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 15% of the expected concentration.

Methane, Ethane, Ethene, Propane, Acetylene 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 $\leq$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, 100uL 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 50-120% 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

TABLE 8.5: INSTRUMENT CALIBRATION & QC

Analysis/ Instrument	Calibration Type	Number of Standards	Acceptance/ Rejection Criteria	Frequency
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 average response factors. Linear regression can be used for any target compound exceeding the 15% RSD	As needed
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.

TABLE 8.5: INSTRUMENT CALIBRATION & QC				
Analysis/ Instrument	**Calibration Type**	**Number of Standards**	**Acceptance/ Rejection Criteria**	**Frequency**
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/ Continuing	2 – Second source (LCS/LCSD)	Must be within +/-30% with an RPD of <25.	Following initial calibration or daily cal. verification

9.0 LABORATORY PRACTICES

9.1 REAGENT GRADE WATER

Reagent Grade water –Type II used in the Air Laboratory is generated in the Microbiology Laboratory and 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 1000 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 SOPs associated with the air laboratory can be found in the following table:

TABLE 10.1: AIR DEPARTMENT SOPs

This Table is subject to revision without notice

SOP #	Title/Description
330367	Measurement of Volatile Organic Compound in Ambient Air by GC/MS (EPA TO-15)
330367OH	Measurement of Volatile Organic Compound in Ambient Air by GC/MS (EPA TO-15) (Ohio VAP only)
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)

SOP #	Title/Description
330370	Method for Determination of Methane, Ethane, and Ethene (Based on RSK-175)
330371	Canister Cleaning, Certification and Storage
330372	The Analysis of Fixed Gases using GC/TCD
330373	Meetac – Methanol and Ethanol Based on EPA 8260B/C

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 (IDOCs) are performed during new analyst training and/or prior to acceptance and use of any new method/instrumentation. Continuing Demonstration of Capability (CDOCs) must be updated at least annually for each analyst performing testing on field samples. 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 qualifiers 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 RLs
This table is subject to revision without notice

Analyte	Method	Matrix	Accuracy (%)	Prec. (% RPD)	RL	Unit
1,1,1-Trichloroethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,1,2,2-Tetrachloroethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,1,2,2-Tetrachloroethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,1,2-Trichloroethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,1-Dichloroethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,1-Dichloroethene	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,2,4-Trichlorobenzene	TO-15	Air	59.7-155	25.0	0.63	ppbv

Table 12.3: QC Targets for Air Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Analyte	Method	Matrix	Accuracy (%)	Prec. (% RPD)	RL	Unit
1,2,4-Trimethylbenzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,2-Dibromoethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,2-Dichlorobenzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,2-Dichloroethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,2-Dichloropropane	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,3,5-Trimethylbenzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,3-Butadiene	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,3-Dichlorobenzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,4-Dichlorobenzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,4-Dioxane	TO-15	Air	70.0-130	25.0	0.2	ppbv
1,1,1-Trichloroethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
2,2,4-Trimethylpentane	TO-15	Air	70.0-130	25.0	0.2	ppbv
2-Chlorotoluene	TO-15	Air	70.0-130	25.0	0.2	ppbv
2-Propanol	TO-15	Air	62.2-137	25.0	0.2	ppbv
4-Ethyltoluene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Acetone	TO-15	Air	70.0-130	25.0	1.25	ppbv
Allyl Chloride	TO-15	Air	70.0-130	25.0	0.2	ppbv
Benzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Benzyl Chloride	TO-15	Air	70.0-130	25.0	0.2	ppbv
Bromomethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
Bromodichloromethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
Bromoform	TO-15	Air	70.0-130	25.0	0.6	ppbv
Carbon Disulfide	TO-15	Air	70.0-130	25.0	0.2	ppbv
Carbon Tetrachloride	TO-15	Air	70.0-130	25.0	0.2	ppbv
Chlorobenzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Chloroethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
Chloroform	TO-15	Air	70.0-130	25.0	0.2	ppbv
Chloromethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
Cis-1,2-Dichloroethene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Cis-1,3-Dichloropropene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Cyclohexane	TO-15	Air	70.0-130	25.0	0.2	ppbv
Dibromochloromethane	TO-15	Air	70.0-130	25.0	0.2	ppbv
Ethanol	TO-15	Air	52.6-145	25.0	0.63	ppbv
Ethyl Acetate	TO-15	Air	70.0-130	25.0	0.2	ppbv
Ethylbenzene	TO-15	Air	70.0-130	25.0	0.2	ppbv

Table 12.3: QC Targets for Air Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Analyte	Method	Matrix	Accuracy (%)	Prec. (% RPD)	RL	Unit
Freon-11	TO-15	Air	70.0-130	25.0	0.2	ppbv
Freon-12	TO-15	Air	70.0-130	25.0	0.2	ppbv
Freon-113	TO-15	Air	70.0-130	25.0	0.2	ppbv
Freon-114	TO-15	Air	70.0-130	25.0	0.2	ppbv
Gasoline Range Organics	TO-15	Air	70.0-130	25.0	50	ppbv
Heptane	TO-15	Air	70.0-130	25.0	0.2	ppbv
Hexachloro-1,3-Butadiene	TO-15	Air	55.7-144	25.0	0.63	ppbv
Hexane	TO-15	Air	70.0-130	25.0	0.2	ppbv
Isopropylbenzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
M&P-Xylene	TO-15	Air	70.0-130	25.0	0.4	ppbv
Methyl Butyl Ketone	TO-15	Air	36.5-155	25.0	1.25	ppbv
Methyl Ethyl Ketone	TO-15	Air	70.0-130	25.0	1.25	ppbv
Methyl Isobutyl Ketone	TO-15	Air	51.3-144	25.0	1.25	ppbv
Methyl Methacrylate	TO-15	Air	70.0-130	25.0	0.2	ppbv
Methyl tert Butyl Ether	TO-15	Air	70.0-130	25.0	0.31	ppbv
Methylene Chloride	TO-15	Air	70.0-130	25.0	0.63	ppbv
Naphthalene	TO-15	Air	53.4-158	25.0	0.63	ppbv
N-butyl benzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
N-propyl benzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
o-Xylene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Propene	TO-15	Air	70.0-130	25.0	0.4	ppbv
Sec-butyl benzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Styrene	TO-15	Air	70.0-130	25.0	0.2	ppbv
t-Butyl Alcohol	TO-15	Air	70.0-130	25.0	0.2	ppbv
Tert-butyl benzene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Tetrachloroethylene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Tetrahydrofuran	TO-15	Air	70.0-130	25.0	0.2	ppbv
Toluene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Trans-1,3-Dichloropropene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Trans-1,2-Dichloroethene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Trichloroethylene	TO-15	Air	70.0-130	25.0	0.2	ppbv
Vinyl Acetate	TO-15	Air	70.0-130	25.0	0.2	ppbv
Vinyl Bromide	TO-15	Air	70.0-130	25.0	0.2	ppbv
Vinyl Chloride	TO-15	Air	70.0-130	25.0	0.2	ppbv
Methane	RSK-175	Air/ Headspace	70.0-130	25.0	0.01	ppmv

Table 12.3: QC Targets for Air Accuracy (LCS), Precision and RLs
This table is subject to revision without notice

Analyte	Method	Matrix	Accuracy (%)	Prec. (% RPD)	RL	Unit
Ethane	RSK-175	Air/ Headspace	70.0-130	25.0	0.0129	ppbmv
Ethene	RSK-175	Air/ Headspace	70.0-130	25.0	0.0127	ppmv
Propane	RSK-175	Air/ Headspace	70.0-130	25.0	0.0186	ppmv
Acetylene	Rsk-175	Air/ Headspace	70.0-130	25.0	0.0208	ppmv
Carbon Dioxide	ASTM D1946	Air	70.0-130	25.0	0.50 / 200	% / ppmv
Carbon Monoxide	ASTM D1946	Air	70.0-130	25.0	0.50 / 200	% / ppmv
Methane	ASTM D1946	Air	70.0-130	25.0	0.50 / 200	% / ppmv
Nitrogen	ASTM D1946	Air	70.0-130	25.0	0.50 / 200	% / ppmv
Oxygen	ASTM D1946	Air	70.0-130	25.0	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 Regulatory Affairs 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 #030230, *Standards Logger, SOP #030227, Data Review* 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 12.0.

1.0 SIGNATORY APPROVALS

Aquatic Toxicity Laboratory
QUALITY ASSURANCE MANUAL

APPENDIX IX TO THE ESC
QUALITY ASSURANCE MANUAL

for

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NOTE: The QAM has been approved by the following people.
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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 guidance and materials 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 12.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Dr. Christabel Fernandes-Monteiro, with a Ph.D. in Applied Biology, is the Department Manager of Biology. She oversees supervision of laboratory operations in the Mold, Aquatic Toxicity, Microbiology, Protozoan and BOD laboratories. Her responsibilities include assurance of reliable data through monitoring of quality control, corroborating the analysis performed, protocol development, coordination with clients regarding sample analysis, scheduling of tests and overall production in all sections within the Biology Laboratory, including management of staff.

Shain Schmitt with a B.S. degree in Biological Sciences, is the Primary Analyst for the Aquatic Toxicity laboratory. Mr. Schmitt is proficient in aquatic toxicity analytical methods and is responsible for sample analysis, review and approval of all data associated with toxicity analyses. His responsibilities also include the coordination with clients regarding sample analysis, scheduling, data reductions, interpretation and validation of toxicity testing. In his absence, Brandon Etheridge assumes his responsibilities.

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–Aquatic Toxicity.* Performance is documented using an initial demonstration of capability (IDOCs) and continuing demonstration of capability (CDOC). On-going acceptable capability in toxicity analysis is also demonstrated by acceptable participation in the Phenova 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. 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.
- 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
  - 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. 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 are 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°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 $\leq$ 5.0 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

LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Aquatic Toxicity Lab ***This table is subject to revision without notice.***			
Item	***Manufacturer***	***Model***	***Location***
pH Meter	Orion	VersaStar	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
pH/Conductivity Benchtop meter	Thermo Scientific Orion	VSTAR 52	Aquatic Tox Lab
RDO Probe	Thermo Scientific Orion	VSTAR-RD	Aquatic Tox Lab
Oven (2)	VWR	13054	Aquatic Tox Lab
Stereoscope	Olympus	SZH-STS	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)

PREVENTATIVE MAINTENANCE FOR LABORATORY EQUIPMENT		
INSTRUMENT	***P. M. DESCRIPTION***	***FREQUENCY***
pH meter	•ATC checks	Annually
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
RDO probe	•Replace sensor cap	Annually
RDO probe	•Clean sensor cap	As needed
RDO probe	•Other	As described in manufacturer's manual
pH/Conductivity/DO meter	•Calibrate with each use	Daily
Light Meter	•Calibrate	Annually

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°C	14 days after thawing
Selenastrum capricornatum	Aq. Biosystems	1-6°C	One month from concentration date
Vitamin B12	Fisher	1-6°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°C	14 days
B12 Solution	0.01125g to 1L of DI Water	1-4°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 is documented. All yeast purchased is at least food grade and has passed FDA standards. All (YCT) Yeast Trout Chow is made in-house. New lots are tested for pesticides, metals, and PCBs.

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 12 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 - 80-100 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 within the manufacturer's acceptable range prior to use. Perform automatic temperature compensation (ATC) checks annually on the pH probe. 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 electrochemical probe membrane is changed every two to four weeks to maintain accurate readings. The RDO probe sensor cap should be cleaned regularly, and replaced once per year. The RDO probe sensor cap must be stored in a moist environment.

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.

Light Meter

Calibrate the light meter annually to ensure it meets original performance specifications

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 (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 12 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 12 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 350335, Quality Control and Quality Assurance of Microbiological Equipment and Testing Materials.*. 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 SOPs associated with the Aquatic Toxicity laboratory can be found in the following table:

TABLE 10.1: AQUATIC TOXICITY DEPARTMENT SOPs

This Table is subject to revision without notice

SOP #	Title/Description
340312	Dissolved Oxygen Membrane Electrode Method
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, EPA Method 2000.0
350303NC	North Carolina *Pimephales promelas* Acute Toxicity Testing
350304	*Ceriodaphnia dubia* Acute Toxicity Testing EPA Method 2002.0
350304NC	North Carolina *Ceriodaphnia dubia* Acute Toxicity Testing
350317	WET Reference toxicant testing
350318	Mini Chronic *C. dubia* NC
350320	Acceptability Test for 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*
350345	Receipt and Maintenance of *Pimephalas Promelas* (Fathead Minnow)
350346	Ceriodaphnia Dubia Culture Maintenance, Food Preparation, and Food Maintenance
350355	Technical Training and Personnel Qualifications for Biomonitoring-Aquatic Toxicity, Mold and Microbiology
350356	Water Bath and Incubator Temperature Stability and Load Testing
350362	Analytical Balance Operation and Verification in the Aquatic Toxicity Microbiology Lab
350364	North Carolina Phase II Chronic Whole Effluent Toxicity Test Procedure for Ceriodaphnia dubia

10.2 Additional information regarding Aquatic 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 performs 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 Regulatory Affairs 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 and fresh sample.

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 and fresh sample.

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 and fresh sample.

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 and fresh sample.

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 and fresh sample.

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 and fresh sample.

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 & 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 #030230, *Standards Logger, SOP #030227, Data Review* 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 12.0.

1.0 SIGNATORY APPROVALS

Microbiology Laboratory
QUALITY ASSURANCE MANUAL

APPENDIX X TO THE ESC
QUALITY ASSURANCE MANUAL

for

ESC LAB SCIENCES
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NOTE: The QAM has been approved by the following people.
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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 guidance and materials 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 12.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Dr. Christabel Fernandes-Monteiro, with a Ph.D. in Applied Biology, is the Department Manager of Biology. She oversees supervision of laboratory operations in the Mold, Aquatic Toxicity, Microbiology, Protozoan and BOD laboratories. Her responsibilities include assurance of reliable data through monitoring of quality control, corroborating the analysis performed, protocol development, coordination with clients regarding sample analysis, scheduling of tests and overall production in all sections within the Biology Laboratory, including management of staff.

Shain Schmitt with a B.S. degree in Biological Sciences, is the Primary Analyst for the Microbiology laboratory. Mr. Schmitt is proficient in microbiological analytical methods and is responsible for sample analysis, review and approval of all data associated with microbiological analyses. In his absence, Brandon Etheridge assumes his responsibilities.

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 Phenova 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. 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.
- 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
  - 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 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 generally 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 (plus two hour transport 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
Oven	VWR	13054	Microbiology Lab
pH meter/Conductivity meter	Thermo Scientific Orion	VStar 52	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, and Water Baths	•Maintenance service	Determined by twice daily temperature performance checks @ least 4 hours apart, when in use.
Water Bath	•Check thermometer vs. NIST traceable	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	With each use– Chemical Indicator Strip
Conductivity Meter	•Calibrate and clean probe	Daily
Conductivity Meter	•Replace or replatinize probe	When 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 pH 4.0 Buffer	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 (per manufacturer)	Daily
Quanti-Tray Sealer	•Check sealer for leaks	Monthly
Water Purifier	•Conductivity check using a calibrated conductivity meter	Monthly
Water Purifier	•Check for TOCs, 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
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/cm^2 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 with each use 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 manufacturer's acceptable range prior to use. Automatic temperature compensation (ATC) verifications are performed annually on the pH probe.

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. The error of calibration must not exceed 2.5%.

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.

Ultraviolet Lamp

The output of the UV lamp used to measure fluorescence for the identification of *E. coli* is tested quarterly with a UV light meter. The UV bulbs are replaced if the output is less than 70% of the original.

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. The Use test is performed quarterly and the Water Suitability test is performed annually.

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 350335, Quality Control and Quality Assurance of Microbiological Equipment and Testing Materials.* 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 SOPs associated with the microbiology laboratory can be found in the following table:

TABLE 10.1: MICROBIOLOGICAL DEPARTMENT SOPs
This Table is subject to revision without notice

SOP #	Title/Description
350305	Fecal Coliform: Membrane Filter Technique
350315	Fecal Coliform Determination in Biosolids: Membrane Filter Technique (SM9222D)
350316	Total Coliform
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

SOP #	Title/Description
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
350343	Colilert
350348	Enterolert
350354	HPC, Method 9215 B
350355	Technical Training and Personnel Qualification for Biomonitoring-Microbiology
350356	Water bath and Incubator Temperature Stability and Load Testing
350359	Calibration and Maintenance of Autoclaves
350369	Sterilization, Sanitization and Residue Testing of Microbiological Glassware and Equipment
350380	Class "A" MPN Fecal Coliform Analysis

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 (PTs) in various matrices by analyzing samples provided by Phenova. Blind samples are received and analyzed according to instructions from Phenova 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 and qualified, and sample re-collected.

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 Regulatory Affairs 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 #030230, *Standards Logger, SOP #030227, Data Review* 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 12.0.

1.0 SIGNATORY APPROVALS

Mold/BOD Laboratory
QUALITY ASSURANCE MANUAL

APPENDIX XI TO THE ESC
QUALITY ASSURANCE MANUAL

for

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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 guidance and materials 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 12.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Dr. Christabel Fernandes-Monteiro, with a Ph.D. in Applied Biology, is the Department Manager for Biology. She oversees supervision of laboratory operations in the Mold, Aquatic Toxicity, Microbiology, BOD and Protozoan laboratories. Her responsibilities include assurance of reliable data through monitoring of quality control, corroborating the analysis performed, protocol development, coordination with clients regarding sample analysis, scheduling of tests and overall production in all sections within the Biology Laboratory, including management of staff. Dr. Fernandes-Monteiro oversees the review and approval processes of all data associated with all Biological laboratory sections. 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. She also reviews AIHA and EPA online training modules related to the methods being performed in the Mold and BOD Laboratory. In her absence, Bridget Miller assumes responsibility for Mold/BOD departmental decisions.

Bridget Miller, with a BS degree in Biology, is the Primary Analyst in the Mold and BOD laboratory. She is proficient in Mold analytical methods as per AIHA guidelines. Bridget has gained analytical experience at ESC, an AIHA accredited laboratory, and obtained additional training in Mold analysis at the McCrone Research Institute. She reviews AIHA and EPA online training modules related to the methods being performed in the Mold and BOD 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*. Analyst performance in the Mold/BOD Laboratory 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), Round Robin analysis and daily Quality Control sample analysis. 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 Stericycle 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 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 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	Bacteriology Lab
Class I BSC	AirFiltronix	AirFiltronix HS 4500	41031	Mold Lab
Class II BSC	Labconco	Labconco 36213	60554894	Mold Lab

LABORATORY EQUIPMENT LIST: MAJOR ITEMS – Mold/ BOD Analysis
This table is subject to revision without notice

Item	**Manufacturer**	*Model*	*Serial #*	*Location*
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	Labtronix	BOD2100D	21000010213	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	Blue M-MagniWhirlpool	MW-1110A	14991	Bacteriology Lab
Waterbath	Precision	Circulating 260	21-AJ11	BOD
Biolog MicroStation	Biolog, Inc.	Microlog 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
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	VWR	Symphony B10P	12284S0009	BOD
Spectrophotometer	Hach	DR 2700	1388224	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, Waterbaths, & Incubators	•Maintenance service	As needed - determined by daily temperature performance checks twice daily and at least 4 hours apart
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
Incubators and Waterbaths	Perform Temperature stability and load testing	Annually
Autoclave	•Check sterilization efficiency	Weekly – *G. stearothermophilus*
Autoclave	•Check sterilization efficiency	Per Use – Chemical Indicator
Autoclave	Check timing devices	Quarterly
Autoclave	Check pressure (annual Maintenance contract)	Annually
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	Calibrate and check slope (acceptable; range of 95-	Daily
pH meters	Reference junction & electrode replacement	As needed
pH meters	Probe stored in KCl	At all times when not in use
pH meters	ATC checks	Annually
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	Weekly
BOD SP Robotic Analyzer	Rinse ATU (seed) dispenser using rinse pump option	As needed
BOD SP Robotic Analyzer	Clean rinsing vessel	Every three 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 tables 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
CNA w/5 % SB	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	2 weeks
Potato Dextrose Agar (PDA)	Fisher/Difco	Room Temp	As specified by Manufacturer	PDA + Water	4 ± 2°C	2 weeks
Modified Saboraud's Agar (MSA)	Fisher/Difco	Room Temp	As specified by Manufacturer	M-SAB Dex + Water	4 ± 2°C	2 weeks
R2A	Fisher/Difco	Room Temp	As specified by Manufacturer	R2A + Water	4 ± 2°C	2 weeks
2 % Malt Extract	Fisher/Oxoid	Room Temp	As specified by Manufacturer	Bacteriological Agar + Malt	4 ± 2°C	2 weeks

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	2 weeks
Biolog Universal Agar (BUG)	Biolog	Room Temp	As specified by Manufacturer	BUG + Water	4 ± 2°C	2 weeks
Biolog Universal Anaerobic Agar (BUA)	Biolog	Room Temp	As specified by Manufacturer	BUA + Water	4 ± 2°C	2 weeks
Biolog Universal Yeast Agar (BUY)	Biolog	Room Temp	As specified by Manufacturer	BUY + Water	4 ± 2°C	2 weeks
Biolog Universal Agar (BUG) with 0.25%	Biolog	Room Temp	As specified by Manufacturer	BUG + Water + Maltose	4 ± 2°C	2 weeks
Anaerobic Agar (ANA)	Hi Media	Room Temp	As specified by Manufacturer	ANA + water	4 ± 2°C	2 weeks
Tryptic Soy Agar (TSA)	Fisher/Difco	Room Temp	As specified by Manufacturer	TSA + Water	4 ± 2°C	2 weeks
Tryptic Soy Broth (TSB)	Fisher/Difco	Room Temp	As specified by Manufacturer	TSB + Water	4 ± 2°C	3 months

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	Ambient	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 proficiency testing samples, laboratory contaminants and client samples, 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.

Source of Bacteria

A collection of bacteria is maintained in the laboratory as training and reference material. The bacterial strains are purchased from an accredited microbiological supply company and are used as positive and negative reference controls. Alternatively, bacterial strains are collected from proficiency testing samples and laboratory contaminants, and stored as Tryptic Soy Agar slants for 3 months at 4 ± 2ºC.

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. In addition temperature chart recorders are being used to continuously monitor the temperature in the incubators used for BOD analysis and the BOD Lab.

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 serviced annually by an external microscope 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 in triplicate 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, 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 per the manufacturer's operating manual. Automatic temperature compensation (ATC) verifications are performed annually on the pH probe.

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 the 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%.

Air Sampler

The air sampling pump used for laboratory environmental monitoring is calibrated monthly prior to use with a calibrator that is verified annually by an ISO 17025 accredited laboratory to ensure its measurement integrity.

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. The water suitability test is performed annually and the USE test is performed quarterly.

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 and BOD 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 Andersen
350308	Fungal Quantification
350309	Fungal Rodac
350310	Direct Exam Prep Procedure
350311	Fungal Identification
350312	Mold QA/QC

SOP #	Title
350313	Mold Lab Safety
350314	MUG Ecoli/Coliforms/Enterococcus
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
350351	Evaluation of Cosmetic Products
350352	Anaerobic Plate Count
350357	Actinomycetes Identification
350367	Labconco Flaskscrubber Operation and Maintenance
350370	Preparation of Culture Media
350371	Mold lab Autoclave Maintenance and Operation
350379	Mold Lab Reference Culture Maintenance

11.0 QUALITY CONTROL CHECKS

11.1 ESC participates in proficiency testing (PTs) in support of various laboratory accreditations/recognitions. For Mold analyses, PTs are administered quarterly by AIHA. ESC participates in both the Direct Examination and Bacterial/Fungal Culturable proficiency testing. The samples are received and analyzed by method according to the vendor's instructions and according to the ESC SOP.

For BOD analysis, environmental PTs are purchased from Phenova. The WP 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 (IDOCs) 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, a laboratory control sample run in triplicate, 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.

11.10.1 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. All blanks must meet method acceptance criteria. If all method blanks fail, data is qualified. The depletion of the method blank must be < 0.20mg but no lower than -0.20 mg.

11.10.2 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

11.10.3 The CCV should not vary more than 0.2g DO/L within a run.

11.10.4 The BOD value for the LCS must be within 167.5 and 228.5.

11.10.5 The RPD for the sample duplicate must be <30% for high and low.

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 Data Review Department performs the secondary review of the data package using the ESC SOP#030227, *Data Review*. The QC Reviewer verifies that the analysis is performed as required and meets method criteria, All associated 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-1+1/N-2+……1/N-r+1]
Quantitative Fungal/Bacterial	$\frac{\text{CFU}}{\text{gm}}$ or $\frac{\text{CFU}}{\text{Swab}} = \frac{\text{\# of Colonies} \times \text{Dilution Factor}}{\text{Sample Amount}}$
BOD, 5-DAY	$\frac{\text{Initial D.O. – Final D.O. – CF}}{\text{\% Dilution Sample}}$ *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, <30% 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 RLs
This table is subject to revision without notice

Analyte	Analysis Method	Matrix	Accuracy Range (%)	Precision (RPD)	RL (ppm)
Biochemical Oxygen Demand	SM5210B	W	85-115	≤30	5
Biochemical Oxygen Demand - Carbonaceous	SM5210B	W	85-115	≤30	5

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 Regulatory Affairs 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 followed; 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 Regulatory Affairs 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 any of the blanks fail, all data must be reported with a qualifier.

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 #030230, *Standards Logger, SOP #030227, Data Review* 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 12.0.

1.0 SIGNATORY APPROVALS

Protozoa Laboratory
QUALITY ASSURANCE MANUAL

APPENDIX XII TO THE ESC QUALITY ASSURANCE MANUAL

for

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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 guidance and materials 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 12.0.*

5.0 PERSONNEL AND TRAINING

5.1 PERSONNEL

Dr. Christabel Fernandes-Monteiro, with a Ph.D. in Applied Biology, is the Department Manager of Biology. She oversees supervision of laboratory operations in the Mold, Aquatic Toxicity, Microbiology, Protozoan and BOD laboratories. Her responsibilities include assurance of reliable data through monitoring of quality control, corroborating the analysis performed, protocol development, coordination with clients regarding sample analysis, scheduling of tests and overall production in all sections within the Biology Laboratory, including management of staff.

Kasey Raley, with a B.S. degree in Biological Sciences, is the Principal Analyst for the Protozoan laboratory. Ms. Raley 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. In her absence, Stacy Kennedy assumes her responsibilities.

5.2 TRAINING

The Principle Analyst trains all new analysts in 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 Elga UltraPure 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 compliance 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)	VWR	Concentrated	ambient	1 year
Hydrochloric Acid (HCl)	VWR	Concentrated	ambient	1 year
Laureth-12	VWR	--	ambient	1 year
Tris Stock	VWR	--	ambient	NA
EDTA	Supelco	0.5 M, pH 8.0	2 - 8°C	1 year
Antifoam A	Supelco	--	ambient	NA
Dynabeads® GC-Combo/Crypto	Idexx	--	2 - 8°C	2 years
Direct labeling kit for det. of oocysts and cysts, Merifluor Cryptosporidium/Giardia	VWR	--	2 - 8°C	1 year
Phosphate Buffered Saline (PBS) Solution, pH 7.4	Supelco	--	ambient	1 year
4', 6-diamidino-2-phenylindole (DAPI) stain	Waterborne, Inc	2mg/mL	2 - 8°C /Darkness	18 months/When positive control fails
Purified, live *Cryptosporidium* oocysts stock suspension	WSLH	--	2 - 8°C	1 month
Purified, live *Giardia* cysts stock suspension	WSLH	--	2 - 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	0°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	--	2 - 8°C	Prepared Daily
Staining 1X wash buffer	--	ambient	3 months
Phosphate Buffered Saline (PBS) Solution, pH 7.4	--	ambient	1 week
Working DAPI stain	10µL Stock/25ml Phosphate Buffer	Ambient/Dark container	1 day

9.0 LABORATORY PRACTICES

9.1 REAGENT GRADE WATER

ASTM Type II grade water: Reagent water is analyzed for total chlorine, heterotrophic bacteria, specific conductance, pH, total organic carbon, ammonia and organic nitrogen on a monthly basis. Reagent water is tested for metals: Lead, Cadmium, Chromium, Copper, Nickel, and Zinc on an annual basis. A Use Test is performed on a quarterly 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*.

10.0 ANALYTICAL PROCEDURES

10.1 A list of laboratory SOPs associated with the protozoan laboratory can be found in the following table:

TABLE 10.1: PROTOZOAN DEPARTMENT SOPs

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 the PT sample provider who issues the testing results as either a "pass" or "fail" to all regulatory agencies, as requested by ESC. If the laboratory fails a PT round, a follow-up test is performed in an attempt to meet the necessary requirements for proficiency. 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 organization.

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 at least once weekly or per every 20 samples processed. 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 after 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 complete, and that the tests have been performed appropriately and within the appropriate sample 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. 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 must be clearly defined. The effectiveness of the corrective action must be assessed and noted. The CAR is kept on file by the Regulatory Affairs 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% of the expected concentration. 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 $\pm$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 #030230, *Standards Logger, SOP #030227, Data Review* 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 12.0.

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APPENDIX C

TestAmerica, Inc. Quality Assurance Manual (provided electronically)

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Quality Assurance Manual

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Quality Assurance Manual
Approval Signatures

Laboratory Director - Jodie Carnes	5/24/13 Date
Quality Manager - Sarah E. Nagel	5/24/2013 Date
Technical Manager (Radiochemistry) – Kenneth Miller	5/24/2013 Date
Technical Manager (Metals) – Tabitha Liebrecht	5/28/13 Date

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REFERENCED CORPORATE SOPs AND POLICIES

SOP / Policy Reference	Title
CA-Q-S-001	Solvent and Acid Lot Testing and Approval
CA-Q-S-002	Acceptable Manual Integration Practices
CA-Q-S-004	Method Compliance & Data Authenticity Audits
CA-Q-S-006	Detection Limits
CA-Q-S-008	Management Systems Review
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure
CW-L-S-002	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CA-L-S-002	Subcontracting Procedures
CW-L-P-004	Ethics Policy
CA-L-P-002	Contract Compliance Policy
CW-F-P-002	Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CA-C-S-001	Work Sharing Process
CA-T-P-001	Qualified Products List
CW-F-S-007	Controlled Purchases Policy
CW-F-S-018	Vendor Selection
CA-Q-M-002	Corporate Quality Management Plan
CW-E-M-001	Corporate Environmental Health & Safety Manual

REFERENCED LABORATORY SOPs

SOP Reference	Title
RL-DR-001	Review of Environmental and Bioassay Data
RL-DR-003	Review and Analysis of Alpha Spectrometry Spectra
RL-HS-006	Disposal/Return of Completed Samples
RL-IT-001	Software Quality Assurance
RL-QA-001	Review of Quality Control Data
RL-QA-002	Nonconformance and Corrective Action System
RL-RPL-001	Reagent and Non-Radioactive Standard Labeling
RL-RS-001	Guidelines For Radiation and Contamination Surveys
RL-RS-002	Checking The Portable Survey Meters
RL-SE-002	Annual Verification of Thermometers
RL-SRV-001	Receiving and Login of Samples By Sample Control
RL-SRV-002	Temperature Monitoring of Sample Refrigerators

SECTION 3. INTRODUCTION, SCOPE AND APPLICABILITY

3.1 Introduction and Compliance References

TestAmerica Richland's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with the U. S. Department of Energy (DOE), Quality Systems for Analytical Services, (QSAS, current revision); U. S. Department of Defense (DoD), Quality System Manual (QSM, version 4.2); the 2009 NELAC Institute (TNI) Standard, , Volume 1 Modules 2 and 4, and ISO/IEC Guide 17025:2005. In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plan (CQMP) and the various accreditation and certification programs listed in Appendix 3. The CQMP provides a summary of TestAmerica's quality and data integrity system, and contains requirements and general guidelines under which all TestAmerica facilities shall conduct their operations.

The QAM has been prepared to be consistent with the requirements of the following documents:

- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document (HASQARD)*, U. S. Department of Energy, Revision 3, June 2007
- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water,* EPA, Revised July 1991
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water,* Supplement III, U. S. Environmental Protection Agency, August 1995
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* U. S. Environmental Protection Agency, March 1979
- SW-846, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods, [Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008],* U. S. Environmental Protection Agency, January 2008
- *DoD Quality Systems Manual for Environmental Laboratories, Version 4.2,* U.S. Department of Defense, October 2010
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- EPA 815-R-05-004, *Manual for the Certification of Laboratories Analyzing Drinking Water,* U. S. Environmental Protection Agency, January 2005
- *Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, U. S. Environmental Protection Agency, Contract Laboratory Program Multi-media, Multi-concentration.*
- American Public Health Association, *Standard Methods for the Examination of Water and Wastewater,* 18th Edition, 19th, 20th, 21st, and on-line Editions.
- *U.S. Department of Energy* Order 414.1B, *Quality Assurance*, Approved April 2004.
- *U.S. Department of Energy* Order 414.1C, *Quality Assurance*, June 2005.
- *U.S. Department of Energy*, *Quality Systems for Analytical Services*, Revision 3.6, November 2010.

- U.S. Department of Defense, *Air Force Center for Environmental Excellence Quality Assurance Project Plan,* Version 4.0.02, May 2006.
- Nuclear Regulatory Commission Quality Assurance Requirements.
- Marine Protection, Research and Sanctuaries Act.
- Toxic Substances Control Act (TSCA).
- DOE-STD-1112-98, *The Department of Energy Laboratory Accreditation Program for Radiobioassay, U. S. Department of Energy,* December 1998.
- AIHA Laboratory Quality Assurance Program Policy Document, current revision.
- ASTM D7282-06, Standard Practice for Set-up, Calibration, and Quality Control of Instruments Used for Radioactivity Measurements, American Society for Testing & Materials, current revision.
- Nureg-1576, Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP) *U. S.* Environmental Protection Agency.
- HPS-N13.30-1996, "Performance Criteria for Radiobioassay" Health Physics Society, An American National Standard
- ANSI N42.23, Measurement and Associated Instrumentation Quality Assurance for Radioassay Laboratories, 1996.

3.2 Terms and Definitions

A Quality Assurance (QA) Program is a company-wide system designed to ensure that data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOP) and quality control (QC). The TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 2 for the Glossary/Acronyms.

3.3 Scope / Fields of Testing

The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among air, drinking water, effluent water, groundwater, hazardous waste, sludge, filters, soils, food products, animal tissue, vegetation, materials from decontamination / decommissioning, and bioassay (urine and feces). The Quality Assurance Program applies to all activities of the laboratory, whether carried out onsite or in a mobile or temporary facility. The program contains specific procedures and methods to test samples of differing matrices for chemical, physical and biological parameters. The Program also contains guidelines for maintaining documentation of analytical processes, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all analytical requests are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of

test methods used by the laboratory can be found in the QA files. The approach of this manual is to define the minimum level of QA and QC necessary to meet these requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPP), project specific data quality objectives (DQO), Statement of Work, or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director (LD) and the QA Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The LD and the QA Manager must determine if it is in the laboratory's best interest to follow the less stringent requirements.

3.4 Management of the Manual

3.4.1 Review Process

The template on which this manual is based is reviewed annually by QA Manager and laboratory personnel to assure that it remains in compliance with Section 3.1. This manual itself is reviewed annually by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into the document. All updates will be reviewed by the QA Manager, LD, Technical Manager(s) and relevant operational staff. The laboratory updates and approves such changes according to Document Control, Section 6 of this manual. Pencil changes to this manual pending document update are not authorized for this laboratory.

The QA Manager controls distribution of this manual by posting the current approved version in the laboratory QAM database in electronic PDF format. Employees sign a form indicating they have read and understand the contents. This form is retained in the QA files. Hard copies, unless otherwise specified, are uncontrolled. When an approved revision of a TestAmerica Richland controlled document is ready for distribution, obsolete copies of the document are replaced with the current version of the document. The previous revision of the controlled document is archived by the QA Department.

SECTION 4. MANAGEMENT REQUIREMENTS

4.1 Overview

TestAmerica Richland is a local operating unit of TestAmerica Laboratories, Inc. The organizational structure, responsibilities and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the TestAmerica CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., President, Chief Executive Officer, Corporate QA, etc.). The laboratory operational and support staff work under the direction of the LD. Current laboratory organization charts are maintained in the QA files. An example of the organizational structure for both Corporate & TestAmerica Richland is presented in Figure 4-1.

4.2 Roles and Responsibilities

In order for the QA Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. This manual is specific to the Richland laboratory. Role descriptions for corporate personnel are defined in the CQMP. The following descriptions briefly define each role in its relationship to the QA Program.

4.2.1 Additional Requirements for Laboratories

The responsibility for quality resides with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for upholding the standards therein. Each person carries out his/her daily tasks in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for corporate personnel are defined in the CQMP. This manual is specific to the operations of TestAmerica's Richland laboratory. All laboratory employees are responsible for implementing the QA Program. All laboratory employees have Stop Work Authority.

4.2.2 Laboratory Director

The TestAmerica Richland LD is responsible for the overall quality, safety, financial, technical, human resource and service performance of the whole laboratory and reports to the General Manager (GM). The LD provides the resources necessary to implement and maintain an effective and comprehensive QA and Data Integrity Program.

Specific responsibilities include, but are not limited to:

- Ensuring that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work,
- Exercising signature authority for this QAM, SOPs, other QA documents, final reports and contracts,
- Ensuring TestAmerica's human resource policies are adhered to and maintained,
- Ensuring that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory,

- Ensuring that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits,
- Ensuring that client specific reporting and QC requirements are met, and
- Annually assessing the effectiveness of the QAM with respect to laboratory operations.

4.2.3 QA Manager or Designee

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system. The QA Manager shall have documented training and/or experience in the QA/QC procedures and be knowledgeable in the quality system as defined under NELAC, American Industrial Hygiene Association(AIHA), DOE QSAS, and the DoD QSM.

The QA Manager reports directly to the LD and has access to Corporate QA for advice and resources. This position is able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence. Corporate QA may be used as a resource in dealing with regulatory requirements, certifications and other QA related items. The QA Manager directs the activities of the QA assistants to accomplish specific responsibilities, which include, but are not limited to:

- Serving as the focal point for QA/QC in the laboratory,
- Functioning independently from laboratory operations for which he/she has QA oversight,
- Maintaining and updating the QAM and exercising signature authority for the laboratory quality documents,
- Monitoring and evaluating laboratory certifications; scheduling proficiency testing samples,
- Monitoring and communicating regulatory changes that may affect the laboratory to management,
- Training and advising the laboratory staff on QA/QC procedures that are pertinent to their daily activities, and monitoring training effectiveness,
- Maintaining personal documented training and/or experience in QA/QC procedures and the laboratory's Quality System,
- Assuring personal general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed),
- Arranging for or conducting internal audits on quality systems and the technical operation,
- Maintaining records of all ethics-related training, including the type and proof of attendance,
- Maintaining, improving, and evaluating the corrective action database and the corrective and preventive action systems,
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken.
- Objectively monitoring standards of performance in QC and QA without outside (e.g., managerial) influence,

- Coordinating document control of SOPs, Method Detection Limits (MDL); Minimum Detectable Concentration (MDC), control limits, and miscellaneous forms and information,
- Reviewing a percentage of all final data reports for internal consistency. Review of Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness of any corrective action statements, 5% of calculations, format, holding time, sensibility and completeness of the project file contents.
- Reviewing external audit reports and data validation requests.
- Following up audits to ensure client QAPP requirements are met.
- Establishment of reporting schedule and preparation of various quality reports for the LD, clients and/or Corporate QA.
- Development of suggestions and recommendations to improve quality systems.
- Researching current state and federal requirements and guidelines.
- Captains the QA team to enable communication and to distribute duties and responsibilities.
- Ensuring communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Ensure compliance with ISO 17025, 2009 TNI Standard, AIHA policy modules, DOE QSAS and the DoD QSM, Compliance with DoD ELAP.
- Evaluation of thoroughness and effectiveness of training.
- Exercising final authority to accept or reject data, and to stop work in the event that procedures or practices compromise the validity and integrity of analytical data.
- Certifying via signature on each Demonstration of Capability (DOC) that personnel with appropriate educational and/or technical background perform all tests for which the laboratory is accredited by the DoD ELAP.

4.2.4 Technical Manager or Designee

The Technical Manager(s) is accountable for all analyses and analysts under their experienced supervision and for compliance with ISO 17025, the 2009 TNI Standard, AIHA policy modules, DOE QSAS and the DoD QSM as well as compliance with the DoD ELAP. The scope of responsibility ranges from the new-hire process and existing technology through the ongoing training and development programs for existing analysts and new instrumentation. Specific responsibilities include, but are not limited to:

- Exercising day-to-day supervision of laboratory operations for the appropriate field of accreditation and reporting of results. Coordinating, writing, and reviewing preparation of all test methods, i. e., SOPs, with regard to quality, integrity, regulatory and optimum and efficient production techniques, and subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples. He/she insures that the SOPs are properly managed and adhered to at the bench. He/she develops standard costing of SOPs to include supplies, labor, overhead, and capacity (design vs. demonstrated versus first-run yield) utilization.
- Exercising signature authority for QAM and other QA documents.

- Reviewing and approving, with input from the QA Manager, proposals from marketing, in accordance with an established procedure for the review of requests and contracts. Monitoring the validity of the analyses performed and data generated in the laboratory. This activity begins with reviewing and supporting all new business contracts, insuring data quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process (training, development, and accountability at the bench), and providing technical and troubleshooting expertise on routine and unusual or complex problems.
- Certifying via signature on each Demonstration of Capability (DOC) that personnel with appropriate educational and/or technical background perform all tests for which the laboratory is accredited by the DoD ELAP.
- Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.
- Enhancing efficiency and improving quality through technical advances and improved Laboratory Information Management System (LIMS) utilization. Capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.
- Coordinating sample management from “cradle to grave,” insuring that no time is lost in locating samples.
- Scheduling all QA/QC-related requirements for compliance, e.g., MDLs, etc…
- Captains department personnel to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.
- Coordinates audit responses with the QA Manager.

4.2.2 Operations Managers

The Operations Manager reports directly to the LD, and manages and directs a portion of the analytical production sections of the laboratory. Specific responsibilities include, but are not limited to:

- Constantly monitoring and modifying the processing of samples through the departments to achieve technical, client and regulatory requirements.
- Assuring adequate supervision of laboratory technicians and analysts to achieve planned processing of samples through the facility.
- Evaluating the level of internal/external non-conformances for all departments.
- Continuously evaluating production capacity and improving capacity utilization.
- Continuously evaluating compliance with client turnaround time (TAT) requirements, and addressing any problems that may hinder meeting the required and committed TATs from the various departments.
- Development and improvement of analyst training, in cooperation with the Technical Manager and QA Manager and in compliance with regulatory requirements.
- Utilizing supplies in an efficient manner.

- Supporting audits and complying with corrective actions, as applicable.
- Assisting to maintain a working environment which encourages open, constructive problem solving and continuous improvement.

4.2.3 Lab Support Supervisor

The Lab Support Supervisor reports directly to the LD. Primary responsibilities include, but are not limited to:

- Establishment and maintenance of the LIMS for tracking all samples in the laboratory.
- Continuously updating and enhancing LIMS to best support laboratory operations.
- Programming and testing modifications and changes to locally developed software.
- Coordination of testing to ensure that all LIMS software accurately performs its intended functions.
- Maintenance of historical software archives, software operating procedures (manuals), software changes/modifications (Change Log) and software version numbers.
- Maintenance of log of repairs and service performed on LIMS hardware.
- Development and verification of security practices to assure the integrity of LIMS data. Identification of threats, potential threats, and future threats.
- Assuring awareness of any environmental conditions of the facility housing the LIMS that may compromise LIMS raw data, and informing management of needed facility changes.
- Assuring that laboratory facilities and equipment are maintained in operable condition.
- Assuring that adequate reagents, supplies, equipment and services are purchased in accordance with company guidelines.

4.2.4 Environmental Health and Safety Coordinator (EHSC) or Designee

The EHSC reports directly to the LD. Primary responsibilities include, but are not limited to:

- Implementing daily requirements of the Environmental Health and Safety (EH&S) program.
- Ensuring that manufacturer Material Safety Data Sheets (MSDS) are up to date and available to all laboratory staff via the corporate website.
- Maintaining knowledge of regulations that affect EH&S at the facility, and assuring that all staff is aware of general safety and environmental requirements.
- Exercising signature authority to ensure that SOPs include adequate safety precautions.

NOTE: The roles and responsibilities described above are also those of the EHSC designee.

4.2.5 Radiation Safety Officer or Designee

The Radiation Safety Officer (RSO) reports directly to the LD. Primary responsibilities include, but are not limited to:

- Advising management on matters of policy related to implementation of the Radiation Protection Plan.
- Maintenance of the laboratory Radioactive Materials License and related certifications.
- Monitoring of laboratory operations and processes for compliance with the Radiation Protection Plan.
- Development of staff training for the handling of radioactive materials. Conducting, evaluating and documenting training of TestAmerica personnel responsible for handling radioactive materials.

NOTE: The roles and responsibilities described above are also those of the RSO designee.

4.2.6 Supervisors

Supervisors report to their manager. Each one's responsibilities include, but are not limited to:

- Ensure that analysts in their department adhere to applicable SOPs and the QAM.
- Participate in the selection, training, and development of performance objectives and standards of performance, appraisal (measurement of objectives), scheduling, counseling, discipline, and motivation of analysts. Document these activities in accordance with systems developed by the QA and Human Resources (HR) Departments. Evaluate staffing sufficiency and overtime needs.
- Encourage the development of analysts to become cross-trained in various methods.
- Provide guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the Technical Manager, Operations Manager, and/or QA Manager.
- Ensure all logbooks are maintained, current, and properly labeled or archived.
- Report all non-conformance conditions to the QA Manager, Technical Manager, Operations Manager, and/or LD.
- Maintain adequate and valid inventory of reagents, standards and other relevant resources required to perform daily analysis.
- Achieve optimum TATs on analyses, and compliance with holding times and related requirements.
- Assist with writing responses to external and internal audit issues.
- Suggest method improvements to their manager, the Technical Manager, or the QA Manager.

4.2.7 Laboratory Analysts

Laboratory analysts are responsible for conducting analyses and performing all tasks assigned to them by the supervisor. Analysts are responsibilities include, but are not limited to:

- Perform analyses while adhering to analytical and QC protocols prescribed by current SOPs, the QAM, and project-specific plans. Perform analyses honestly, accurately, timely, safely, and in the most cost-effective manner.

- Stop work if an unsafe situation arises.
- Document standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on work lists, bench sheets, lab notebooks and/or the Non-Conformance Database according to SOP requirements.
- Report to their supervisor (or the Technical Manager or QA Manager as appropriate) all non-conformance situations, instrument problems, matrix problems and QC failures which might affect the reliability of the data.
- Suggest method improvements to their supervisor, the Technical Manager, or the QA Manager.
- Work cohesively as a team in their department to achieve the goals of accurate results, optimum TATs, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

4.2.8 Customer Service Manager/Manager of Project Management

The Customer Service Manager reports to the LD and manages the Project Management Team to ensure total client satisfaction through timely communication and customer service. With the overall goal of total client satisfaction, specific responsibilities include, but are not limited:

- Technical training, mentoring and growth of the Project Management team.
- Technical liaison for the Project Management team.
- Human resource management of the Project Management team.
- Assigning a primary and alternate project manager/associate (PM) to each client, and monitoring overall effectiveness of client communications.
- Ensuring that each PM communicates known client project and QA requirements to the laboratory.
- Notifying laboratory managers of incoming projects and sample delivery schedules.
- Providing overall accountability to clients through support of PMs when data package-related problems and resolving service issues.
- Assuring that appropriate staff is familiar with specific quotes, sample log-in review, and final report completeness.
- Coordinating with corporate sales staff to assure that quotes, proposals and related business communications are prepared in a complete and timely fashion to achieve laboratory business goals.
- Monitoring the status of all data package projects in-house to ensure timely and accurate delivery of reports.

4.2.9 Project Managers / Project Management Associates

Project Managers and Project Management Associates (both referred to as PM in this document) report to the Customer Service Manager, and serve as the interface between the

laboratory and the laboratory's clients. With the overall goal of total client satisfaction, the functions of this position are outlined below, but are not limited:

- Ensures that assigned clients receive the proper sampling supplies.
- Notifies laboratory managers of incoming projects and sample delivery schedules. Coordinates technical and documentation details for incoming projects with laboratory staff.
- Ensures that client specifications, when known, are met by communicating project and QA requirements to the laboratory.
- Monitors the status of assigned projects in-house to ensure timely and accurate delivery of reports.
- Communicates proactively with assigned clients regarding COC issues, sample progress, project or data package-related problems and to resolve service issues.
- Responds to client inquiries concerning sample status.
- Assembles and transmits required reports and invoicing for assigned clients. Certifies that client reports are complete and appropriate by signing certificate of analysis.
- Acting as the approved signatory on behalf of the AIHA Technical Manager

4.2.10 Sample Custodian / Sample Receiving

Sample custodians report to the manager, and are responsible for safely conducting sample receipt and storage activities. Sample custodians are responsibilities include, but are not limited to:

- Ensuring implementation of proper sample receipt procedures, including COC requirements.
- Reporting nonconformances associated with condition-upon-receipt of samples.
- Logging in samples to the LIMS.
- Ensuring that all samples are stored in the proper environment.
- Assisting the EHSC with sample disposal.

4.3 Deputies

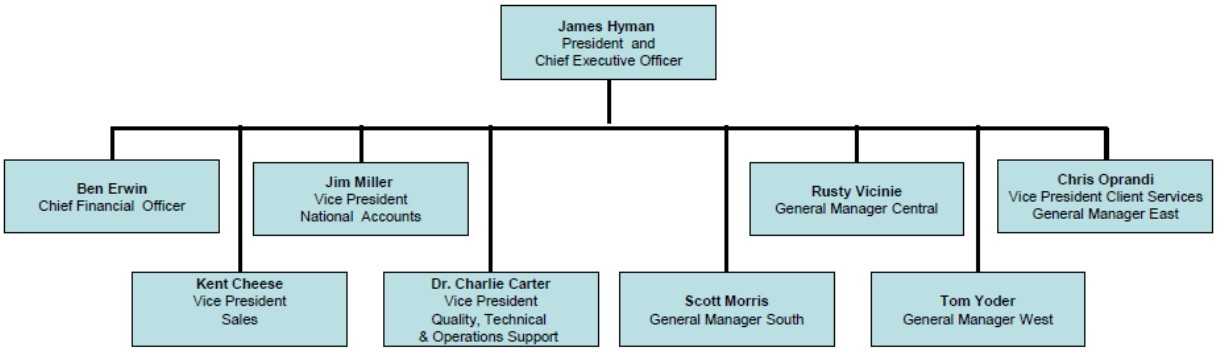
The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy
Jodie Carnes Laboratory Director	Erika Jordan Customer Service Manager
Sarah Nagel QA Manager	Rhonda Wagar Project Manager
Tabitha Liebrecht Metals/Asbestos Technical Manager	Timothy Armstrong Inorganic Operations Manager
Kenneth Miller Radiochemistry Technical Manager	Mathias Lardy Radiochemistry Technical Advisor
David Harbinson EH&S Coordinator	Timothy Armstrong Inorganic Operations Manager
Tanya Wood Radiation Safety Officer	Mathias Lardy & Authorized Users
David Harbinson HAZWOPER Sample Shipping	Peter Norton Waste Disposal Technician

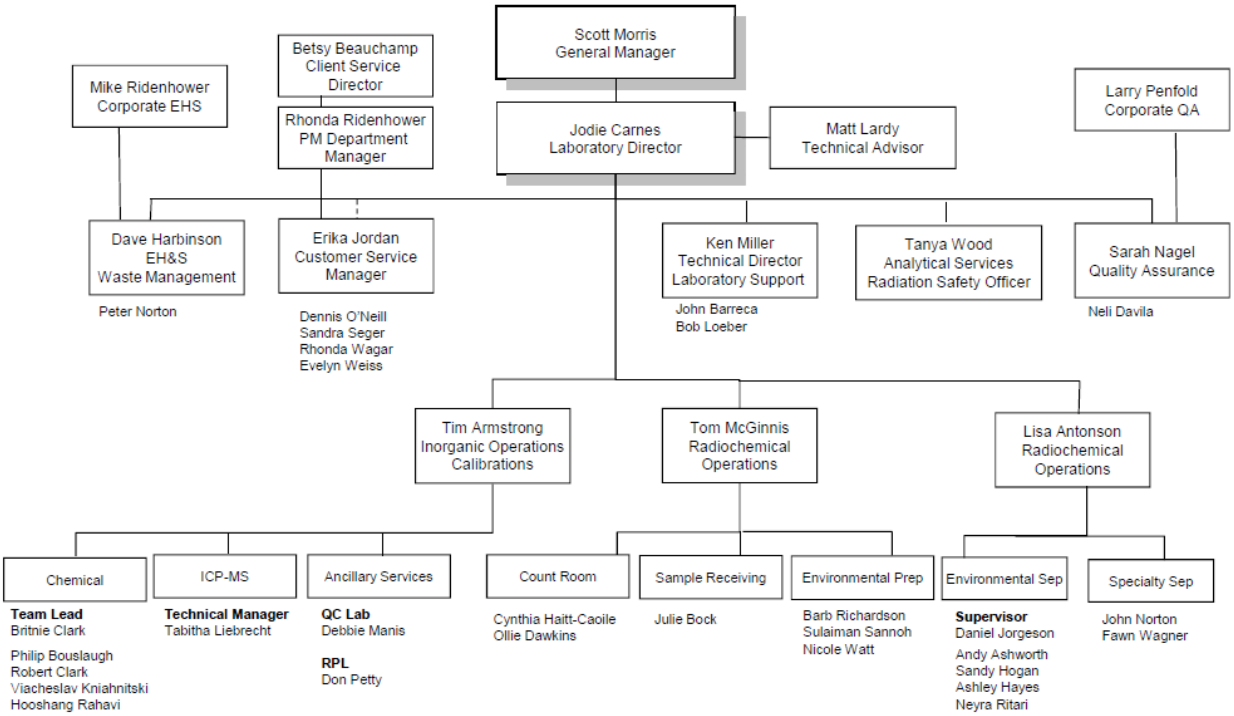
Note: The deputy RSO and EH&S coordinators will have equivalent training to the key personnel for those positions.

Figure 4-1. Example Corporate and Laboratory Organization Charts

TestAmerica Executive Team



Richland Laboratory Staff



SECTION 5. QUALITY SYSTEM

5.1 Quality Policy Statement

It is TestAmerica's Policy to:

- Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.
- Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.
- Continually improve systems and provide support to quality improvement efforts in laboratory, administrative and managerial activities. TestAmerica recognizes that the implementation of a QA program requires management's commitment and support as well as the involvement of the entire staff.
- Provide clients with the highest level of professionalism and the best service practices in the industry.
- To comply with the ISO/IEC 17025:2005(E) International Standard, the 2009 NELAC Standard and to continually improve the effectiveness of the management system.

Every staff member at the laboratory plays an integral part in QA and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 Ethics and Data Integrity

TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of TestAmerica's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy No. CW-L-P-004) and Employee Ethics Statements.
- Ethics and Compliance Officers (ECO).
- A Training Program.
- Self-governance through disciplinary action for violations.
- A Confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct. (Corporate SOP No. CW-L-S-002)
- Procedures and guidance for recalling data if necessary (Corporate SOP No. CW-L-S-002).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15).

Each TestAmerica employee shall

- Produce results that are accurate and include QA/QC information that meets client pre-defined DQOs.

- Present services in a confidential, honest and forthright manner.
- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 Quality System Documentation

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab-specific QA manual.
- Corporate SOPs and Policies – Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.
- Work Instructions – A subset of procedural steps, tasks or forms associated with an operation of a management system (e.g., checklists, preformatted bench sheets, forms).
- Laboratory SOPs – General and Technical
- Corporate Quality Policy memorandums
- Laboratory QA/QC Policy Memorandums
- Laboratory Chemical Hygiene Plan (within Laboratory Safety Plan Addendum)
- Laboratory Waste Management Plan (comprised of several SOPs)
- Laboratory Radiation Protection Plan including Radioactive Material License

The laboratory shall have SOPs in place for (but not limited to) the following areas:

- Sample Management
- Reagent/Standard Preparation
- General Laboratory Techniques
- Test Methods (for all procedures performed)
- Glassware Cleaning
- Instrument and Equipment Calibration and Maintenance
- QC
- Corrective Action
- Data Reduction and Validation
- Reporting
- Records Management (contained in this QAM)

- Radioactive and Hazardous Material Management

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies and procedural documents, the order of precedence is as follows:

- Corporate CQMP
- Corporate Quality Policy Memorandum
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory QAM
- Laboratory SOPs and Policies
- Other (corporate Work Instructions (WI), laboratory Operator Aids, memos, flow charts, etc.)

Note: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's QAM shall comply with the regulatory requirements of the jurisdiction and shall take precedence over the CQMP in those cases.

5.4 QA/QC Objectives for the Measurement of Data

QA and QC are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. QA is generally understood to be more comprehensive than QC. QA can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

QC is generally understood to be limited to the analyses of samples and to be synonymous with the term *"analytical quality control"*. QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits (RL).

Request for Proposals (RFP) and QAPPs provide a mechanism for the client and the laboratory to discuss the DQO in order to ensure that analytical services closely correspond to client needs. Unless the laboratory agrees by contract to do so, the client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to meet the DQOs specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. Additionally, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS).

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet DQOs of the U. S. Environmental Protection Agency (EPA or USEPA) and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference (RPD) between separately procured, but otherwise identical samples or sample aliquots.

The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness and RL statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision and RLs with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability will be defined in a QAPP, project scope or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take

the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), interelement corrections (separation), use of matrix modifiers (separation), specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific gamma/alpha energies (identification), specific wavelengths (identification), specific mass spectra (identification), etc…

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Method Detection Limit) or quantified (Reporting Limit or RL).

5.5 Criteria for Quality Indicators

TestAmerica Richland Laboratory has SOPs that summarize the precision and accuracy acceptability limits for performed analyses. The SOPs include an effective date, are updated each time new limits are generated, and are managed by the laboratory's QA department.

Some acceptability limits are derived from US EPA methods when they are required. Where US EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits are contained in Section 24.

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs (such as the Ohio Voluntary Action Plan). The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The analysts are instructed to use the current limits in the laboratory LIMS (dated and approved by the Technical Manager and QA Manager). The QA department maintains an archive of all limits used within the laboratory. If a method defines the QC limits, the method limits are used.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the LIMS following the guidelines described in Section 24. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

Current QC limits are entered and maintained in the LIMS analyte database. As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.6.1 QC Charts

Trend Analysis shall be performed by the QA Manager or designee(s) quarterly to identify significant problems within trends and evaluated for timely and appropriate corrective actions. Quality related information which can be included as part of the trend analysis is:

- Performance Data
- Audit reports
- Surveillance reports
- Nonconformance reports
- Failure rates
- Quality-related information from external sources

Trends determined to be adverse to quality shall be reported to the responsible supervisor for corrective action. Trend analysis is discussed further in RL-QA-001, current revision.

Counting instrument QC data are maintained electronically. Hard copies of control charts are prepared upon request. Trend analysis is performed on an as needed basis.

The QA Manager evaluates these to determine if adjustments need to be made or for corrective actions to methods. All findings are documented and kept on file.

5.7 Quality System Metrics

In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

SECTION 6. DOCUMENT CONTROL

6.1 Overview

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled:

- Laboratory QAM
- Laboratory SOPs
- Laboratory Policies
- Work Instructions, Operator Aids and Forms
- Corporate Policies and Procedures distributed outside the intranet

Corporate Quality posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving corporate documents is found in Corporate SOP No. CW-Q-S-001, Corporate Document Control and Archiving. The laboratory's internal document control procedure is defined in this section.

The laboratory QA Department also maintains access to various references, document sources and software integral to the operation of the laboratory. This includes reference methods and regulations. Instrument manuals (hard or electronic copies) are also maintained by the laboratory. The location of these sources is maintained on a master document control list by the QA department.

The laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports. Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports.

6.2 Document Approval and Issue

The pertinent elements of a document control system for each document include a unique document title and number, pagination, the total number of pages of the item or an 'end of document' page, the effective date, revision number and the laboratory's name. The QA Manager and his/her personnel are responsible for the maintenance of this system and maintain the items in the QA files.

Controlled documents are authorized by the QA Department and other management. In order to develop a new document, a manager submits an electronic draft to the QA Department for suggestions and approval before use. Upon approval, QA personnel add the identifying version information to the document and retain the signed original as the official document on file. The signed electronic document is then provided to all applicable operational units (may include

electronic access). Controlled documents are identified as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed annually and revised as appropriate. Changes to documents occur when a procedural change warrants. Altered or new text is identified through a change log entry at the end of the SOP or other controlled document. Use of the change log concept began in 2010 therefore; until the next review cycle is completed for all documents some may not have this feature.

6.3 Procedures for Document Control Policy

For changes to the QA Manual, refer to Section 3.4.1. Uncontrolled copies must not be used within the laboratory. Previous revisions and back-up data are archived by the QA department. The latest revision is posted as an electronic copy on the Data2 server in the QAM folder.
For changes to SOPs, refer to SOP No. CW-Q-S-002, *Writing a Standard Operating Procedure*. The SOP identified above also defines the process of changes to SOPs. All SOPs are posted on the Data2 server in the SOP folder in electronic PDF® format

All new SOPs and subsequent revisions shall be reviewed and approved by the LD, Technical Manager or designee, the QA Manager and Environmental Health and Safety Coordinator. Each reviewer is responsible for ensuring that the procedure is accurate and adequate based on their area of expertise. During the revision process all work aids shall be evaluated and incorporated into the SOP as necessary.

Upon receipt of hard copy new procedures/revisions of controlled documents, the user shall remove the old version and insert the updated version of the document. The user will sign a document receipt form acknowledging the manual has been updated and will forward the signed form and old revision to the QA Department. The old version is disposed in the locked recycle bins available throughout the laboratory.

For clients who require approval of procedural change, a copy of the proposed revision shall be sent to the client for approval. The change shall not be implemented for that client until the client's requirements have been met.

Uncontrolled copies of manuals and SOPs will only be supplied to clients upon request. Uncontrolled copies will not be updated after distribution.

Forms, worksheets, work instructions and operator aids are organized by a QA assigned number. This number, date created, and revision number shall be placed on the bottom of the form. An original or copy of the form shall be maintained in the Quality files. Form revisions shall have the same requirements as the original form.

Occasionally, a minor variation to an SOP is needed that does not warrant a permanent change. This variation must be pre-approved and documented before beginning the task. To accomplish this, each SOP must contain the following text:

> **"Note**: One time procedural variations are allowed if deemed necessary by the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, and chemistry, sample size or other parameters. Any variation in procedure shall require approval by supervision and immediate notification of the QA Group. If contractually required, the client shall be notified prior to any procedure changes. A Nonconformance Memo shall be completed and forwarded to the QA Group within one day of the supervisor's approval. The Nonconformance Memo will be filed in the project file. "

Procedures that do not meet the standards set forth in the QAM or laboratory SOPs shall be investigated following steps outlined in Section 12, and if deemed necessary may be temporarily suspended during the investigation.

6.4 Obsolete Documents

All invalid or obsolete documents are removed from laboratory SOP notebooks and the controlled server, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. Obsolete hard copy documents are collected from employees according to distribution lists and are destroyed. One copy of the obsolete document is archived in the QA files.

SECTION 7. SERVICE TO THE CLIENT

7.1 Overview

The laboratory has established procedures for the review of work requests, tender and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

The review procedure addresses the methods to be used for analysis and any limitations in relation to the laboratory's capability and resources to meet the client's expectations. Differences are resolved before the contract is signed and work begins. A system documenting any significant changes is maintained, as well as pertinent discussions with the client regarding their requirements or the results of the analyses during the performance of the contract. All work subcontracted by the laboratory must be approved by the client. Any deviations from the contract must be disclosed to the client. Once the work has begun, any amendments to the contract must be discussed with the client and so documented.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of analyte lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements [% Recovery, Relative Error Ratio (RER) and RPD]. The reviewer ensures that the laboratory's test methods are suitable to achieve regulatory and client requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed TAT will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services to an outside firm or work share to another TestAmerica facility, this will be documented and

discussed with the client prior to contract approval. Refer to Section 8 for Subcontracting Procedures.

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or TestAmerica, are documented in writing. If the original contract allows, this may take place via electronic mail.

All contracts, QAPPs, Sampling and Analysis Plans (SAP), contract amendments, and documented communications become part of the project record.

The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes. Any accreditation changes such as suspension, revocation or voluntary withdrawal must be reported to the client in writing. This may take place via electronic mail.

7.2 Review Sequence and Key Personnel

Appropriate personnel will review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the PM is considered adequate. The PM confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements and that the lab has the capacity to meet client turnaround time needs.

For large new or complex projects, the proposed contract (or RFP) may be given to the corporate Proposal Management Group, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in TestAmerica's Corporate SOP No. CA-L-P-002**,** Contract Compliance Policy.

This review encompasses all facets of the operation. The Statement of Work is distributed to appropriate personnel, as needed based on scope of contract, for evaluation per the requirements shown above:

- Corporate Legal & Contracts Director
- Corporate GM
- The Laboratory Manager of Project Management
- Laboratory and/or Corporate Technical Manager(s)
- Laboratory and/or Corporate Information Technology Managers/Directors
- Regional and/or National Account Representatives
- Laboratory and/or Corporate Quality
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors
- Business Development & Customer Service Manager

- Appropriate laboratory Operations Manager
- Account Executives
- QA Manager

The LD reviews the formal laboratory quote or proposal, and makes final acceptance for their facility. In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements.

The National Account Director, Legal Contracts Director, or local account representative then submits the final proposal to the client.

Note: The Legal & Contracts Director maintains copies of all signed contracts. A copy also will be maintained by the project management group.

7.3 Documentation

Appropriate records are maintained for every contract, tender or work request. All stages of the contract review process are documented and include records of any significant changes. The documentation is maintained as part of the project record.

A copy of any contract signed at the laboratory level must be submitted to the Legal & Contracts Director, who maintains copies of all signed contracts. A copy will also be maintained by the TestAmerica Richland project management group.

The contract will be distributed to and maintained by the appropriate sales/marketing personnel and the Account Executive. A copy of the contract and formal quote will be filed with the laboratory PM and the LD.

Records are maintained of 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. The PM is responsible for maintaining all documentation including phone logs of conversations and email correspondence with the client.

7.3.1 Project-Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, the laboratory assigns a PM to each client. The PM is the first point of contact for the client. It is the PM's responsibility to ensure that project-specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA department involvement may be needed to assist in the evaluation of custom QA requirements.

PMs are the primary client contact and they ensure resources are available to meet project requirements. Although PMs do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project Management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, TATs, holding times, methods, analyte lists, RLs, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during production meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, work instructions (i.e. "Blue Sheets, QAS") and/or site/project specific requirements may be associated with each sample batch as a reminder upon sample receipt and analytical processing.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes (e.g., use of a non-standard method or modification of a method) and approvals must be documented prior to implementation. Documentation pertains to any document, e.g., letter, e-mail, variance, contract addendum, which has been signed by both parties.

Such changes are also communicated to the laboratory during production meetings. Such changes are updated to the project notes and are introduced to the managers at these meetings. The laboratory staff is then introduced to the modified requirements via the PM or the individual laboratory Operations Manager. After the modification is implemented into the laboratory process, documentation of the modification is made in the case narrative of the data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 Special Services

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 15 and 25).

Note: ISO/IEC 17025 states that a laboratory "shall afford clients or their representatives cooperation to clarify the client's request". This topic is discussed in Section 7.

The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

- Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.
- Assist client-specified third party data validators as specified in the client's contract.
- Supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

7.5 Client Communication

PMs are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. PMs will maintain ongoing client communication throughout the entire client project.

Technical Managers are available to discuss any technical questions or concerns that the client may have.

Whenever a contract needs to be amended after work has begun, the PM is responsible to report to the client any accreditation suspensions, revocations or voluntary withdrawals that are relevant to the contract. This may include accreditation scope.

7.6 Reporting

Analytical results are reported to clients according to the requirements in the client contract with the laboratory (see SOP RL-PM-001 for required steps). The laboratory works with clients to produce any special communication reports required by the contract.

7.7 Client Surveys

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service. TestAmerica's Sales and Marketing teams periodically develop lab and client specific surveys to assess client satisfaction.

SECTION 8. SUBCONTRACTING OF TESTS

8.1 Overview

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the TestAmerica laboratories. The phrase “work sharing” refers to internal transfers of samples between the TestAmerica laboratories. The term outsourcing refers to the act of subcontracting tests.

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients due to project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and will meet the same commitments we have made to the client. Refer to TestAmerica’s Corporate SOPs on Subcontracting Procedures (CA-L-S-002) and the Work Sharing Process (CA-C-S-001).

When outsourcing analytical services, the laboratory will assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified by TNI/ISO 17025 and/or the client’s QAPP. All QC guidelines specific to the client’s analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-TNI accredited work where required. See Figure 8-1, Example-Subcontracted Sample Form.

The PM or Customer Service Manager is responsible for obtaining client approval prior to outsourcing any samples. The laboratory will advise the client of a subcontract or work sharing arrangement in writing and when possible approval from the client shall be retained in the project folder.

Note: In addition to the client, some regulating agencies (e.g., USDA) or contracts (e.g., certain US Army Corps of Engineers projects) may require notification prior to placing such work**.**

For DOE or DoD projects, the laboratory shall not use any third party (sub-tier) laboratories, including other TestAmerica laboratories, for performance of work without written approval from the DOE Procurement Representative. Note that some DOE clients may not allow any subcontracting to a sub-tier laboratory. The laboratory meets all of the requirements in this section, including being accredited to the DoD ELAP or other program as appropriate, and must be available for client inspections and audits.

8.2 Qualifying and Monitoring Subcontractors

Whenever a PM becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory;

- Firms specified by the client for the task; NOTE: documentation that a subcontractor was designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder;
- Firms listed as pre-qualified and currently under a subcontract with TestAmerica: A listing of all approved subcontracting laboratories is available on the TestAmerica intranet site. Supporting documentation is maintained by corporate offices and by the TestAmerica laboratory originally requesting approval of the subcontract lab. Verify necessary accreditation, where applicable, (e.g., on the subcontractors TNI, A2LA accreditation or State Certification).
- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses;
- TNI or A2LA accredited laboratories.
- Assure that the firm holds the appropriate certification to perform the work required.

With the exception of DoD and DOE programs noted in 8.1, all TestAmerica laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approved sending samples to that laboratory. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. (Corporate SOP No. CA-C-S-001, Work Sharing Process).

When the potential sub-contract laboratory has not been previously approved, the PM may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the LD. The LD requests that the QA Manager begin the process of approving the subcontract laboratory as outlined in Corporate SOP No. CA-L-S-002, Subcontracting Procedures. Work may not proceed until the client has provided acknowledgement that the samples can be sent to that facility (an email is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented).

8.2.1 Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to Corporate Contracts for formal contracting with the laboratory. They will request addition of the lab to the approved list on the intranet site and notify the finance group for JD Edwards.

8.2.2 Should the client designate a preferred subcontract laboratory, the client will assume responsibility for the quality of the data generated by the subcontracted laboratory. The qualified subcontractors on the intranet site are known to meet minimal standards. TestAmerica does not certify laboratories. The subcontractor is on our approved list and can only be recommended to the extent that we would use them.

8.2.3 The status and performance of qualified subcontractors will be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified will be brought to the attention of TestAmerica's Corporate Finance or Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation and corrective action will be maintained in the subcontractor's file on the intranet site. Complaints are posted using the Vendor Performance Report.
- Information shall be updated on the intranet when new information is received from the subcontracted laboratories.
- Subcontractors in good standing will be retained on the intranet listing. The QA Manager will notify all TestAmerica laboratories, Corporate Quality and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all LDs, QA Managers and Sales Personnel.

8.3 Oversight and Reporting

The PM must request that the selected subcontractor be presented with a subcontract, if one is not already executed between the laboratory and the subcontractor. The subcontract must include terms which flow down the requirements of our clients, either in the subcontract itself or through the mechanism of work orders relating to individual projects. A standard subcontract and the Lab Subcontractor Vendor Package (posted on the intranet) can be used to accomplish this, and the Legal & Contracts Director can tailor the document or assist with negotiations, if needed. The PM responsible for the project must advise and obtain client consent to the subcontract as appropriate, and provide the scope of work to ensure that the proper requirements are made a part of the subcontract and are made known to the subcontractor.

Prior to sending samples to the subcontracted laboratory, the PM shall confirm the certification status to determine if the accreditation/certification is current and if the analyses required are included in the certification scope (field of testing). The information is documented on a Subcontracted Sample Form (Figure 8-1) and the form is retained in the project record. For TestAmerica laboratories, certification detail can be viewed on the company's Total Access Database or from the external corporate web page.

The Sample Receiving department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

All subcontracted samples must be accompanied by a TestAmerica COC. A copy of the original COC sent by the client must also be included with all samples work shared within TestAmerica. Client COCs are only forwarded to external subcontractors when samples are shipped directly from the project site to the subcontractor lab. Under routine circumstances, client COCs are not provided to external subcontractors.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

If the project requires TNI accreditation, any non-TNI accredited work must be identified in the subcontractor's report as appropriate. If TNI accreditation is not required, the report does not need to include this information.

Reports submitted from subcontractor laboratories are not altered, and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the originating laboratory electronic data deliverable (EDD), the report must explicitly indicate which lab produced the data for which methods and samples.

Note: The results submitted by a TestAmerica work sharing laboratory may be transferred electronically and the results reported by the TestAmerica work sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4 Contingency Planning

With the exception of DoD and DOE programs noted in Section 8.1, The LD may waive the full qualification of a subcontractor process temporarily to meet emergency needs; however, this decision & justification must be documented in the project files, and the 'Purchase Order Terms And Conditions For Subcontracted Laboratory Services' must be sent with the samples and Chain-of-Custody. In the event this provision is utilized, the laboratory (e.g., PM) will be required to verify and document the applicable accreditations of the subcontractor. All other quality and accreditation requirements will still be applicable, but the subcontractor need not have signed a subcontract with TestAmerica at this time. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

Figure 8-1. Example - Sample Subcontractor Form

Date/Time: _____

Subcontracted Laboratory Information:

- Subcontractor's Name: _____
- Subcontractor Point of Contact: _____
- Subcontractor's Address: _____
- Subcontractor's Phone: _____
- Analyte/Method: _____
- Certified for State of Origin: _____
- TNI Certified: Yes_____No_____
- **USDA Permit (__Domestic __ Foreign)** **Yes**_____**No**_____
- A2LA (or ISO 17025) Certified: Yes_____No_____
- CLP-like Required: Yes_____No_____
  (Full doc required)
- Requested Sample Due Date: _____
  (Must be put on COC)
- **Client POC Approval on-file to Subcontract Samples to Sub Laboratory:** **Yes**_____**No**_____

PM: _____

Laboratory Sample # Range: _____
(Only of Subcontracted Samples)

Laboratory Project Number (Billing Control #): _____

All subcontracted samples are to be sent via bonded carrier and Priority Overnight. Please attach tracking number below and maintain these records in the project files.

PM Signature_____**Date**_____

SECTION 9. PURCHASING SERVICES AND SUPPLIES

9.1 Overview

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with TestAmerica's Corporate Controlled Purchases Procedure, SOP No. CW-F-S-007.

Contracts will be signed in accordance with TestAmerica's Corporate Authorization Matrix Policy, Policy No. CW-F-P-002. RFPs will be issued where more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts Policy (Policy No. CW-F-P-004). RFPs allow TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the TestAmerica facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 Glassware

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

Glassware to be used for DoD projects must meet acceptance criteria in the DoD QSM, Gray Box 31.

9.3 Reagents, Standards & Supplies

Purchasing guidelines for equipment and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with TestAmerica's Corporate SOP on Solvent and Acid Lot Testing and Approval, SOP No. CA-Q-S-001. Standards and reagents are purchased and handled per SOP RL-STD-002 and RL-RPL-001.

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination.

The Richland laboratory maintains a Reagent Preparation Lab (RPL), a QC Lab for makeup of radioactive standards, and an onsite consignment warehouse for supplies and glassware. The analyst completes the Material Request Sheet (or uses the barcode reader) when requesting reagent from the RPL, standards from the QC Lab, or supplies from the warehouse.

All purchasing is completed through the laboratory support department / purchasing manager.

Procurement of Quality-Related Items/Services:

The quality of instruments, equipment, standards, reagents and laboratory containers used in analyses must be known so that their effect upon analytical results can be defined. These items must meet a minimum quality requirement. Laboratory staff responsible for selection and purchasing shall be trained to this detailed procurement process. The training documentation is encompassed in the QAM training. Quality related items or services (QRI) shall be evaluated to ensure that they meet the requirements and specifications established by TestAmerica Richland. If any changes are made, these changes will go through the same evaluation as the original. These requirements and specifications can be obtained from project-specific QA requirements, DQOs, analytical method requirements and defined technical specifications. Verification that such requirements are met can be performed by one of the following:

- Source evaluation and selection (i.e. historical performance)
- Source verification
- Audit
- Examination of items or services before use

Any documentation of quality specifications required by regulations or client contract (e.g. product certification required by the laboratory, calibration documentation, etc.) shall be included or referenced in the purchasing documents for the procurement of the applicable items/services. For commercial items, reference to an approved model, lot number, catalog line item or chemical grade is sufficient. Procurement records shall be maintained, including evidence of conformance. Any changes to procurement documents shall receive the same level of review and approval as the original documents.

If applicable, the procurement process shall ensure that the supplier, designer and end-user requirements are met during the production phase.

When the QRI is received it shall be verified that the specified requirements have been met, such as material certificates are included and delivered on time. If the QRI meets the requirements, it is released for use and maintained appropriately. Receiving documentation (e.g. packing slip) is initialed to document inspection. If there any deficiencies in the item these are noted on the document and filed by the Laboratory Support department.

If the QRI does not meet specifications, a Nonconformance Memo shall be generated. Corrective actions for failure of an item/service to meet required specifications are as follows:

- Review current supplies and segregate the affected items.
- Return item(s) to vendor or destroy
- Evaluate a new lot or alternate supplier
- Evaluate the impact on product or process
- Notification to the appropriate management

Receipt records for quality-affecting items or services must include the following information as applicable:

- Date of receipt
- Expiration date
- Source
- Lot or serial number
- Calibration and verification records
- Certifications

For items that are used regularly by TestAmerica Richland where no unique requirements or specifications are required, the items may be purchased off-the-shelf. These items are ordered from the supplier on the basis of specifications set forth in the supplier's published product description. Off-the-shelf items include general laboratory supplies such as glassware, filter paper and pipettes.

Evaluation of instruments purchased shall be conducted according to acceptance testing (i.e. initial calibration). Acceptance criteria may include instrument reliability, sensitivity, stability, accuracy and ability to interface with existing computer systems and networks.

9.3.2 Receiving

It is the responsibility of the purchasing manager to receive the shipment. Once the ordered reagents or materials are received and inspected by the appropriate support staff (RPL or QC lab), the order is made available to the analyst. It is the responsibility of the analyst to assure that the reagent, standard or supplies label information meets the quality level specified. MSDSs are available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.3.3 Specifications

Method SOPs in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, analytical reagent grade will be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five year expiration date on inorganic dry chemicals and solvents unless noted otherwise by the manufacturer or by the reference source method. Chemicals/solvents should not be used past the manufacturer's or SOP expiration date unless 'verified' (refer to item 3 listed below).

- An expiration date cannot be extended if the dry chemical/solvent is discolored or appears otherwise physically degraded, the dry chemical/solvent must be discarded.

- Expiration dates can be extended if the dry chemical/solvent is found to be satisfactory based on acceptable performance of QC samples (Continuing Calibration Verification (CCV), Blanks, Laboratory Control Sample (LCS), etc.).
- If the dry chemical/solvent is used for the preparation of standards, the expiration dates can be extended 6 months if the dry chemical/solvent is compared to an unexpired independent source in performing the method and the performance of the dry chemical/solvent is found to be satisfactory. The comparison must show that the dry chemical/solvent meets CCV limits. The comparison studies are maintained in RPL files.

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user. Secondary standard expiration dates cannot exceed that of the primary standard. The RSO must approve radioactive material purchases.

Compressed gases in use are checked for pressure and secure positioning daily. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of standards or reagents must have a specific conductivity of less than 1 mmho- µmho/cm (or specific resistivity of greater than 1.0 megohm-cm) at 25°C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Reagent Preparation Laboratory must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified "clean" by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standards lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased bottle ware (such as VOA vials) used for sampling must be certified clean and the certificates must be maintained. If uncertified sampling bottle ware is purchased, all lots must be verified clean prior to use. Written verification records must be maintained along with project records.

Records of manufacturer's certification and traceability statements are maintained in files or binders in each laboratory section. These records include date of receipt, lot number (when applicable), and expiration date (when applicable). Incorporation of the item into the record indicates that the analyst has compared the new certificate with the previous one for the same purpose and that no difference is noted, unless approved and so documented by the Technical Director or QA Manager.

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health & Safety Manual (Corp. Doc. No. CW-E-M-001) and laboratory

analytical method SOPs. Standards must be stored separately from samples. Radioactive materials are stored in a designated area.

9.4 Purchase of Equipment / Instruments / Software

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or supervisor makes a supply request to the Technical Manager/Director and/or the LD. If they agree with the request, the procedures outlined in TestAmerica's Corporate Policy No. CA-T-P-001, Qualified Products List, are followed. A decision is made regarding which piece of equipment can best satisfy the requirements. The appropriate written requests are completed and Purchasing places the order.

Upon receipt of a new or used piece of equipment, an identification name is assigned and added to the equipment list. The laboratory support manager must also be notified so that they can synchronize the instrument for back-ups. Instrument capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated, followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to the manufacturer's instructions). Any deviations shall be documented in the Instrument Database (IDB).

Instrument or equipment software operation must be deemed reliable, and evidence of instrument verification must be retained by the QA Department. Software certificates supplied by the vendors are filed with the Lab Support Department. The manufacturer's operation manual is retained at the bench.

9.5 Services

Service to analytical instruments (except analytical balances) is performed on an as needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is determined by analysts and/or Operations Managers. The service providers that perform the services are approved by the Lab Support Manager.

9.6 Suppliers

TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Corporate Finance documents on Vendor Selection (SOP No. CW-F-S-018) and Procurement & Contracts Policy (Policy No. CW-F-P-004). The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The JD Edwards purchasing system includes all suppliers/vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report.

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.
As deemed appropriate, the Vendor Performance Reports will be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors.

When there are indications that subcontractors knowingly supplied items or services of substandard quality, this information shall be forwarded to appropriate management for action and notification will be sent to the affected clients.

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the JD Edwards purchasing system.

9.6.1 New Vendor Procedure

TestAmerica employees who wish to request the addition of a new vendor must complete a J.D. Edwards Vendor Add Request Form.

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with TestAmerica employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department and/or the Technology Director are consulted with vendor and product selection that have an impact on quality.

SECTION 10. COMPLAINTS

10.1 Overview

The laboratory considers an effective client complaint handling processes to be of significant business and strategic value. Listening to and documenting client concerns captures 'client knowledge' that enables our operations to continually improve processes and client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of our business services (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is documented using the client complaint/compliment tracking form. It is the laboratory's goal to provide a satisfactory resolution to complaints in a timely and professional manner.

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint on a Non-Conformance Memo.

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints should be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Complaint Investigation and Service Recovery
- Process Improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.3 Internal Complaints

Internal complaints include, but are not limited to: errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and shall follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing and IT may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 12.

10.4 Management Review

The number and nature of client complaints is reported by the QA Manager to the LD and corporate QA in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Review (Section 16).

SECTION 11. CONTROL OF NON-CONFORMING WORK

11.1 Overview

In the context of radiochemical and environmental testing, a non-conformance is any situation in which some aspect of the work does not conform to the laboratory's own procedures or agreed client requirements. A non-conformance does not necessarily invalidate the reported data, but It does initiate the requirements of this section.

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the corrective action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. When an analyst encounters such a situation, the problem is presented to the supervisor for resolution. The supervisor may elect to discuss it with the Technical Director or have a representative contact the client to decide on a logical course of action. Once an approach is agreed upon, the analyst documents it using the laboratory's corrective action system described in Section 12. This information can then be supplied to the client in the form of a footnote or a case narrative with the report.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 19. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Technical Director and QA Manager, documented, and included in the project folder. Deviations must also be noted on the final report with a statement that the compound is not reported in compliance with TNI (or the analytical method) requirements and the reason. Data being reported to a non-TNI state would need to note the change made to how the method is normally run.

11.2 Responsibilities and Authorities

TestAmerica's Corporate SOP entitled *Internal Investigation of Potential Data Discrepancies and Determination for Data Recall* (SOP No. CW-L-S-002 outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

Under certain circumstances, the LD, Technical Manager, Operations Manager, or QA Manager may authorize departures from documented procedures or policies. The departures may be a

result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc... In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's corrective action procedures. This information may also be documented in logbooks and/or data review checklists as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to laboratory management within 24-hours. The Senior Laboratory Management Team is comprised of the LD, the QA Manager, the Technical Manager, and the Operations Managers. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an ECO, Director of Quality & Client Advocacy and the laboratory's Quality manager within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

The LD, QA Manager, ECOs, Corporate Quality, the GMs and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

All lab employees have the authority to stop work for reasons of unresolved safety or quality issues. Employees are encouraged to work through their chain of command to resolve such problems, but TestAmerica also presents other lines of communication in ethics and safety training that is available to all employees.

11.3 Evaluation of Significance and Actions Taken

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

TestAmerica's Corporate Data Investigation & Recall Procedure (SOP No. CW-L-S-002) distinguishes between situations when it would be appropriate for laboratory management to make the decision on the need for client notification (written or verbal) and data recall (report revision) and when the decision must be made with the assistance of the ECOs and Corporate Management. Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/corrective action reporting in lieu of the data recall determination form contained in TestAmerica's Corporate SOP No. CW-L-S-002.

When applicable (e.g., for all affected DoD or DOE clients), the laboratory shall immediately notify the affected clients of potential data quality issues. Corrective actions taken to resolve the issue shall be submitted to the client in a timely and responsive manner.

11.4 Prevention of Non-Conforming Work

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's corrective action system. Periodically as defined by the laboratory's preventive action schedule, (or add the lab's schedule; e.g., monthly, weekly.) The QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's corrective action process may be followed.

11.5 Method Suspension / Restriction (Stop Work Procedures)

In some cases, it may be necessary to suspend/restrict the use of a method or target compound which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 5.

Prior to suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the LD.

The LD shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases, that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line.
The QA Manager will also initiate a corrective action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed upon steps should be faxed or e-mailed by the laboratory to the appropriate GM and member of Corporate QA. This fax/e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the internet. It is the responsibility of the LD to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction (e.g., Project Management, Log-in, etc…). Clients will NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (LD, Technical Manager, QA Manager) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management plus the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete. This approval is given by final signature on the completed corrective action report.

If the nonconformance involves 10 CFR 21 "Reporting of Defects and Noncompliance" requirements for a Nuclear Regulatory Commission licensee, the LD or designee shall be informed and the PM shall verbally inform the customer of the nonconformance, followed by a written report to the customer within five days.

A complete copy of 10 CFR 21 shall be posted in a conspicuous location. The following notification shall also be posted:

ANY EMPLOYEE WHO HAS REASON TO BELIEVE THAT GOODS OR SERVICES SUBJECT TO REGULATION BY THE NUCLEAR REGULATORY COMMISSION HAVE BEEN DELIVERED FROM THIS FACILITY WHICH IS NONCOMPLIANT OR DEFECTIVE, AS DEFINED IN 10 CFR 21 SHALL IMMEDIATELY INFORM HIS SUPERVISOR.

As Washington State is an Agreement State, employees may also refer to form RHF-3 with the Washington State Department of Health, Division of Radiation Protection. Chapter 246-222 WAC is a reference to workers rights.

SECTION 12. CORRECTIVE ACTION

12.1 Overview

A major component of TestAmerica's QA Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the corrective action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Corrective actions are documented using Non-Conformance Reports (NCR) and Corrective Action Reports (CAR) (refer to Figure 12-1).

The DOE requires that prior to implementation of corrective actions where client data is affected; the laboratory shall notify the client of the proposed corrective action.

12.2 General

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc. SOP RL-QA-002 provides further detail about the laboratory's nonconformance system…

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility(s) for investigation.
- Resolve non-conformance events and assign responsibility for any required corrective action.
- Identify Systematic Problems before they become serious.
- Identify and track client complaints and provide resolution.

12.2.1 Non-Conformance Memo (NCM) - is used to document the following types of corrective actions:

- Deviations from an established procedure or SOP
- QC outside of limits (non-matrix related)
- Isolated reporting / calculation errors
- Client complaints
- Discrepancies in materials / goods received vs. manufacturer packing slips.

12.2.2 Corrective Action Report (CAR) - is used to document the following types of corrective actions:

- Questionable trends that are found in the periodic review of NCMs
- Issues found while reviewing NCMs that warrant further investigation
- Internal and external audit findings
- Failed or unacceptable PT results
- Corrective actions that cross multiple departments in the laboratory

- Systematic reporting / calculation errors
- Client complaints
- Data recall investigations
- Identified poor process or method performance trends
- Excessive revised reports
- Health and Safety violations

This will provide background documentation to enable root cause analysis and preventive action.

12.3 Closed Loop Corrective Action Process

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. An NCM or CAR must be initiated, someone is assigned to investigate the issue and the event is investigated for cause. Table 12-1 provides some general guidelines on determining responsibility for assessment.
- The cause analysis step is the key to the process as a long term corrective action cannot be determined until the cause is determined.
- If the cause is not readily obvious, the Operations Manager, Technical Manager, LD, or QA Manager (or QA designee) is consulted.

12.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.
- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.
- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The NCM or CAR is used for this documentation.

12.3.3 Root Cause Analysis

Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness.

Systematically analyze and document the Root Causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the Root Cause data from these incidents to identify Root Causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

Identify the one event associated with the problem and ask why this event occurred. Brainstorm the root causes of failures; for example, by asking why events occurred or conditions existed; and then why the cause occurred 5 consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and continue to plague the laboratory or operation.

12.3.4 Monitoring of the Corrective Actions

- The Technical Manager and QA Manager are responsible to ensure that the corrective action taken was effective.
- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Operations Managers are accountable to the LD to ensure final acceptable resolution is achieved and documented appropriately.
- Each NCM and CAR is entered into a database for tracking purposes and a monthly summary of all corrective actions is printed out for review to aid in ensuring that the corrective actions have taken effect.
- The QA Manager reviews monthly NCMs and CARs for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA Manager and shall be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements.
- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

(Also refer to Section 15.1.4, Special Audits.)

12.4 Technical Corrective Actions

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and QC have occurred (refer to Section 11). The documentation of these procedures is through the use of an NCM or CAR.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs. The laboratory may also maintain Work Instructions on these items that are available upon request.

Table 12-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in Method SOPs, Work Instructions, QAM Sections 19 and 20. All corrective actions are reviewed monthly, at a minimum, by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all QC measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the PM is notified by an NCM and appropriate corrective action (e.g., reanalysis) is taken and documented**.**

12.5 Basic Corrections

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g. no white-out)], and the correct value entered alongside. All such corrections shall be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original “uncorrected” file must be maintained intact and a second “corrected” file is created.

This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

Figure 12-1.
Example - Corrective Action Report

Clouseau Nonconformance Memo

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

NCM #: 10-19291
NCM Initiated By:
Date Opened: 09/29/2011
Date Closed: 09/29/2011

Classification: Anomaly
Status: CLOSED
Production Area: Counting
Tests: None
Lot #'s (Sample #'s): XYZ123 (17)
QC Batches: None.,

Nonconformance: Tracer yield out of limits
Subcategory: Matrix effect

Problem Description / Root Cause

Name	Date	Description
ME Analyst	09/29/2011	EXAMPLE ONLY: For sample XYZ123, the tracer yield of 132% exceeded the client allowable maximum of 125%. Other data for this sample were consistent with the rest of the samples in this batch. Client requires notification and permission to recount - client was contacted and instructed to recount. The tracer yield for the recount was acceptable at 123%.

Corrective Action

Name	Date	Corrective Action
A Counter	09/29/2011	Sample was recounted for an acceptable result.

Client Notification Summary

Client	Project Manager	Notified	Response	How Notified	Note
Example Client	PM Name	09/29/2011	09/29/2011	by e-mail	

Response	Response Note
Other	Client instructed to recount and notify again only if tracer yield still above maximum.

Quality Assurance Verification

Verified By	Due Date	Status	Notes
QA Manager	9/30/2011	Verified/completed	Example Only

Approval History

Date Approved	Approved By	Position
9/29/2011	A Manager	Count Room Supervisor
9/29/2011	PM Manager	Client Service Manager

Date Printed: 9/29/2011

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Table 12-1. Example – General Corrective Action Procedures

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Initial Instrument Blank *(Analyst)*	- Instrument response < MDL.	- Prepare another blank. - If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc...
Initial Calibration Standards *(Analyst, Operations Manager)*	- Correlation coefficient > 0.99 or standard concentration value. - % Recovery within acceptance range. - See details in Method SOP.	- Reanalyze standards. - If still unacceptable, remake standards and recalibrate instrument.
Independent Calibration Verification (Second Source) *(Analyst, Operations Manager)*	- % Recovery within control limits.	- Remake and reanalyze standard. - If still unacceptable, then remake calibration standards or use new primary standards and recalibrate instrument.
Continuing Calibration Standards *(Analyst, Data Reviewer)*	% Recovery within control limits.	- Reanalyze standard. - If still unacceptable, then recalibrate and rerun affected samples.
Matrix Spike / Matrix Spike Duplicate (MS/MSD) *(Analyst, Data Reviewer)*	- % Recovery within limits documented in RL-DR-001 for Radiochemistry, RL-MT-001 for Metals, RL-WC-003 for Cr+6.	- If the acceptance criteria for duplicates or matrix spikes are not met because of matrix interferences, the acceptance of the analytical batch is determined by the validity of the LCS. - If the LCS is within acceptable limits the batch is acceptable. - The results of the duplicates, matrix spikes and the LCS are reported with the data set. - For matrix spike or duplicate results outside criteria, the data for that sample shall be reported with qualifiers.

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Laboratory Control Sample (LCS) *(Analyst, Data Reviewer)*	- % Recovery within limits specified in RL-DR-001.	- Batch must be re-prepared and re-analyzed. This includes any allowable marginal exceedance. When not using marginal exceedances, the following exceptions apply: 1) when the acceptance criteria for the positive control are exceeded high (i.e., high bias) and there are associated samples that are non-detects, then those non-detects may be reported with data qualifying codes; 2) when the acceptance criteria for the positive control are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level with data qualifying codes. **Note:** If there is insufficient sample or the holding time cannot be met, contact client and report with flags.
Surrogates *(Analyst, Data Reviewer)*	- % Recovery within limits of method or within three standard deviations of the historical mean.	- Individual sample must be repeated. Place comment in LIMS. - Surrogate results outside criteria shall be reported with qualifiers.
Method Blank (MB) *(Analyst, Data Reviewer)*	< RL [1]	- Reanalyze blank. - If still positive, determine source of contamination. If necessary, reprocess (i.e. digest or extract) entire sample batch. Report blank results. - Qualify the result(s) if the concentration of a targeted analyte in the MB is at or above the RL AND is > 1/10 of the amount measured in the sample.
Proficiency Testing (PT) Samples *(QA Manager, Technical Manager(s)*	- Criteria supplied by PT Supplier.	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.
Internal / External Audits *(QA Manager, Operations Manager, Laboratory Director)*	- Defined in Quality System documentation such as SOPs, QAM, etc...	- Non-conformances must be investigated through CAR system and necessary corrections must be made.

QC Activity *(Individual Responsible for Initiation/Assessment)*	**Acceptance Criteria**	**Recommended Corrective Action**
Reporting / Calculation Errors (Depends on issue – possible individuals include: Analysts, Data Reviewers, PMs, Operations Manager, QA Manager, Corporate QA, Corporate Management)	- SOP CW-L-S-002, Internal Investigation of Potential Data Discrepancies and Determination for Data Recall.	- Corrective action is determined by type of error. Follow the procedures in SOP CW-L-S-002 or your lab's CA SOP.
Client Complaints *(PMs, Lab Director/Manager, Sales and Marketing)*	-	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., database needs to be updated).
QA Monthly Report (Refer to Section 16 for an example) (QA Manager, Lab Director/Manager, *Operations Manager*)	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated.
Health and Safety Violation (ESHC, Lab Director/Manager, *Operations Manager)*	- Environmental Health and Safety Manual.	- Non-conformance is investigated and corrected through CAR system.

Note:

1. Except as noted below for certain compounds, the method blank should be below the detection limit. Concentrations up to five times the RL will be allowed for the ubiquitous laboratory and reagent contaminants: methylene chloride, toluene, acetone, 2-butanone and phthalates provided they appear in similar levels in the reagent blank and samples. This allowance presumes that the detection limit is significantly below any regulatory limit to which the data are to be compared and that blank subtraction will not occur. For benzene and ethylene dibromide (EDB) and other analytes for which regulatory limits are extremely close to the detection limit, the method blank must be below the method detection limit

SECTION 13. PREVENTIVE ACTION / IMPROVEMENT

13.1 Overview

The laboratory's preventive action programs improve or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive and continuous process of improvement activities that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, customer service and client satisfaction can be improved through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered during management reviews, the monthly QA Metrics Report, evaluation of internal or external audits, results & evaluation of proficiency testing (PT) performance, data analysis & review processing operations, client complaints, staff observation, etc...

The monthly Management Systems Metrics Report shows performance indicators in all areas of the laboratory and quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, ethics training, etc... These metrics are used in evaluating the management and quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

The laboratory's corrective action process is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action provides a valuable mechanism for identifying preventive action opportunities.

13.2 Elements of Preventive Action System

The following elements are part of a preventive action system:

- Identification of an opportunity for preventive action
- Process for the preventive action
- Define the measurements of the effectiveness of the process once undertaken
- Execution of the preventive action
- Evaluation of the plan using the defined measurements
- Verification of the effectiveness of the preventive action

- Close-Out by documenting any permanent changes to the Quality System as a result of the Preventive Action. Documentation of Preventive Action is incorporated into the monthly QA reports, corrective action process and management review.

13.2.1 Any Preventive Actions undertaken or attempted shall be taken into account during the annual Management Systems Review (Section 16). A highly detailed report is not required; however, a summary of successes and failures within the preventive action program is sufficient to provide management with a measurement for evaluation.

SECTION 14. CONTROL OF RECORDS

The laboratory maintains a records management system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued.

14.1 Overview

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. Quality records are maintained by the QA Manager in a database, which is backed up as part of the regular laboratory backup. Records are of two types; either electronic or hard copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by the Laboratory Support Manager.

14.1.1 All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or an offsite location that provides a suitable environment to prevent damage or deterioration and to prevent loss. All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees and shall be documented with an access log. Records archived off-site are stored in a secure location where a record is maintained of any entry into the storage facility. Whether on-site or off-site storage is used, logs are maintained in each storage box to note removal and return of records. Retention of records is maintained on-site at the laboratory for at least 1 year after their generation and moved offsite for the remainder of the required storage time. Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention shall be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 14-2 have lengthier retention requirements and are subject to the requirements in Section 14.1.3.

Table 14-1. Record Index[1]

	Record Types [1]:	Retention Time:
Technical Records	- Raw Data - Logbooks[2] - Standards - Certificates - Analytical Records - MDLs/IDLs/DOCs - Lab Reports	5 Years from analytical report issue*
Official Documents	- QAM - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals	5 Years from document retirement date*
QA Records	- Internal & External Audits/Responses - Certifications - Corrective/Preventive Actions - Management Reviews - Method & Software Validation / Verification Data - Data Investigation - QC Performance Checks	5 Years from archival* Data Investigation: 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)
Project Records	- Sample Receipt & COC Documentation - Contracts and Amendments - Correspondence - QAPP - SAP - Telephone Logbooks - Lab Reports	5 Years from analytical report issue*
Administrative Records	Finance and Accounting	10 years
	EH&S Manual, Permits	7 years
	Disposal Records	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	Refer to HR Manual
	Administrative Policies Technical Training Records	7 years

[1] Record Types encompass hardcopy and electronic records.
[2] Examples of Logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).
* Exceptions listed in Table 14-2.

14.1.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Table 14-2. Example: Special Record Retention Requirements

Program	[1]Retention Requirement
Drinking Water – All States	5 years (project records) 10 years - Radiochemistry (project records)
Drinking Water Lead and Copper Rule	12 years (project records)
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
Alaska	10 years
Louisiana – All	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
Navy Facilities Engineering Service Center	10 years
NY Potable Water NYCRR Part 55-2	10 years
Ohio Voluntary Action Plan	10 years and State contacted prior to disposal
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

[1]Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data (Records stored off site should be accessible within 2 days of a request for such records). The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

The Laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hard copy or in a secure, readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to section 19.12.1 for more information.

14.1.4 The record keeping system allows for historical reconstruction of all laboratory

activities that produced the analytical data, as well as rapid recovery of historical data. The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory's copy of the COC is stored with the invoice and the work order sheet generated by the LIMS. The COC would indicate the name of the sampler. If any sampling notes are provided with a work order, they are kept with this package.

- All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.

- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set). Instrument data is stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; a copy of each day's run long or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is recorded in logbooks or entered into the LIMS for each method as required.

- Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

- The reason for a signature or initials on a document is clearly indicated in the records such as "sampled by," "prepared by," "reviewed by", or "analyzed by".

- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.

- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data is lost and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard copy that was scanned.

- Also refer to Section 19.14.1 'Computer and Electronic Data Related Requirements'.

14.2 Technical and Analytical Records

14.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement. The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records shall include the identity of laboratory personnel responsible for the sampling,

performance of each analysis and reviewing results.

14.2.2 Observations, data and calculations are recorded real-time and are identifiable to the specific task.

14.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails. The record keeping system shall fulfill the following requirements:

- The records shall include the identity of personnel involved in preparation, calibration or testing.
- All information relating to the laboratory facilities, equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation or data verification shall be documented.
- All documentation entries shall be signed or initialed by responsible personnel.
- All generated data except those that are generated by automated data collection systems, shall be recorded directly, promptly and legibly in permanent ink.
- Entries in records shall not be obliterated by methods such as erasures, overwritten files or markings. All corrections to record-keeping errors shall be made by one line marked through the error. The individual making the correction shall sign or initial and date the correction (this is the person who authorized the change). Equivalent measures shall be taken for electronic records so as not to erase or overwrite the original information (audit trails).
- Units shall accompany all numbers that are not dimensionless.
- Use leading zeros for numbers less than one.
- If a data correction is not self-explanatory, a written justification is required.

The term ‘logbook’ may be defined as a hardcopy record or as an electronic record. Electronic logbooks shall be maintained and archived as required for all electronic records as described in the quality manuals and software SOPs.

Note: verify with clients that require specific logbook entries that this definition of logbook is acceptable.

The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

A log of names, initials and signatures for all individuals signing or initialing any laboratory record shall be maintained.

Should a record become lost or damaged, efforts will be made to regenerate the record by electronic means or transcription. It is the responsibility of the area supervisor where the record was originally generated to recapture the information and attempt to regenerate the record as much as possible. The regenerated record shall be reviewed and approved by the QA Manager or designee. Each page of the regenerated record shall be labeled “Regenerated Record.” In cases where regeneration is not possible, an NCM shall be filed with the appropriate records.

Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19.

Changes to electronic records in LIMS or instrument data are recorded in audit trails. The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

- laboratory sample ID code**;**
- Date of analysis; Time of Analysis is also required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook or on a bench sheet.
- Instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available.
- analysis type**;**
- all manual calculations and manual integrations**;**
- analyst's or operator's initials/signature**;**
- sample preparation including cleanup, separation protocols, incubation/ingrowth periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents**;**
- test results**;**
- 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**;**
- QC protocols and assessment**;**
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected QC requirements. These are indicated both in the LIMS and on specific analytical report formats**.**

14.3 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- all original raw data, whether hard copy or electronic, for calibrations, samples and QC measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records)**;**
- a written description or reference to the specific test method used which includes 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; and
- results of data review, verification, and crosschecking procedures

14.3.1 Sample Handling Records

Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include but are not limited to records pertaining to:

- sample preservation including appropriateness of sample container and compliance with holding time requirement;
- sample identification, receipt, acceptance or rejection and login;
- sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.4 Administrative Records

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 14-1.

14.5 Records Management, Storage and Disposal

All records (including those pertaining to test equipment), certificates and reports are safely stored, held secure and in confidence to the client. Certification related records are available upon request.

All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access**.**

The laboratory has a record management system (a.k.a., document control) for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. Laboratory notebooks are issued on a per analysis basis, and are numbered sequentially. All data are recorded sequentially within a series of sequential notebooks. Bench sheets are filed sequentially. Standards are maintained in the LIMS – no logbooks are used to record that data**.** Records are considered archived when noted as such in the records management system (a.k.a., document control.)

The individual preparing records for submittal shall place all documents in a designated container for transfer to the storage area. The project files, data and data package identification information shall be entered into the archive database. This information is printed and included in the archive box.

All records, other than project records, shall be submitted using a record transmittal form. Hard copy records may be transferred to an electronic media for storage. The transmittal forms and information sheets shall accompany the records to the storage area. The archive custodian shall verify the contents of the document container to the transmittal form. If there are any discrepancies, the document container is returned to the submitter.

When the document container and forms are approved by the custodian, a box and location number shall be placed on the side of the container. The custodian shall complete the records transmittal forms by supplying the container and location number.

If amendments or supplemental information/data is generated, it shall be filed with the original records. The original version shall be kept intact and the supplemental data will be clearly identified if it is a correction to previously generated records.

The original forms shall remain in the container and a copy will be maintained in the archive file. The custodian will also enter the appropriate information into the archive database.

All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory or an offsite location that provides a suitable environment. All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration. Dual storage in a separate building or location can also satisfy this requirement.

Access to the data is limited to laboratory and company employees. When there is a need to retrieve a document for review in the record storage area, a request is given to the archive custodian or designee. The custodian will determine the location of the document container via the database and retrieve the container. An outcard listing the appropriate information shall replace the file(s) removed.

When removal from the storage area is necessary, a records request form shall be filled out. This form shall include the name of the person receiving the records, description of the records, the date removed and the signature of the person requesting the file. This form shall be filed in the archive file. An outcard listing the appropriate information shall replace the file(s) removed.

When the records are returned to the storage area, the custodian shall place them in the original location and remove the outcard. The custodian signs and dates the records request form and returns the form to the archive files.

A complete system to retrieve all electronically stored records shall be maintained at the laboratory. This system shall be tested every six months to ensure proper operation. This is accomplished by loading a file and obtaining a hard copy printout.

14.5.1 Transfer of Ownership

In the event that the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

14.5.2 Records Disposal

Records are removed from the archive and destroyed after 5 years unless otherwise specified by a client or regulatory requirement. On a project specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration. (Refer to Tables 14-1 and 14-2).

Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required.

14.5.2.1 The custodian shall transfer records to the custody of the client when requested. An external records release form shall be completed relinquishing custody of the records. The custodian will update the database accordingly.

14.5.3.1 Written approval must be received from all affected clients prior to disposal of any records associated with DOE analytical data.

SECTION 15. AUDITS

15.1 Internal Audits

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and, when requested, to corporate management.

Audits are conducted and documented as described in the TestAmerica Corporate SOP on performing Internal Audits, SOP No. CA-Q-S-004. The types and frequency of routine internal audits are described in Table 15-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA Manager.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems Audits	QA Department, QA approved designee, or Corporate QA	All areas of the laboratory annually
Method Audits	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CA-Q-S-004)	Methods Audits Frequency: 50% of methods annually 100% of methods annually (DoD Labs)
Special	QA Department or Designee	Surveillance or spot checks performed as needed, e.g., to confirm corrective actions from other audits.
Performance Testing	Analysts with QA oversight	Two successful per year for each TNI field of testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, TestAmerica's Data Integrity and Ethics Policies, NELAC, AIHA, DoD ELAP, and TNI quality systems , client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to data review, quality controls, preventive action and corrective action. The completeness of earlier corrective actions is assessed for effectiveness & sustainability. The audit is divided into sections for each operating or support area of the lab, and each section is comprehensive for a given area. The area audits may be performed on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

15.1.2 QA Technical Audits

QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining logbooks, run logs and records of manual integrations. Manual calculations are checked. Where possible, electronic audit miner programs (e.g., MintMiner and Chrom AuditMiner) are used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the laboratory Technical Manager or qualified designee at least every two years. It is also recommended that the work of each newly hired analyst is assessed within 3 months of working independently, e.g., completion of method Initial Determination Of Capability (IDOC). In addition, as analysts add methods to their capabilities, (new IDOC) reviews of the analyst work products will be performed within 3 months of completing the documented training.

15.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

15.1.5 Performance Testing

The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: [Drinking Water, Non-potable Water, Soil, Air]

It is TestAmerica's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Written responses to unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

Performance Evaluation Sample Program Description	Analysis Performed	Frequency of Participation
Environmental Resource Associates	Gamma, Iodine, Gross Alpha, Gross Beta, Tritium, Radium-226, Radium-228, Strontium-89 & 90, Natural Uranium	Semi-Annually for each study
DOE Environmental Laboratory Accreditation Program (DOELAP)	Natural Uranium, Americium, Gamma, Plutonium, Strontium, Isotopic Uranium, Isotopic Thorium, Tc-99, Np-237	Annual
Mixed Analyte Performance Evaluation Program	Americium, Gamma, Plutonium, H-3, Strontium, Isotopic Uranium, Ni-63, Fe-55	Semi-Annual
AIHA (IHPAT, BePAT, BaPAT)	Asbestos (PCM & PLM), metals	Semi-Annual

15.2 External Audits

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time allotted by the client or agency performing the audit. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2009 TNI standards.

15.3 Audit Findings

Audit findings are documented using the corrective action process and database. The laboratory's corrective action responses for both types of audits may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must be set and agreed to by operations management and the QA Manager.

Developing and implementing corrective actions to findings is the responsibility of the Operations Manager where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory shall take timely corrective action, and shall notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24-hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

For DOE and other programs where required, the client will be informed of the proposed corrective action prior to initiating the change.

SECTION 16. MANAGEMENT REVIEWS

16.1 QA Report

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the LD, Technical Manager, Operations Managers and their Quality Director as well as the GM. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the LD, GM or Corporate QA may request that additional information be added to the report.

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Executive Committee and GMs.

16.2 Annual Management Review

The senior lab management team conducts a review annually of its quality systems and LIMS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining goals, objectives and action items that feed into the laboratory planning system. Corporate Operations and Corporate QA personnel are included in this meeting at the discretion of the LD. The LIMS review consists of examining any relevant audits, complaints or concerns that have been raised during the year. The laboratory will summarize any critical findings that cannot be solved by the lab and report them to Corporate IT.

This management systems review (Corporate SOP No. CA-Q-S-008 and Work Instruction No. CA-Q-WI-020) uses information generated during the preceding year to assess the "big picture" by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective. Therefore the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

- Matters arising from the previous annual review
- Prior Monthly QA Reports issues
- Laboratory QA Metrics
- Review of report reissue requests
- Review of client feedback and complaints
- Issues arising from any prior management or staff meetings
- Minutes from prior senior lab management meetings
- Issues that may be raised from these meetings include:
  - Adequacy of staff, equipment and facility resources,
  - Adequacy of policies and procedures, or
  - Future plans for resources and testing capability and capacity.

- The annual internal double blind PT program sample performance (if performed),
- Compliance to the Ethics Policy and Data Integrity Plan, including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity.
- Compliance to the health and safety program including hazardous and radioactive materials management functions.

A report is generated by the QA Manager and management. The report is distributed to the appropriate GM and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants
- A reference to the existing data quality related documents and topics that were reviewed
- Quality system or operational changes or improvements that will be made as a result of the review [e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)]

Any corrective actions that arise from the management review shall be recorded. The LD shall ensure that those actions are carried out within an appropriate and agreed timescale.

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

16.3 Potential Integrity Related Managerial Reviews

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. TestAmerica's Corporate Data Investigation/Recall SOP shall be followed (SOP No. CW-L-S-002). All investigations that result in finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

TestAmerica's VP of Client & Technical Services, GMs and Quality Directors receive a monthly report from the Director of Quality & Client Advocacy summarizing any current data integrity or data recall investigations. The GMs are also made aware of progress on these issues for their specific labs.

SECTION 17. PERSONNEL

17.1 Overview

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the example organization chart in Figure 4-1.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training shall be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

Personnel dealing with sample receipt, radioactive waste management and materials shipping shall be trained in waste management, shipping (49 CFR 172) and handling, and radioactive material control, as appropriate.

17.2 Education and Experience Requirements for Technical Personnel

The laboratory makes every effort to hire analytical staff that possess a college degree (AA, BA, and BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental and radiobioassay testing the laboratory performs.

Job Descriptions are located on the TestAmerica intranet site Human Resources web page (Also see Section 4 for position descriptions/responsibilities).

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc., are also considered).

As a general rule for analytical staff:

Specialty	(i)Education	(ii)Experience
Extractions, Digestions, some electrode methods (pH, DO, Redox, etc.), or Titrimetric and Gravimetric Analyses	High school diploma	On the job training
GFAA, CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC	A college degree in an applied science or 2 years of college and at least 1 year of college chemistry	Or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, Herbicides, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	or 5 years of prior analytical experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	Plus 2 years relevant experience Or 5 years of prior analytical experience
Operations Managers	Bachelors Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	Plus 2 years experience in environmental analysis of representative analytes for which they will oversee
Technical Managers – **Wet Chem** only (no advanced instrumentation)	Associates degree in an applied science or engineering or 2 years of college with 16 semester hours in chemistry	And 2 years relevant experience

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Operations Manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

17.3 Training

The laboratory is committed to furthering the professional and technical development of employees at all levels. All personnel are to be trained appropriately for each task they are required to perform, prior to beginning the task.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training:

Required Training	Time Frame	Employee Type
Environmental Health & Safety	Prior to lab work	All
Ethics – New Hires	1 week of hire	All
Ethics – Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All
Ethics – Comprehensive Refresher	Annually	All
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance.	Technical
Competency Testing for Bioassay	6 months after IDOC	Bioassay Technicians
Requalifications	Once every 12 months per analytical procedure. Once every six months for technicians and analysts performing procedures used in AIHA work.	All Laboratory Associates

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to "Demonstration of Capability" in Section 19.

The training of technical staff is kept up to date by:

- Each employee must have documentation in their training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics is maintained in their training file.
- Documentation of proficiency (refer to Section 19).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.

- The HR department maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics). This information is maintained in the employee's secured personnel file.

Evidence of successful training could include such items as:

- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.
- Analyst's knowledge to refer to QA Manual for quality issues.
- Analysts following SOPs, i.e., practice matches SOPs.
- Analysts regularly communicate to supervisors and QA if SOPs need revision, rather than waiting for auditors to find problems.

Within the first quarter of initial employment, an associate shall receive training on the QA Program. In order to demonstrate qualification, each associate shall be required to take a QA examination. A score of 70% correct is considered acceptable. If an associate's test does not meet the criteria, they shall receive further instruction or be allowed to retake the exam. An associate is not considered qualified to perform independently until they have received a passing score.

For non-analytical procedures, the trainee is assigned to a qualified associate and will work under their direction until such time that the trainer's and supervisor's judge that the associate is qualified to work independently. In some cases, this may require only reading and understanding the requirements described in the SOP.

For analytical procedures, the trainee shall observe and work under the direction of a qualified analyst. During this training period, the trainer shall enter their initials along with the trainee's signature/initials on the Internal Chain of Custody (ICOC) documentation. When the trainee has successfully completed the DOC study, they may work independently on client samples.

When training sessions are given, each associate shall sign an attendance sheet as evidence of their attendance. A brief description of the topics covered will be on or attached to the attendance sheet. The attendance sheet shall be kept in the Quality Files.

When the associate completes a course, class or seminar given by any external agency, the associate shall provide proof of attendance to place in the training files.

After the analyst has been trained, a copy of the first PT results for each applicable test shall be included in the individual's training record.

All training forms and attendance sheets shall have the time duration of the training.

Retraining or reassignment of an associate may be required if determined by the supervisor, QA Manager, Technical Manager or LD. Examples of instance where this is warranted are:

a) QC results are outside expected limits for that individual's data exclusively.
b) The individual omits a step or performs a step incorrectly.

If the associate is reassigned for the reasons listed above, the associate will be disqualified for that SOP. The supervisor may choose to disqualify the associate for related SOPs depending on the circumstances. If at a later date the associate has gained the experience to requalify, as determined by the supervisor, the DOC process shall be followed.

17.4 Data Integrity and Ethics Training Program

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica. It is a formal part of the initial employee orientation within 1 week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and an annual refresher for all employees. Senior management at each facility performs the ethics training for their staff.

In order to ensure that all personnel understand the importance TestAmerica places on maintaining high ethical standards at all times; TestAmerica has established a Corporate Ethics Policy (Policy No. CW-L-P-004) and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on Government contracts, and for that reason, TestAmerica has a Zero Tolerance approach to such violations.
Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.
- Ethics Policy
- How and when to report ethical/data integrity issues. Confidential reporting.
- Record keeping.
- Discussion regarding data integrity procedures.
- Specific examples of breaches of ethical behavior (e.g. peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion)
- Internal monitoring. Investigations and data recalls.
- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution.

- Importance of proper written narration / data qualification by the analyst and PM with respect to those cases where the data may still be usable but are in one sense or another partially deficient.

Additionally, a data integrity hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

SECTION 18. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1 Overview

The laboratory is a 33,000 ft^2 secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc., OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity controlled), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, environmental radiological sample preparation and separation, radiobioassay, inorganic sample analysis, microbiological sample analysis, and administrative functions.

18.2 Environment

Laboratory accommodation, test areas, energy sources, lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage, temperature, and vibration levels in the laboratory.

When any of the method or regulatory required environmental conditions changes to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and LIMS are regulated to protect against raw data loss.

18.3 Work Areas

There is effective separation between neighboring laboratory areas when the activities therein are incompatible with each other. Examples include:

- Bioassay and environmental radiological testing,
- Microbiological culture handling and sample incubation areas
- Radiological counting rooms and other sampling handling
- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.
- Urine and Fecal processing
- Low level and Intermediate level processing
- Segregation of Alpha Spectrometry Detectors

Access to and use of all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory. Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory.
- Sample receipt areas.
- Sample storage areas.
- Chemical, radiochemical, and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

18.4 Floor Plan

A floor plan can be found in Appendix 1.

18.5 Building Security

Building keys and alarm codes are distributed to employees as necessary.

Visitors to the laboratory sign in and out in a visitor's logbook, and are escorted by an associate while on laboratory property unless the visitor is considered a frequent visitor or vendor. Frequent visitors and vendors are issued door access badges for the duration of their visit, and sign in on the general board if the visit will last more than one day. Visitor access badges are not to leave the premises.

A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed. Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook.

Persons delivering samples and supplies to the laboratory may be admitted through the receiving door or other entrance that facilitates delivery. Delivery personnel are not required to obtain a badge.

Contractors and service personnel shall obtain a contractors badge with a key card. The contractors and service personnel may move about the building unescorted.

Associates shall be issued a key card on their first day of work. All associates shall use this key card upon entering the facilities. Key cards shall not be lent or borrowed from other associates. If a key card is lost, the associate shall immediately notify the Laboratory Support Manager who is responsible for assuring that the lost card is invalidated and a replacement issued. If a key card is forgotten, a temporary card may be issued. The associate shall return the temporary card upon the completion of work for that day.

Any associate who discovers a visitor who is unbadged or unescorted shall escort that person to the reception desk. The person shall be badged or the proper escort located.

Facility breaches of security after business hours are identified with an audible alarm and a dial out alarm. The contracted security firm will call the laboratory facility to ascertain if the building is occupied. If there is no answer, the security firm shall use the call out list provided to them by the laboratory.

Upon notification of an alarm, if evidence of criminal activity is discovered appropriate law enforcement shall be notified. If an associate suspects that samples have been tampered with, they shall report that information immediately to supervision. The appropriate manager shall determine if samples have actually been affected and an evaluation as to the possible impact to data.

SECTION 19. TEST METHODS AND METHOD VALIDATION

19.1 Overview

The laboratory uses analytical methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples, analytical equipment and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

The laboratory takes into account many factors in developing environmental test methods and procedures, in the training and qualification of personnel, and in the selection and calibration of the equipment it uses. Factors include staff education and training, laboratory environmental conditions, available test methods and validation as well as equipment selection, measurement traceability, sampling techniques and sample handling.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, SOPs, reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.2 Standard Operating Procedures

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, reporting analytical results, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for writing an SOP are incorporated by reference to TestAmerica's Corporate SOP entitled *Writing a Standard Operating Procedure*, No. CW-Q-S-002.
- SOPs are reviewed at a minimum of every 2 years (annually for Drinking Water and DoD SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.
- The SOPs are organized for easy retrieval using a numbering system that includes a two-letter code identifying the laboratory, a two-to-three code for the type of task along with a sequential number. The key for the task type is shown below:

- **SOP Title Key:**

Task Indicator	Task Type
ALP	Separation for Alpha Spectrometry
ASB	Asbestos Analysis
CI	Analytical Instrument Calibration and Use
COC	Sample Tracking
DR	Data Maintenance (Logbooks) and Review
GAM	Separation for Gamma Spectrometry
GPC	Separation for Gas Flow Proportional Counting
HS	Waste Handling
IT	Software Quality Assurance
KPA	Separation and Analysis byr Kinetic Laser-Induced Phosphorescence Analysis
LSC	Separation and Analysis by Liquid Scintillation Counting
MT	Preparation and Analysis of Metals by ICP
PM	Project Management Tasks
PRP	Sample Preparation
QA	Quality Assurance / Quality Control Tasks
RA	Separation and Analysis of Radium
RPL	Reagent Handling
RS	Radiological Control
SE	Equipment Calibration and Verification
SRV	Sample Control
STD	Preparation and Control of Standards and Tracers
WC	Wet Chemistry

19.3 Laboratory Methods Manual

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP. The laboratory's methods manual consists of a collection of published methods, available for reference in the Technical Manager's office.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains an SOP Index for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

19.4 Selection of Methods

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the PM. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists), the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.4.1 Sources of Methods

Routine analytical services are performed using standard EPA-accepted methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific published methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used without modification unless approval is granted by the client prior to use.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Reference methods include:

- *Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980.*
- *Eastern Environmental Radiation Facility Radiochemistry Procedures Manual, EPA, PB84-215581, June 1984.*
- *HASL-300 28th Edition, Environmental Measurements Laboratory (EML), 1997.*

- *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fourth Edition, EPA/600/4-90/027F, August 1993.*
- *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition, EPA-821-R-02-012, October 2002.*
- *Analytical Method for Determination of Asbestos Fibers in Water, EPA-600/4-83, September 1983.*
- *Determination of Asbestos Structures Over 10-mm in Length in Drinking Water, EPA-600/R-94-134, June 1994.*
- *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, US EPA, January 1996.*
- *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and Appendix A-C; 40 CFR Part 136, USEPA Office of Water. Revised as of July 1, 1995, Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA 600 Series)*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.*
- *Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.*
- *Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992. Supplement III EPA/600/R-95/131 - August 1995 (EPA 500 Series) (EPA 500 Series methods)*
- *Technical Notes on Drinking Water Methods, EPA-600/R94-173, October 1994*
- *NIOSH Manual of Analytical Methods, 4th ed., August 1994.*
- *Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th/ on-line edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.*
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.*
- *National Status and Trends Program, National Oceanographic and Atmospheric Administration, Volume I-IV, 1985-1994.*
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)*
- *Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261*

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory shall inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it will be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on QC samples.

A demonstration of capability is performed whenever there is a change in instrument type (e.g., new instrumentation), method or personnel (e.g., analyst hasn't performed the test within the last 12 months).

The initial demonstration of capability must be thoroughly documented and approved by the Technical Manager and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures.

The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default RL is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL).

- The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted: *Reporting Limit based on the low standard of the calibration curve.*

19.4.3 **Initial Demonstration of Capability Procedures**

19.4.3.1 The spiking standard used must be prepared independently from those used in instrument calibration.

19.4.3.2 The analyte(s) shall be diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified by a method or the laboratory SOP.

19.4.3.3 At least four aliquots shall be prepared (including any applicable clean-up procedures) and analyzed according to the test method (either concurrently or over a period of days).

19.4.3.4 Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations for each parameter of interest.

19.4.3.5 When it is not possible to determine the mean and standard deviations, such as for presence, absence and logarithmic values, the laboratory will assess performance against criteria described in the Method SOP.

19.4.3.6 Compare the information obtained above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory generated acceptance criteria (LCS or interim criteria) if there is no mandatory criteria established. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

19.4.3.7 When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to either option listed below:

- Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with 19.4.3.3 above.
- Beginning with 19.4.3.3 above, repeat the test for all parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all analytes of interest beginning with 19.4.3.1 above.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

A certification statement (see example in Figure 19-1) shall be used to document the completion of each initial demonstration of capability. A copy of the certification is archived in the analyst's training folder.

Methods online prior to the effective date of this Section shall be updated to the procedures outlined above as new analysts perform their demonstration of capability. A copy of the new record will replace that which was used for documentation in the past. At a minimum, the precision and accuracy of four mid-level laboratory control samples must have been compared to the laboratory's QC acceptance limits.

19.4.4 Re-Qualifications

Every 12 months, each laboratory associate's Demonstration of Capabilities for every procedure for which they are deemed capable will be reviewed for requalifications. If there have been four successful spikes performed by the technician over the course of the year or if they have performed one passing PT sample they are able to continue carrying out the procedure. If they are not currently performing the procedure but the Supervisor has requested requalification, they will be required to show competency in the form of four successful spikes for each particular analysis. The requalification process will be handled by the QA Department.

19.4.5 Competency Testing

For Bioassay laboratory personnel only; a competency test will be performed by a new employee six months after the Initial Demonstration of Capability was performed and annually from this point on.

19.5 Laboratory Developed Methods and Non-Standard Methods

From time to time, the laboratory may determine that a newly-developed method is needed. Development of test methods must be a planned activity assigned to qualified personnel equipped with adequate resources. Plans must be reviewed and updated as necessary. Effective communication between all affected personnel is needed.

Any new method developed by the laboratory must be fully defined in an SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method.

19.6 Validation of Methods

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

All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 Method Validation and Verification Activities for All New Methods

While method validation can take various courses, the following activities can be required as part of method validation. Method validation records are designated QC records and are archived accordingly.

19.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other analytes in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

19.6.1.2 Determination of Method Sensitivity

Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed.

The MDC for a radionuclide by radiochemical measurement is determined from the blank/background variability associated with the appropriate detector, the detector efficiency, sample aliquot size and chemical yield. The background variability is proportional to the sample count time.

Note: The background variability is based on the analytical test and derived by: 1) using sample specific parameters, or 2) process blank specific parameters, or 3) by averaging the multiple MDCs derived in 1 or 2.

(b) The MDC is calculated for individual samples (depending on counting technique) using the Environmental Protection Agency's definition as found in the Health Physics Society (HPS) Committee Report – HPSR-1 "Upgrading Environmental Radiation Data", EPA 520/1-80-012 published in 1980. The MDC is expected to be less than the Client Required Detection Limit (CRDL). Cesium-137 is the MDC analyte of interest for gamma evaluation.

(c) The MDC is calculated periodically for each group of blank QC samples containing a similar analyte and matrix which has been analyzed using equivalent procedures. Reagent blanks are more frequently analyzed to obtain the group MDC, but wherever possible, matrix blanks are analyzed. The specific parameters are defined for Radiobioassay, in HPS Standard N13.30, 1996, *Performance Criteria for Radiobioassay* and for environmental measurements in ANSI standard N42.23, 1996, *Measurement and Associated Instrumentation Quality Assurance for Radioassay Laboratories*. The MDC is expected to be less than the CRDL for the analyte.

If the sample MDC is greater than the CRDL or RL, the Data Reviewer shall examine the sample volume/weight, counting time, tracer yield and/or other relevant factors. The Data Reviewer shall decide the corrective action which may include reanalysis, recounting or data acceptance and document per laboratory procedure.

19.6.1.3 Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)

An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded.

The QL is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result. For radiochemical measurements, the QL is typically instrument or method driven.

19.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

19.6.1.5 Determination of Range

Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or QL cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of bias and precision.

19.6.1.6 Determination of Accuracy and Precision

Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

19.6.1.7 Continued Demonstration of Method Performance

Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS, method blanks or PT samples.

19.7 Method Detection Limits / Limits of Detection

MDLs are initially determined in accordance with 40 CFR Part 136, Appendix B or alternatively by other technically acceptable practices that have been accepted by regulators. MDL is also sometimes referred to as Limit of Detection (LOD). The MDL theoretically represents the concentration level for each analyte within a method at which the Analyst is 99% confident that the true value is not zero. The MDL is determined for each analyte initially during the method validation process and updated as required in the analytical methods, whenever there is a significant change in the procedure or equipment, or based on project specific requirements. Generally, the analyst prepares at least seven replicates of solution spiked at one to five times the estimated method detection limit (most often at the lowest standard in the calibration curve) into the applicable matrix with all the analytes of interest. Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples. Where

possible, the seven replicates should be analyzed over 2-4 days to provide a more realistic MDL.

Refer to the Corporate SOP No. CA-Q-S-006 for details on the laboratory's MDL process.

19.8 Instrument Detection Limits (IDL)

The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in demonstration of instrument performance in other areas.

IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using 7 replicate spike analyses, like MDL but without sample preparation, or by the analysis of 10 instrument blanks and calculating 3 x the absolute value of the standard deviation.

If the IDL is greater than the MDL, it may be used as the reported MDL.

19.9 Verification of Detection and Reporting Limits

Once the MDL is determined, it must be verified on each instrument used for the given method. TestAmerica defines the DoD QSM Detection Limit (DL) as being equal to the MDL. TestAmerica also defines the DoD QSM Limit of Detection (LOD) as being equal to the lowest concentration standard that successfully verifies the MDL, also referred to as the MDL Verification Check standard (MDLV). MDL and MDLV standards are extracted/digested and analyzed through the entire analytical process. The MDL and MDLV determinations do not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDLV standard is not successful, then the laboratory will redevelop their MDL or perform and pass two consecutive MDLVs at a higher concentration and set the LOD at the higher concentration. Initial and quarterly verification is required for all methods listed in the laboratory's DoD ELAP Scope of Accreditation.

The laboratory quantitation limit is equivalent to the DoD Limit of Quantitation (LOQ), which is at a concentration equal to or greater than the lowest non-zero calibration standard. The DoD QSM requires the laboratory to perform an initial characterization of the bias and precision at the LOQ and quarterly LOQ verifications thereafter. If the quarterly verification results are not consistent with three-standard deviation confidence limits established initially, then the bias and precision will be reevaluated and clients contacted for any on-going projects. For DoD projects, TestAmerica makes a distinction between the RL and the LOQ. The RL is a level at or above the LOQ that is used for specific project reporting purposes, as agreed to between the laboratory and the client. The RL cannot be lower than the LOQ concentration, but may be higher.

19.10 Retention Time Windows

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis or as specific in the reference method, each analyte will have a specific time of elution from the column to the detector. This is known as the analyte retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept with the files associated with an instrument for later quantitation of the analytes. Complete details are available in the laboratory SOPs.

19.11 Evaluation of Selectivity

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical, atomic absorption or fluorescence profiles, co-precipitation evaluations and specific electrode response factors.

19.12 Estimation of Uncertainty of Measurement

19.12.1 Uncertainty is “a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurement” (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result’s validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, count times and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an “expanded uncertainty”: the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor k=2.

19.12.2 Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

19.12.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.12.4 To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent uncertainties at approximately the 99% confidence level with a coverage factor of k = 3. As an example, for a reported result of 1.0 mg/l with an LCS recovery range of 50 to 150%, the estimated uncertainty in the result would be 1.0 +/- 0.5 mg/l.

19.12.5 In the case where a well recognized test method specifies limits to the values of major sources of uncertainty of measurement (e.g., 524.2, 525, etc.) and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

19.13 Sample Reanalysis Guidelines

Because there is a certain level of uncertainty with any analytical measurement, a sample re-preparation (where appropriate) and subsequent analysis (hereafter referred to as 'reanalysis') may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats. Client specific Contractual Terms & Conditions for reanalysis protocols may supersede the following items.

- Homogenous samples: If a reanalysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within $\pm$ 1 RL for samples $\leq$ 5x the RL, the original analysis will be reported. At the client's request, both results may be reported on the same report but not on two separate reports.

- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and reanalyze the sample a third time for confirmation if sufficient sample is available.

- Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.

- Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Area Supervisor *or* LD if unsure.

19.14 Control of Data

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.14.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. More detail is outlined in SOP RL-IT-001. The laboratory is currently running the QuanTIMS which is a, custom in-house developed LIMS system along with RadCalc. The combination is referred to as LIMS for the remainder of this section. The LIMS utilizes SQL which is an

industry standard relational database platform. It is referred to as Database for the remainder of this section.

19.14.1.1 **Maintain the Database Integrity:** Assurance that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection; data change requirements, as well as an internal LIMS permissions procedure.

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use. Cells containing calculations must be lock-protected and controlled.
- Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails and controlled access.

19.14.1.2 **Ensure Information Availability:** Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, and secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.14.1.3 **Maintain Confidentiality:** Ensure data confidentiality through physical access controls such as password protection or website access approval when electronically transmitting data.

19.14.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings, radioactive progeny ingrowth, and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values. Measurement data from nuclear detection instruments are electronically handled. Where available in instrument software, all electronic tracking and audit functions must be enabled.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the Department Manager or alternate analyst prior to updating the data in LIMS. The spreadsheets, or any other type of applicable documents, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s).

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP No. CA-Q-S-002, *Acceptable Manual Integration Practices* or RL-DR-003. For DoD clients, the spectra obtained before and after the manual integration must be retained to permit reconstruction of the results, and the analyst must sign and date each set of data with a note regarding rationale.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff.

Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.14.2.1 All raw data must be retained in the work list folder, computer file (if appropriate), and/or run log. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). It must be easily identifiable who performed which tasks if multiple people were involved.

19.14.2.2 In general, concentration results are reported in milligrams per liter (mg/l) or micrograms per liter (µg/l) for liquids and milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg) for solids. For values greater than 10,000 mg/l, results can be reported in percent, i.e., 10,000 mg/l = 1**%.** Units are defined in each lab SOP.

19.14.2.3 In reporting, the analyst or the instrument output records the raw data result using values of known certainty plus one uncertain digit. If final calculations are performed external to LIMS, the results should be entered in LIMS with at least three significant figures. In general, results are reported to 2 significant figures on the final report.

19.14.2.4 For those methods that do not have an instrument printout or an instrumental output compatible with the LIMS System, the raw results and dilution factors are entered directly into LIMS by the analyst, and the software calculates the final result for the analytical report. LIMS has a defined significant figure criterion for each analyte.

19.14.2.5 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the LIMS, the raw results and dilution factors are transferred into LIMS electronically after reviewing the quantitation report, and removing unrequested or poor spectrally-matched compounds. The analyst prints a copy of what has been entered to check for errors. This printout and the instrument's printout of calibrations, concentrations/activities, retention times, chromatograms, and mass spectra, if applicable, are retained with the data file. The data file is stored in a monthly folder on the instrument computer; periodically, this file is transferred to the server and, eventually, to a backup file.

19.14.3 <u>Logbook / Worksheet Use Guidelines</u>

Logbooks and/or worksheets are filled out 'real time' and have enough information on them to trace the events of the applicable analysis/task. (e.g. calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.)

- Logbooks shall have permanent bound sequentially numbered pages.
- The persons responsible for the activity will sign or initial and date the entry. Whenever possible, the entries shall be in chronological order.
- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.

- Unused portions of pages must be "Z"'d out or a diagonal line drawn through the unused portion of the page, initialed and dated.
- Worksheets are created with the approval of the laboratory Technical Manager and QA Manager. The QA Manager controls all worksheets following the procedures in Section 6.

19.14.4 Data Review / Verification Procedures

Review steps are outlined in RL-DR-001 to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data is reported. Laboratory SOP RL-DR-003 provides step for Manual Integrations (hand analysis) of data, to ensure the authenticity of the data. The general review concepts are discussed below, more specific information can be found in the SOPs.

19.14.4.1 The data review process at the laboratory starts at Sample Receiving. Sample Receiving personnel review chain-of-custody forms and input the sample information and required analyses into the LIMS. The Sample Receiving Supervisor reviews the transaction of the chain-of-custody forms and the inputted information. The PMs perform final review of the COC forms and Sample Receiving input before releasing the samples into the laboratory work flow.

19.14.4.2 The next level of data review occurs with the Analysts. As analytical results are generated, analysts review their work to ensure that the results generated meet QC requirements and relevant EPA methodologies. The Analysts transfer the data into the LIMS (in many case, the transfer is automatic). A second analyst or data reviewer adds data qualifiers if applicable.

To ensure data compliance, a different analyst performs a second level of review. Second level review is accomplished by checking reported results against raw data and evaluating the results for accuracy. During the second level review, blank runs, QA/QC check results, initial and continuing calibration results, laboratory control samples, sample data, qualifiers and spike information are evaluated. Where calibration is not required on a daily basis, secondary review of the initial calibration results may be conducted at the time of calibration.

Issues that deem further review include the following:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data does not match with reported results
- Unusual detection limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors

- Results outside of calibration range

19.14.4.3 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the LD, PM, QA Director/Manager, Technical Manager, or Supervisor for further investigation. Corrective action is initiated whenever necessary, and recorded in the NCM system.

19.14.4.4 The results are then entered or directly transferred into the LIMS. and a hard copy (or .pdf) is printed for the client.

19.14.4.5 As a final review prior to the release of the report, the PM reviews the results for appropriateness and completeness. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The process includes, but is not limited to, verifying that the COC is followed, cover letters/ narratives are present, flags are appropriate, and project specific requirements are met.

The following are some examples of radiochemical relationships that are reviewed (if data is available):

- Comparing gross alpha results to alpha emitters
- Comparing gross beta results to beta emitters

When compliance with DoD ELAP is required for a client project, the specific requirements of Grey Box 44 in the DoD QSM must be met. This includes 100% review of results by the analyst, a 100% verification review by a technically qualified supervisor or independent analyst, and a final administrative review. In addition, the QA Manager must include review of a minimum of ten percent (10%) of these projects in the periodic QA review schedule.

19.14.4.6 Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable QC requirements. The PM then signs the final report. The accounting personnel also check the report for any clerical or invoicing errors. When complete, the report is sent out to the client.

19.14.5 <u>Manual Integrations</u>

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet QC acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP (CA-Q-S-002) as the guideline for the laboratory SOP RL-DR-003.

19.14.5.1 The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder

needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.14.5.2 Analysts shall not increase or decrease peak areas for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principals and policy and is grounds for immediate termination.

19.14.5.3 Client samples, performance evaluation samples, and QC samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

19.14.5.4 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale “after” chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale “before” chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

For DoD clients, the raw data obtained before and after the integration must be retained to permit reconstruction of the results, and the analyst must sign and date each set of data with a note regarding rationale.

Figure 19-1. Example - Demonstration of Capability Documentation

DEMONSTRATION OF CAPABILITY (DOC)

Laboratory Name:_____
Laboratory Address:_____
Method:_____ Matrix:_____
Date:_____ Analyst(s):_____
Source of Analyte(s):_____

Analytical Results

Analyst	Conc. (Units)	Rep 1	Rep 2	Rep 3	Rep 4	Avg. % Recovery	% RSD
_____	_____	_____	_____	_____	_____	_____	_____

% RSD = Percent relative standard deviation = standard deviation divided by average % Recovery

Raw data reference: _____

Certification Statement:

We, the undersigned, certify that:
1. The cited test method has met Demonstration of Capability requirements.
2. The test method was performed by the analyst(s) identified on this certification.
3. A copy of the test method and the laboratory-specific SOPs are available for all personnel on site.
4. The data associated with the method demonstration of capability are true, accurate, complete, and self-explanatory.
5. All raw data necessary to reconstruct and validate these analyses have been retained at the facility, and the associated information is well organized and available for review.
6.

_____ _____
Analyst Signature Date

_____ _____
Technical Manager Signature Date

_____ _____
Quality Assurance Coordinator Signature Date

SECTION 20. EQUIPMENT and CALIBRATIONS

20.1 Overview

The laboratory purchases the most technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in laboratory SOPs. A list of laboratory equipment and instrumentation is presented in Table 20-1.

Equipment is only operated by authorized and trained personnel. Manufacturer instructions for equipment use are readily accessible to all appropriate laboratory personnel.

Instructions for allowable equipment or operating software adjustments during operation are included in SOPs, in order to minimize any setting changes that would invalidate test results.

20.1.1 Control of Test Equipment

Test equipment and analytical instrumentation are only operated by authorized and trained personnel. Manufacturer's instructions for equipment use are readily accessible to all appropriate laboratory personnel.

Instructions for allowable equipment or operating software adjustments during operation are included in SOPs. In order to minimize any setting changes that would invalidate test results.

20.2 Preventive Maintenance

The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

Routine preventive maintenance procedures and frequency, such as lubrication, cleaning and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the QC criteria.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Operations Manager to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures may be / are also outlined in analytical SOPs or instrument manuals. (Note: for some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.
- Each entry in the instrument log includes the Analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control. e.g. CCV run on *'date'* was acceptable, or instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.
- When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This stapled in page must be signed across the page entered and the logbook so that it is clear that a page is missing if only half a signature is found in the logbook.

If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it shall be taken out of operation and tagged as out-of-service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory shall examine the effect of this defect on previous analyses.

In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor, manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Back up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the backup is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

If an instrument is sent out for service or transferred to another facility, it must be recalibrated and verified (including new initial MDL study) prior to return to lab operations.

20.3 Support Equipment

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, field sampling devices, temperature measuring devices, thermal/pressure sample preparation devices and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance.

Whenever practicable, any support equipment requiring calibration shall be labeled, coded or otherwise identified to indicate the status of calibration, including the date when last calibrated and date or expiration criteria when recalibration is due. Support equipment to be used for DoD projects shall conform to the minimum criteria found in the DoD QSM, Gray Box 31, in the absence of method-specific criteria.

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked at three weights prior to initial serviceable use with at least two certified ASTM type 1 weights (called working weights) spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). These weights shall bracket the range of expected use for the day.

ASTM type 1 weights used only for calibration of other weights and no other purpose (called master weights) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every three (3) years by an ISO 17025-accredited calibration laboratory, and the provided certificate is kept on file.. Any weights (including ASTM Type 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains “calibration only” ASTM type 1 weights).

All balances are serviced annually by a qualified (**ISO 17025-accredited)** service representative, who supplies the laboratory with a **signed and dated certification** certificate that identifies traceability of the calibration to the NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file.

20.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one umhos/cm.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult pH and Conductivity, and Turbidity SOPs for further information.

20.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer at temperatures bracketing the range of use. Infrared thermometers, digital probes and

thermocouples are calibrated quarterly. Infrared thermometers should be calibrated over the full range of use, including ambient, iced (4 degrees Celsius) and frozen (0 to -5 degrees Celsius), per EPA 600 (drinking water manual)***.***

The NIST reference thermometer is recalibrated every three years (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The NIST thermometer has increments of 0.5 degree C, and has a range applicable to method and certification requirements. The NIST reference thermometer is used for no other purpose than to calibrate other thermometers.

All of this information is documented in logbooks. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in method-specific logbooks. More information on this subject can be found in SOP RL-SE-002

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored daily, when in use. Sample storage refrigerator temperatures are kept between 0ºC and ≤ 6 ºC when in use. Should a refrigerator temperature be out of limits, actions shall be taken as described in SOP RL-SRV-002.

Note: Very few samples handled by the Richland Laboratory require temperature control, therefore refrigerators are rarely in use.

Ovens, water baths and incubators are monitored on days of use.

All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

Sample storage refrigerator temperatures are kept between > 0ºC and ≤ 6 ºC.

Specific temperature settings/ranges for other refrigerators, ovens, microwave bomb digestors, water baths, and incubators can be found in method specific SOPs.

All of this information is documented in Daily Temperature Logbooks and method-specific logbooks.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices (critical pipettes) including burettes (except Class A Glassware and Glass microliter syringes) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis.

For those dispensers that are not used for analytical measurements, a label can be applied to the device stating that it is not calibrated. Any device not regularly verified cannot be used for any quantitative measurements.

20.3.6 Microwave Bomb Digestors

Documentation shall be maintained for the calibration activities required for microwave bomb digestion as prescribed in the analytical method.

20.4 Instrument Calibrations

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day.

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration/activity, response, type of calibration (curve or other calculations that may be used to reduce instrument responses to concentration).

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

Instrument calibration verification must be performed:

1) at the beginning and end of each analytical batch (except, if an internal standard is used, only one verification needs to be performed at the beginning of the analytical batch);
2) whenever it is expected that the analytical system may be out of calibration or might not meet the verification acceptance criteria;
3) if the time period for calibration or the most previous calibration verification has expired; or
4) for analytical systems that contain a calibration verification requirement.

If the initial calibration or continuing calibration verification (CCV) results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 12).

20.4.1 Chemical Calibration Standards

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP. If a reference method does not specify the number of calibration standards, a minimum of 3 calibration points (exception being ICP and ICP/MS methods) will be used.

Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated RL for the method based on the final volume of extract (or sample).

The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to at least the same number of significant figures used to report the data) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exception to these rules is the Inductively Coupled Plasma - Mass Spectrometer (ICP-MS) where a daily low level check standard and a daily linear range verification standards may be used to define the working range. See SOP RL-MT-004.

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst at a different time or a different preparation would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples. For DoD projects, the second source concentration must be at or near the midpoint of the calibration range.

20.4.2 Calibration Verification

The calibration relationship established during the initial instrument calibration must be verified initially and at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and in the 2009 TNI Standard. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. Initial calibration verification is with a standard source secondary (second source standard) to the calibration standards, but continuing calibration verifications may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to here is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, i.e., RPD, per 2009 TNI Std. EL-V1M4 Sec. 1.7.2.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Generally, the initial calibrations must be verified at the beginning of each analytical shift during which samples are analyzed. (Some methods may specify more or less frequent verifications). The analytical shift begins with the injection of the calibration verification standard (or the MS

tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample, QC, or standard that can be injected within 12 hours of the beginning of the shift.

A continuing instrument calibration verification (CCV) must be repeated at the beginning and, for methods that have quantitation by external calibration models, at the end of each analytical batch. Some methods have more frequent CCV requirements see specific SOPs. Most Inorganic methods require the CCV to be analyzed after ever 10 samples or injections, including matrix or batch QC samples.

Note: If an internal standard calibration is being used (for instance, GCMS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

If the results of a CCV are outside the established acceptance criteria and analysis of a second consecutive (and immediate) CCV fails to produce results within acceptance criteria, corrective action shall be performed. Once corrective actions have been completed & documented, the laboratory shall demonstrate acceptable instrument / method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with an unacceptable calibration verification may be fully usable under the following special conditions: and reported based upon discussion and approval of the client:

a). when the acceptance criteria for the CCV are exceeded high (i.e., high bias) and the associated samples within the batch are non-detects, then those non-detects may be reported with a footnote or case narrative explaining the high bias. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted; or

b). when the acceptance criteria for the CCV are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level.

Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted. Samples reported by the 2 conditions identified above will be appropriately flagged.

20.4.2.1 Verification of Linear and Non-Linear Calibrations

Calibration verification for calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. (These calculations are available in the laboratory method SOPs). Verification standards are evaluated based on the % Difference from the average CF or RF of the initial calibration or based on % Drift or % Recovery if a linear or quadratic curve is used.

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been

verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

- When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

- When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted. Alternatively, when applicable, a RL standard may be analyzed to demonstrate that the laboratory can still support non-detects at their RL.

20.4.3 Radiochemical Instrument Calibrations

Radiochemical instrument calibrations shall be performed as prescribed in ASTM method D7282. Frequency of calibrations shall also follow this method.

20.4.3.1 Calibration Standards

- Calibration verification for calibrations involves the calculation of the percent drift or the percent difference.
- Shelf life for stock radioactive standards shall not exceed 5 half lives. Shelf life for stock solutions prepared in the laboratory from salts, metals or dilution from a mother solution shall be no greater than one year, unless stated otherwise on the calibration certificate from the manufacturer. Standards in the form of a soil, sealed sources, filter, plated sources and sealed Marinelli beakers do not always have an expiration date. After the 1 year shelf life of the stock solution has expired, it must be re-certified.
- If the standard is not re-verified, the standard shall be removed or clearly designated as acceptable for qualitative purposes only.
- The expiration date of the secondary standard shall not exceed the expiration date of the primary standard.

The accuracy of calibration standards is checked by comparison with a calibration verification standard from a second vendor. In cases where a second vendor standard source is not available, a source from a different dilution is acceptable. All cases where this requirement cannot be met shall be documented with a nonconformance memo.

When a traceable standard is not available to use for calibration or verification activities, a non-traceable standard may be used if written client approval is obtained (when required).

Calibration standards are prepared using the appropriate procedures. However, the general procedures are described below.

- For each analyte of interest, prepare calibration standards at the minimum number of concentrations as stated in the analytical methods.

- Standards for instrument calibration are obtained from a variety of sources. All radioactive standards are traceable to NIST whenever possible. Dilution standards are prepared from stock standards purchased from commercial suppliers. A standard log is maintained, containing concentration/activity, date of receipt, date of standard preparation, any dilutions made, lot number, supplier, type of solvent and a unique code number to identify the standard.

20.4.3.2 Radiochemical Continuing Instrument Calibration Verification

Check sources shall be used only to verify that efficiencies have not changed. They shall not be used to determine efficiencies.

Performance checks shall be performed using appropriate check sources and monitored with control charts or tolerance charts to ensure that the instrument is operating properly and that the detector response has not significantly changed and therefore the instrument calibration has not changed. The same check source used in the preparation of the tolerance chart or control chart at the time of calibration shall be used in the calibration verification.

GAMMA - For gamma spectroscopy systems, the performance checks for efficiency and energy calibration shall be performed on a day of use basis along with performance checks on peak resolution.

For systems using sample changers and/or long count times that run more than a day, the energy calibration shall be checked before each analytical batch.

The Full-Width-Half-Maximum (FWHM) resolution of the detector shall be evaluated daily or prior to instrument use. The measured FWHM resolution shall be trended. Corrective actions shall be taken when an intolerable condition becomes evident or when gross changes are identified in the resolution of the detector at the energies that bound the applicable energy range.

ALPHA SPECTROSCOPY – For alpha spectroscopy systems, the performance check for energy calibration and counting efficiency shall be performed on a monthly basis.

Detector response (counting efficiency) determinations shall be performed when the check source count is outside the acceptable limits of the control chart.

Calibration or QC sources that will not cause detector contamination from recoil atoms shall be used whenever possible.

GAS-PROPORTIONAL AND LIQUID SCINTILLATION COUNTERS – The performance check for counting efficiency shall be performed on a day-of-use basis. For batches of sample that uninterruptedly count for more than a day, a performance check can be performed at the beginning and end of the batch as long as this time interval is no greater than one week.

For scintillation counters, the calibration verification for counting efficiency shall be performed on a day of use basis. Radon scintillation detector efficiencies shall be verified at least on a monthly basis when the system is in use.

20.4.3.3 Radiochemical Background Measurement

Background measurements shall be made on a day-of-use basis (except for alpha and gamma spectroscopy) and monitored using control charts or tolerance charts to ensure that the laboratory maintains its capability to meet required DQOs. The duration of the background check shall be of sufficient duration (i.e., at least as long as the sample count time). When applicable, these values are subtracted from the total measured activity in the determination of the sample activity.

Successive long background measurements may be evaluated as background check measurements. The background check frequency may be extended to accommodate long sample count times.

A background shall also be collected before and after any counting chamber changes are made, i.e. cleaning, liner replacement, or instrument modification.

GAMMA SPECTROSCOPY – The long background measurements, used for background corrections, shall be performed on at least a monthly basis.

ALPHA SPECTROSCOPY – Background measurements shall be performed on at least a monthly basis. The monthly background shall be performed for each Region of Interest (ROI). A detector background shall be rechecked after counting a high-activity sample.

GAS PROPORTIONAL – Background measurements shall be performed on at least a weekly basis. Long background measurements (to be used for background corrections) shall be performed on a quarterly basis, at a minimum. A detector background shall be rechecked after counting a high-activity sample.

SCINTILLATION COUNTERS – Background measurements shall be performed each day of use. The daily instrument check shall include a check with an unquenched, sealed background vial, which is never used to correct sample results for background.

20.4.3.4 Radiochemical Instrument Contamination Monitoring

SOP RL-RS-001 specifies the requirements for monitoring radiochemical instrumentation. The SOP specifies the monitoring frequencies and criteria for initiating corrective action.

Table 20-1. Laboratory: Example - Instrumentation List

Manufacturer	Model	Detectors	Purchase Date	Auto-sampler	Method Performed
Randam	Randam SC-5	81	1990	No	Alpha Scintillation
Ludlum	Ludlum200, USGS	55	1990	No	Alpha Scintillation
Canberra	Canberra 7401	44	1990	No	Alpha Spectroscopy
Ortec	Ortec 576A	149	1990	No	Alpha Spectroscopy
Ortec	Ortec 576	43	1990	No	Alpha Spectroscopy
Tennelec	Tennelec TC256	28	1990	No	Alpha Spectroscopy
Canberra	CanberraGC25185	1	1990	No	Gamma Spectroscopy
Canberra	Canberra GL20208	1	1990	No	Gamma Spectroscopy
Ortec	Ortec LoAx51370	1	1990	No	Gamma Spectroscopy
Ortec	LO-AX-51370/20	2	2003	No	Gamma Spectroscopy
Ortec	Ortec GEM-25185	1	1990	No	Gamma Spectroscopy
Ortec	GEM-40	4	2003	No	Gamma Spectroscopy
Ortec	Ortec GEM-25195	3	1990	No	Gamma Spectroscopy
Ortec	Ortec GMX-40195	1	1990	No	Gamma Spectroscopy
PGT	PGT NIGC-2519	2	1990	No	Gamma Spectroscopy
PGT	PGT NIGC-2519	3	1990	No	Gamma Spectroscopy
PGT	PGT IGP-2007	1	1990	No	Gamma Spectroscopy
Spectrum Sciences	QA-230	2	1990	No	Gas Proportional Counter
Tennelec	Tennelec LB5100	1	1990	No	Gas Proportional Counter
Tennelec	Tennelec LB4000	3	1990	No	Gas Proportional Counter
UST	UST Quad	8	1990	No	Gas Proportional Counter
Packard	Packard 4530	1	1990	No	Liquid Scintillation
Packard	Packard 2000	1	1990	No	Liquid Scintillation
Packard	Packard 2200CA	2	1990	No	Liquid Scintillation
Packard	Packard 2550TRL	1	1990	No	Liquid Scintillation
Packard	Packard 2500TR	1	1990	No	Liquid Scintillation
Packard	3100 TR	1	2004	No	Liquid Scintillation
Quantalus	Quantalus	1	1990	No	Liquid Scintillation
UST	KPA 2	1	1990	No	Kinetic Phosphorimeter Analyzer
CHEMCHEK	KPA 3	1	1990	No	Kinetic Phosphorimeter Analyzer
Thermo Jarrell Ash 61E ICAP	12621100	1	1995	No	6010B
Perkin Elmer Elan DRC II	AI12010609	1	2007	Yes	ICP-MS

Table 20-2. Example: Schedule of Routine Maintenance

Instrument	Items Checked/Service	Minimum Frequency
Alpha Proportional	Check gas flow/bubbler oil level Clean sample tray	Each day of use Weekly
Beta Proportional	Check gas flow Clean sample holders	Each day of use Weekly
Liquid Scintillation	Clean sample changer Check condensate trays Check air filters	Monthly Monthly Monthly
GPC αβ Proportional	Check gas flow Clean sample holders	Each day of use Weekly
Gamma Spectroscopy	Check LN_2 level Check plastic liner, replace if needed	Bi-weekly Weekly
Alpha Spectroscopy	Clean sample holder Change vacuum pump oil	As needed Every six months
KPA	Clean mirror surfaces Change dye cell contents Clean reference cell Change reference cell contents Replace Plasma cartridge	As needed At least quarterly Every two months As needed Every 2E+07 pulses or as needed
Alpha Scintillation	Vacuum detector chambers	Monthly
ICP – ICP-MS	Check torch tip Clean torch tip Check pump and capillary tubing Check coolant level Clean intelligence controller filters Clean cooling inlet filters Clean and oil guiding rods Oil RFPT coolant fan	Each day of use As needed Weekly Weekly Monthly Monthly Monthly Semi-annually

SECTION 21. MEASUREMENT TRACEABILITY

21.1 Overview

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic and other volumetric measuring devices. (Refer to Section 20.3). With the exception of Class A Glassware, quarterly accuracy checks are performed for all mechanical volumetric devices. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A Glassware and Glass microliter syringes should be routinely inspected for chips, acid etching or deformity (e.g., bent needle). If the Class A glassware or syringe is suspect, the accuracy of the glassware will be assessed prior to use.

21.2 NIST-Traceable Weights and Thermometers

Reference standards of measurement shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), or another accreditation organization that is a signatory to a Mutual Recognition Arrangement of one or more of the following cooperations – ILAC (International Laboratory Accreditation Cooperation) or APLAC (Asia –Pacific Laboratory Accreditation Cooperation). A calibration certificate and scope of accreditation is kept on file at the laboratory.

The calibration laboratory's policy for achieving measurement traceability is defined and includes the subsequent elements of uncertainty.

The uncertainty calculations of the calibration laboratory are supported by uncertainty budgets and are represented by expanded uncertainties typically using a coverage factor of k=2 to approximate the 95% confidence level. This explanation accompanies the measurement result and the associated uncertainty.

The tolerance uncertainty ratio (TUR) is calculated using the expanded uncertainty of the measurement, not the collective uncertainty of the measurement standards. A statement to this effect accompanies the TUR along with the coverage factor and confidence level.

The calibration report or certificate submitted to TestAmerica Richland contains, in a well designed format, a traceability statement, the conditions under which the calibrations were made in the context of any potential influence, a compliance statement with an identified metrological specification and the pertinent clauses, a clearly identified record of the quantities and functional test results before and after re-calibration, and no recommendation on the calibration interval. Opinions and interpretations of results are presented along with the basis

upon which they were made and identified as such. The report may be submitted by facsimile or other electronic means as long as the requirements of the International Standard are achieved. If significant amendments are made to a calibration certificate, a supplemental certificate for the serial-number-specified piece of equipment is so identified. When a new certificate is offered, it uniquely identifies and references the one it replaces. All calibration reports are filed in the QA Office.

The calibration laboratory supports in-house calibration systems: documented procedures for in-house calibrations, evidence by a report, certificate, or sticker, for an appropriate amount of time; training records of calibration personnel; certificates from accreditation services demonstrating traceability to national or international standards of measurement; procedures for evaluating measurement uncertainty; timely and documented recalibration of reference standards. When subcontracting to a calibration laboratory, TestAmerica Richland does not use a firm that in turn subcontracts the work.

An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balance calibrations are checked each day of use. All mercury thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use.

21.3 Reference Standards / Materials

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared standard materials are purchased from vendors accredited by A2LA, NVLAP with an accompanying Certificate of Analysis that documents the standard purity. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis.

All radioactive standards are traceable to NIST whenever possible. Other international traceable radioactive standards may be used when NIST traceable standards are not available. When a traceable standard is not available, written approval for use of a non-traceable standard must be obtained from DOE clients.

The receipt of all reference standards must be documented. Reference standards are labeled with a unique Standard Identification Number and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the ‘true’ value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor certified different lot is acceptable for use as a second source. For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate QC criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample

preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g. calibration checks, laboratory control samples).

All radioactive standards shall be verified prior to initial use and annually. At least three verification measurements of a standard shall be used to determine the mean value and standard deviation of the verification results. The mean value shall be within 5% of the decay corrected certified value. The two sigma value used for the 95% confidence interval of the mean shall not exceed 10% of the mean value of the three verification measurements. If all criteria are met, the certified value shall be used.

Corrections for radioactive decay and/or ingrowth of progeny shall be performed for radionuclide standards.

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

Standards and reference materials shall not be used after their expiration dates unless their reliability is verified by the laboratory and their use is approved by the QA Manager. The laboratory must have documented contingency procedures for re-verifying expired standards.

21.4 Documentation and Labeling of Standards, Reagents, and Reference Materials

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company-wide purchase according to TestAmerica Corporate SOP CA-Q-S-001, Solvent and Acid Lot Testing and Approval.

All manufacturer or vendor supplied Certificates of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained by the Laboratory Support manager. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on documentation and labeling, please refer to method specific SOPs.

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc.., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96% a correction will be made to concentrations applied to solutions prepared from the stock commercial material (for 1613B dioxin/furan analyses the purity must be 98% or corrections must be made).

21.4.1 All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into the laboratory's LIMS system *according to the RadCalc user guide,* and are assigned a unique identification number. Reagents are labeled according to SOP RL-RPL-001. The following information is typically recorded in the electronic database within the LIMS.

- Standard ID
- Description of Standard
- Department
- Preparer's name
- Final volume and number of vials prepared
- Solvent type and lot number
- Preparation Date
- Expiration Date
- Standard source type (stock or daughter)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained electronically for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

21.4.2 All standards, reagents, and reference materials must be clearly labeled per SOP RL-RPL-001. Standard ID numbers must be traceable through electronic database. with a minimum of the following information:

- Expiration Date (include prep date for reagents)
- Standard ID from LIMS
- Special Health/Safety warnings if applicable

Records must also be maintained of the date of receipt for commercially purchased items or date of preparation for laboratory prepared items. Special Health/Safety warnings must also be available to the analyst. This information is maintained in laboratory databases.

21.4.3 In addition, the following information may be helpful:

- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Recommended Storage Conditions.
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include an expiration date and an ID number to trace back to preparation.

Procedures for preparation of reagents can be found in the Method SOPs.

Standard ID numbers must be traceable through associated logbooks, worksheets and raw data.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods as specified in the laboratory SOP.

SECTION 22. SAMPLING

22.1 Overview

The Richland laboratory does not provide sampling services. The laboratory's responsibility in the sample collection process lies in supplying the sampler with the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms, ice, and packing materials required to properly preserve, pack, and ship samples to the laboratory

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Any certificates of cleanliness that are provided by the supplier are maintained at the laboratory.

22.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In some cases containers may be purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Bisulfate – ACS Grade or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent

22.3 Definition of Holding Time

The date and time of sampling documented on the COC form establishes the day and time zero. As a general rule, when the maximum allowable holding time is expressed in "days" (e.g., 14 days, 28 days), the holding time is based on calendar day measured. Holding times expressed in "hours" (e.g., 6 hours, 24 hours, etc.) are measured from date and time zero. The first day of holding time ends twenty-four hours after sampling. Holding times for analysis include any necessary reanalysis. However, there are some programs that determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of how long the holding time is.

22.4 Sampling Containers, Preservation Requirements, Holding Times

The preservation and holding time criteria specified in SOP RL-SRV-001 are derived from the source documents for the methods. If method required holding times or preservation requirements are not met, the reports will be qualified using a flag, footnote or case narrative. As soon as possible or "ASAP" is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 Sample Aliquots / Subsampling

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation. It is the laboratory's responsibility to take a representative subsample or aliquot of the sample provided for analysis.

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn and safety procedures followed when preparing aliquots for analysis.

For water samples, before taking each aliquot for analysis, invert the sample container end-over-end at least three times and immediately pour off the aliquot. Especially when suspended solids are present, adequate mixing of the sample is extremely important.

For solid samples, if the solid can be mixed, stir before removing aliquot. Mix more than is needed for the analysis to be performed (e.g., if 30 g are needed, mix 50-100 g, if 1 g is needed, mix 20 g, etc.).

- For soil samples, avoid debris in the subsample aliquot as much as possible (e.g., gravel, sticks, roots and grass); note this information in the sample preparation record.

If the solid is extremely heterogeneous, and the client has given no instructions, utilize the following technique: take portions of masses from each group, proportional to their contribution to the original sample to make a composite. Record in detail how the composite was created. For very unusual samples, consult with the QA Department or Supervisor.

Note: The holding times are program specific and different programs may have different holding times for equivalent methods.

SECTION 23. HANDLING OF SAMPLES

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

23.1 Chain of Custody

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested TAT
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

If the matrix description is not available on the COC, the laboratory shall contact he client prior to proceeding.

When sampling personnel deliver the samples directly to TestAmerica personnel, the samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory. The sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the sample control personnel at the laboratory. When sampling personnel deliver the samples through a common carrier (Fed-Ex, UPS), the COC relinquished date/time is completed by the field personnel and samples are released to the carrier. Samples are considered to be received by the laboratory when personnel at the laboratory have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The receipt from the courier is stored in log-in by date; it lists all receipts each date.

23.1.2 Legal / Evidentiary Chain-of-Custody

If samples are identified for legal/evidentiary purposes on the COC, Sample Receiving staff will complete the custody seal, retain the shipping record with the COC, and initiate an internal COC for laboratory use by analysts, plus a sample disposal record.

The legal COC records shall establish an intact, continuous record of the physical possession, storage and disposal of sample containers, collected samples, sample aliquots and sample extracts or digestates. The COC record shall account for all time periods associated with the samples. For ease of discussion, the above-mentioned items shall be referred to as samples:

1. A sample is in someone's custody if:
   a) If it is in one's actual physical possession;
   b) It is in one's view, after being in one's physical possession;
   c) It is in one's physical possession and then locked or sealed so that no one can tamper with it and/or
   d) It is kept in a secured area, restricted to authorized personnel only.
2. The COC records shall identify all individuals who physically handled individual samples.
3. When possible, the number of people who physically handled individual samples.
4. A designated sample custodian shall be appointed to be responsible for receiving, storing and distributing samples.
5. Efforts shall be made to limit the number of COC documents.
6. Legal COC shall begin at the point established by the federal or state oversight program. This may begin at the point that cleaned sample containers are provided by the laboratory or the time sample collection occurs.
7. The COC forms shall remain with the samples during transport or shipment.
8. IF shipping containers and/or individual sample containers are submitted with sample custody seals and any seals are not intact, the custodial shall note this on the COC and the client shall be contacted.
9. Mailed packages should be registered with return receipt requested. If packages are sent by common carrier, receipts shall be retained as part of the permanent COC documentation.
10. Once received by the laboratory, laboratory personnel are responsible for the care and custody of the sample and must be prepared to testify that the sample was in their possession and within view of secured in the laboratory at all rimes, from the moment it was received from the custodian until the time that the analyses are completed or the time of sample disposal.

23.2 Sample Receipt

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections.

23.2.1 Laboratory Receipt

When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples per SOP RL-SRV-001. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance, irregularity, or compromised sample receipt must be documented on the Sample Check-In Form and brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record.

23.2.1.1 Unique Sample Identification

All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at anytime. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory.

If the primary container goes through a prep step that creates a “new” container, then the new container is considered secondary and gets another ID. An example of this being a client sample in a 1-Liter amber bottle is sent through a Liquid/Liquid Extraction and an extraction vial is created from this step. The vial would be a SECONDARY container. The secondary ID consists of the original ID plus another character (example: M1K1DA becomes M1K1DAA)

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Figure 23-2) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- a COC filled out completely
- samples must be properly labeled
- proper sample containers with adequate volume for the analysis and necessary QC
- samples must be preserved according to the requirements of the requested analytical method,
- sample holding times must be adhered to
- the sample radioactivity must be within the laboratory license limits

The PM will be notified if any of the above requirements are not met or if the sample is received in damaged condition, this may be achieved by completing the Sample Check In Sheet LS-023 or other forms of communication.

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined.

23.3.1 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.3.2 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or
- Fully document any decision, agreed upon by the client, to proceed with sample analysis that does not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the LIMS according to SOP RL-SRV-001.

23.3.1 Sample Log-in

All samples that are received by the laboratory are logged into the LIMS to allow the laboratory to track and evaluate sample progress. Each group of samples that are logged in together (typically one project from a given client/sampling event) is assigned a unique job number or Sample Delivery group (SDG). Within each job, each sample receives a unique number. Sample numbers are generated sequentially over time, and are not re-assigned. A sample may be composed of more than one bottle since different preservatives may be required to perform all analyses requested. Even if multiple containers are received for a single sample, each container is uniquely identified with alphabetic letters added to the sample number. The LIMS generates sample labels that are attached to each bottle for a given sample.

Each job/set of samples is logged into LIMS with a minimum of the following information:

- Client Name, Project Name, Address, Phone, Report to information, invoice to information (most of this information is “Default Information” that is stored in the LIMS).
- Date and time sampled.
- Date and time received.
- Job and/or project description, sample description;
- Sample matrix, special sample remarks;
- Reporting requirements (e.g., QC level, report format, invoicing format):
- TAT requirements
- Parameters (methods and RLs or MDLs are default information for a given parameter).

Upon receipt of a sample with a short hold time analysis, the appropriate analyst is notified by phone. Also, during login, the LIMS will identify a short hold time analysis and e-mail the laboratory managers.

23.4 Sample Storage

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators, freezers or protected locations suitable for the sample matrix and levels of radioactivity. The storage areas are organized by Lot number. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored near standards or reagents. Samples of various types are segregated to minimize cross-contamination (example: bioassay samples are stored away from environmental samples)…

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every two weeks.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated storage location and place them on carts, analyze the sample, and return the remaining sample or empty container to the storage location from which it originally came. All transfers of samples and fractions are recorded using the electronic ICOC program. The sample containers, analytical batches, employees, SOP numbers and SOP revision numbers all have unique bar codes. The sample or batch, employee and SOP information is entered into the computer using bar codes. This minimizes manual data entry.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

23.4.1 Laboratory Internal Tracking

Tracking records shall include, by direct entry or linkage to other records:

1. Time of day and calendar date of each transfer or handling;

2. Signatures/Electronic entries of all personnel who physically handle samples;

3. All information necessary to produce unequivocal, accurate records that document the laboratory activities associated with sample receipt, preparation, analysis and reporting, and

4. COC forms received from the client and/or common carrier documents.

23.5 Hazardous Samples and Foreign Soils

To minimize exposure to personnel and to avoid potential accidents, hazardous and foreign soil samples are stored in an isolated area designated for hazardous waste only. For any sample that is known to be hazardous at the time of receipt or, if after completion of analysis the result

exceeds the acceptable regulatory levels, a Hazardous Sample Notice must be completed by the analyst. This form may be completed by Sample Control, PMs, or analysts and must be attached to the report. The sample itself is clearly marked with a red stamp, stamped on the sample label reading “HAZARDOUS” or “FOREIGN SOIL” and placed in a colored and/or marked bag to easily identify the sample. The date, log number, lab sample number, and the result or brief description of the hazard are all written on the Hazardous & Foreign Soil Sample Notice. A copy of the form must be included with the original COC and Work Order and the original must be given to the Sample Control Custodian. Analysts will notify Sample Control of any sample determined to be hazardous after completion of analysis by completing a Hazardous Sample Notice. All hazardous samples are either returned to the client or disposed of appropriately through a hazardous waste disposal firm that lab-packs all hazardous samples and removes them from the laboratory. Foreign soil samples are sent out for incineration by a USDA-approved waste disposal facility.

23.6 Sample Shipping

In the event that the laboratory needs to ship samples that require cooling, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses (see Note). The chain-of-custody form is signed by the sample control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

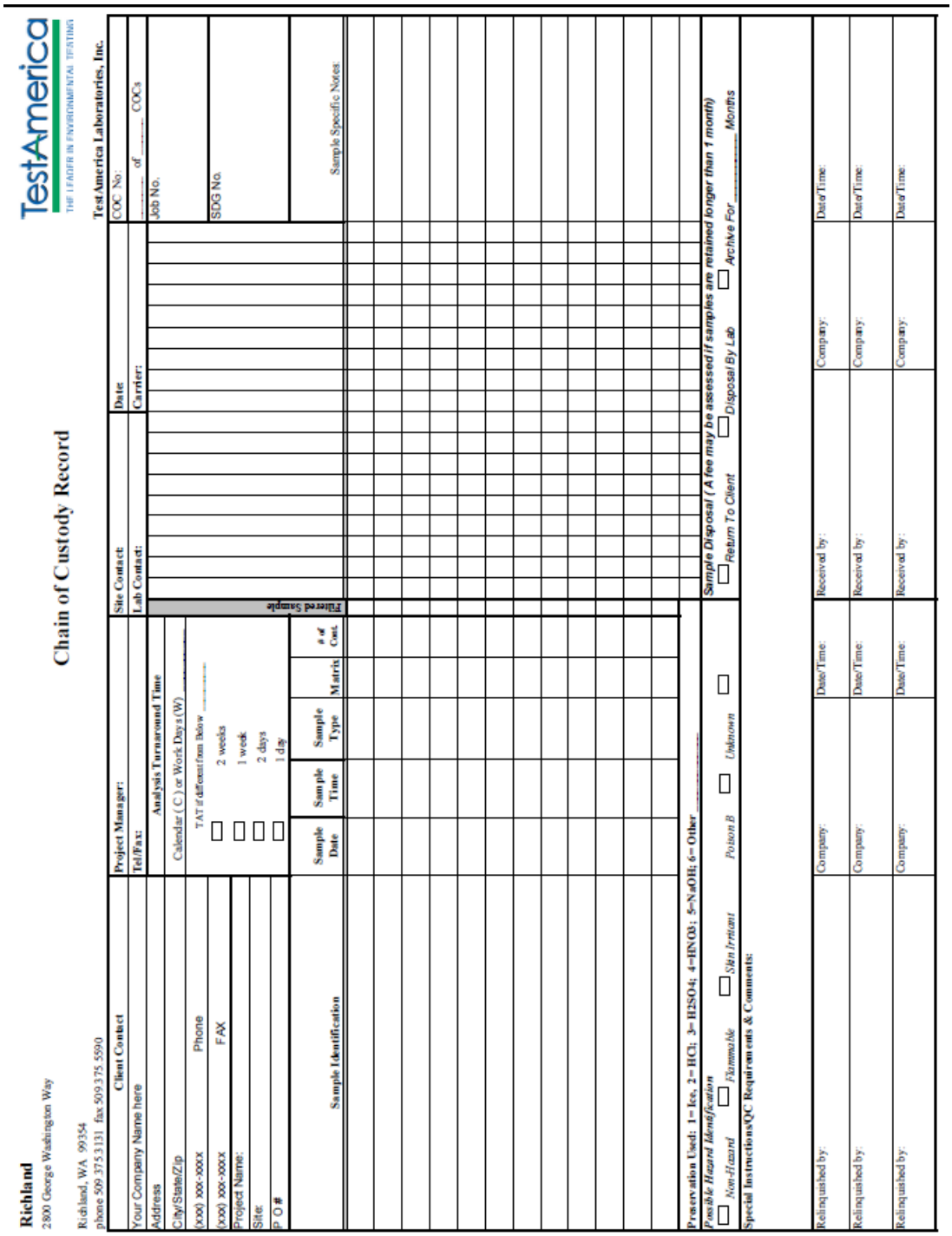
Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

23.7 Sample Disposal

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory’s waste disposal procedure (SOP: RL-HS-006). All requirements in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

If a sample is part of a known litigation, the affected legal authority, sample data user, and/or submitter of the sample must participate in the decision about the sample's disposal. All documentation and correspondence concerning the disposal decision process must be kept on file. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, and return to client), names of individuals who conducted the arrangements and physically completed the task. The laboratory will remove or deface sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated). A Waste Disposal Record should be completed.

Figure 23-1. Example: Chain of Custody



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TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Chain of Custody Record

TestAmerica Laboratories, Inc.

Client Contact	**Project Manager:**	**Site Contact:**	**Date:**
Your Company Name here	**Tel/Fax:**	**Lab Contact:**	**Carrier:**
Address			
City/State/Zip			
(xxx) xxx-xxxx Phone			
(xxx) xxx-xxxx FAX			
Project Name:			
Site:			
P O #			

COC No: _____ of _____ COCs

Job No.

SDG No.

Analysis Turnaround Time
Calendar (C) or Work Days (W)
TAT if different from Below _____
☐ 2 weeks
☐ ☐ 1 week
☐ ☐ 2 days
☐ ☐ 1 day

Sample Identification	Sample Date	Sample Time	Sample Type	Matrix	# of Cont.	Filtered Sample	Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* *Poison B* ☐ *Unknown* ☐

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* _____ *Months*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:

Figure 23-2. Example: Sample Acceptance Policy

All incoming work will be evaluated against the criteria listed below. Where applicable, data from any samples that do not meet the criteria listed below will be noted on the laboratory report defining the nature and substance of the variation. In addition the client will be notified either by telephone, fax or e-mail ASAP after the receipt of the samples.

1) Samples must arrive with labels intact with a (COC) filled out completely. The following information must be recorded.
   - *Client name, address, phone number and fax number (if available)*
   - *Project name and/or number*
   - *The sample identification*
   - *Date, time and location of sampling*
   - *The collectors name*
   - *The matrix description*
   - *The container description*
   - *The total number of each type of container*
   - *Preservatives used*
   - *Analysis requested*
   - *Requested turnaround time (TAT)*
   - *Any special instructions*
   - *Purchase Order number or billing information (e.g. quote number) if available*
   - *The date and time that each person received or relinquished the sample(s), including their signed name.*
   - *The date and time of receipt must be recorded between the last person to relinquish the samples and the person who receives the samples in the lab, and they must be exactly the same.*
   - Information must be legible

2) Samples must be properly labeled.
   - Use durable labels (labels provided by TestAmerica are preferred)
   - Include a unique identification number
   - Include sampling date and time & sampler ID
   - Include preservative used.
   - Use indelible ink
   - Information must be legible

3) Proper sample containers with adequate volume for the analysis and necessary QC are required for each analysis requested. See Lab Sampling Guide.

4) Samples must be preserved according to the requirements of the requested analytical method (See Sampling Guide**.**

5) Most analytical methods require chilling samples to 4° C (other than water samples for metals analysis). For these methods, the criteria are met if the samples are chilled to below 6° C and above freezing (0°C). For methods with other temperature criteria (e.g. some bacteriological methods require $\leq$ 10 ^{o}C), the samples must arrive within $\pm$ 2° C of the required temperature or within the method specified range. **Note:** Samples that are hand delivered to the laboratory immediately after collection may not have had time to cool sufficiently. In this case the samples will be considered acceptable as long as there is evidence that the chilling process has begun (arrival on ice).

5i.) Samples that are delivered to the laboratory on the same day they are collected may not meet the requirements of Section 5. In these cases, the samples shall be considered acceptable if the samples were received on ice.

5ii.) If sample analysis is begun within fifteen (15) minutes of collection, thermal preservation is not required.

5iii.) Thermal preservation is not required in the field if the laboratory receives and refrigerates the sample within fifteen (15) minutes of collection.

- Chemical preservation (pH) will be verified prior to analysis and documented, either in sample control or at the analyst's level. The PM will be notified immediately if there is a discrepancy. If analyses will still be performed, all affected results will be flagged to indicate improper preservation.
- For Volatile Organic analyses in drinking water (Methods 502.2 or 524.2). Residual chlorine must be neutralized prior to preservation. If there is prior knowledge that the samples are not chlorinated, state it on the COC and use the VOA vials pre-preserved with HCl. The following are other options for a sampler and laboratory where the presence of chlorine is not known:
  1. Test for residual chlorine in the field prior to sampling.

     If no chlorine is present, the samples are to be preserved using HCl as usual.

     If chlorine is present, add either ascorbic acid or sodium thiosulfate prior to adding HCl.
  2. Use VOA vials pre-preserved with sodium thiosulfate or ascorbic acid and add HCl after filling the VOA vial with the sample.
- FOR WATER SAMPLES TESTED FOR CYANIDE (by Standard Methods or EPA 335)

  In the Field: Samples are to be tested for Sulfide using lead acetate paper prior to the addition of Sodium Hydroxide (NaOH). If sulfide is present, the sample must be treated with Cadmium Chloride and filtered prior to the addition of NaOH.
- If the sulfide test and treatment is not performed in the field, the lab will test the samples for sulfide using lead acetate paper at the time of receipt and if sulfide is present in the sample, the client will be notified and given the option of retaking the sample and treating in the field per the method requirements or the laboratory can analyze the samples as delivered and qualify the results in the final report.
- It is the responsibility of the client to notify the laboratory if thiosulfate, sulfite, or thiocyanate are known or suspected to be present in the sample. This notification may be on the COC. The samples may need to be subcontracted to a laboratory that performs a UV digestion. If the lab does not perform the UV digestion on samples that contain these compounds, the results must be qualified in the final report.
- The laboratory must test the sample for oxidizing agents (e.g. Chlorine) prior to analysis and treat according to the methods prior to distillation. (ascorbic acid or sodium arsenite are the preferred choice).

6) Sample Holding Times

- TestAmerica will make every effort to analyze samples within the regulatory holding time. Samples must be received in the laboratory with enough time to perform the sample analysis. Except for short holding time samples (< 48hr HT) sample must be received with at least 48 hrs (working days) remaining on the holding time for us to ensure analysis.

- Analyses that are designated as "field" analyses (Odor, pH, Dissolved Oxygen, Disinfectant Residual; a.k.a. Residual Chlorine, and Redox Potential) should be analyzed ASAP by the field sampler prior to delivering to the lab (within 15 minutes). However, if the analyses are to be performed in the laboratory, TestAmerica will make every effort to analyze the samples within 24 hours from receipt of the samples in the testing laboratory. Samples for "field" analyses received after 4:00 pm on Friday or on the weekend will be analyzed no later than the next business day

after receipt (Monday unless a holiday). Samples will remain refrigerated and sealed until the time of analysis. The actual times of all "field" sample analyses are noted on the "Short Hold Time Detail Report" in the final report. Samples analyzed in the laboratory will be qualified on the final report with an 'H' to indicate holding time exceedance.

7) All samples submitted for Volatile Organic analyses must have a Trip Blank submitted at the same time. TestAmerica will supply a blank with the bottle order.

8) The PM will be notified if any sample is received in damaged condition. TestAmerica will request that a sample be resubmitted for analysis.

9) Recommendations for packing samples for shipment.

- Pack samples in Ice rather than "Blue" ice packs.
- Soil samples should be placed in plastic zip-lock bags. The containers often have dirt around the top and do not seal very well and are prone to intrusion from the water from melted ice.
- Water samples would be best if wrapped with bubble-wrap or paper (newspaper, or paper towels work) and then placed in plastic zip-lock bags.
- Fill extra cooler space with bubble wrap.

SECTION 24. ASSURING THE QUALITY OF TEST RESULTS

24.1 Overview

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process QC measurements (e.g. Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These QC checks are performed as required by the method or regulations to assess precision and accuracy. QC samples are to be treated in the exact same manner as the associated field samples being tested. In addition to the routine process QC samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

QC samples shall be analyzed as part of the analytical batches. Batch QC samples shall be prepared and counted in the same time frame and with the same instrumentation configurations as the samples.

The laboratory standards used to prepare the LCS and MS shall be from sources independent of the standards used for calibration. In case where an independent source is not available a different lot numbers should be used. The radiochemical LCS and MS activities shall be at least 5 times the CRDL.

24.2 Controls

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 Negative Controls

Evaluation criteria and corrective action for these controls are defined in the specific SOP for each analysis.

Table 24-1. Example – Negative Controls

Control Type	Details
Method Blank (MB)	are used to assess preparation and analysis for possible contamination during the preparation and processing steps.
	The specific frequency of use for method blanks during the analytical sequence is defined in the specific SOP for each analysis. Generally it is 1 for each batch of samples; not to exceed 20 environmental samples.
	The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).

Table 24-1. Example – Negative Controls

Control Type	Details
	Reanalyze or qualify associated sample results when the concentration of a targeted analyte in the blank is at or above the RL as established by the method or by regulation, AND is greater than 1/10 of the amount measured in the sample.
Calibration Blanks	are prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.
Instrument Blanks	are blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.
Trip Blank [1]	are required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses (or as specified in the client's project plan). Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples.
Field Blanks [1]	are sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)
Equipment Blanks [1]	are also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. [TNI]
Holding Blanks	also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory

[1] When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

24.4 Positive Controls

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) (Matrix spikes are not applicable to air) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch

Note: Frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCSs may be processed for solid matrices; final results may be calculated as mg/kg or µg/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

The specific frequency of use for LCS during the analytical sequence is defined in the specific SOP for each analysis. It is generally 1 for each batch of samples; not to exceed 20 environmental samples.

If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses,

permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

- For methods that have 1-10 target analytes, spike all components.
- For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.
- For methods with more than 20 target analytes, spike at least 16 components.

24.5 Sample Matrix Controls

Table 24-2. Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	used to assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;
	Typical Frequency [1]	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects. If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	essentially a sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Are similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.
Duplicates[2]	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency [1]	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Are spiked into all environmental and QC samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] See the specific analytical SOP for type and frequency of sample matrix control samples.

[2] LCSDs are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as “Relative Percent Difference” (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 Acceptance Criteria (Control Limits)

As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

Laboratory generated % Recovery acceptance (control) limits are generally established by taking $\pm$ 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

- Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV). (Unless the analytical method specifies a tighter limit).

- In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the DQOs can be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

- The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for benzidine will be 5% and the analyte must be detectable and identifiable.

- The maximum acceptable recovery limit will be 150%.

- The maximum acceptable RPD limit will be 35% for waters and 40% for soils. The minimum RPD limit is 10%.

- If either the high or low end of the control limit changes by $\leq$ 5% from previous, the control chart is visually inspected and, using professional judgment, they may be left unchanged if there is no affect on laboratory ability to meet the existing limits.

24.6.1 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical control limits. The Richland laboratory uses the current limits and maintains the historical information within the proprietary RADCALC database system.

24.6.2 An LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with

recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

- The analyte results are below the RL and the LCS is above the upper control limit.
- If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

Or, for TNI and DoD work, there is an allowable number of Marginal Exceedances (ME):

<11 analytes	0 marginal exceedances are allowed.
11 – 30 Analytes	1 marginal exceedance is allowed
31-50 Analytes	2 marginal exceedances are allowed
51-70 Analytes	3 marginal exceedances are allowed
71-90 Analytes	4 marginal exceedances are allowed
> 90 Analytes	5 marginal exceedances are allowed

- Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit [TNI].
- Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

Though marginal exceedances may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

24.6.3 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.6.4 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client). Under certain circumstances, where all of the samples are from the same location and share similar chromatography, the reanalysis may be performed on a single sample rather than all of the samples and if the surrogate meets the recovery criteria in the reanalysis, all of the affected samples would require reanalysis.

24.7 Additional Procedures to Assure Quality Control

The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21) and use of PT samples (see Section 15).

A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

- Use of formulae to reduce data is discussed in the method SOPs and in Section 20.
- Selection of appropriate reagents and standards is included in Section 9 and 21.
- A discussion on selectivity of the test is included in Section 5.
- Constant and consistent test conditions are discussed in Section 18.
- The laboratories sample acceptance policy is included in Section 23.

SECTION 25. REPORTING RESULTS

25.1 Overview

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client. Review of reported data is included in Section 19.

25.2 Test Reports

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed on laboratory letterhead, reviewed, and signed by the appropriate PM. At a minimum, the standard laboratory report shall contain the following information:

- A report title (e.g. Analytical Report For Samples) with a "sample results" column header.
- Each report cover page printed on company letterhead, which includes the laboratory name, address and telephone number.
- A unique identification of the report (e.g. work order number) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

  Note: Page numbers of report are represented as page # of ##. Where the first number is the page number and the second is the total number of pages.
- A copy of the COC (any COCs involved with subcontracting are included.)
  - In most cases, the applicable COC is not paginated but is an integral part of the report. If the COC is not a paginated portion of the report then there will be a statement on the front of the report to effect of "The Chain of Custody, X page(s), is included and is an integral part of this report.". The number of pages of the CoC (X) is entered into Element so that it is correct for each report.
  - Any additional addenda to the report must be treated in a similar fashion so it is a recognizable part of the report and cannot accidentally get separated from the report (e.g., Sampling information).
- Each addendum to the report must be paginated so it is a recognizable part of the report and cannot accidentally get separated from the report (e.g., Sampling information).

- The name and address of client and a project name/number, if applicable.
- Client project manager or other contact
- Description and unambiguous identification of the tested sample(s) including the client identification code.
- Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.
- Date reported or date of revision, if applicable.
- Method of analysis including method code (EPA, Standard Methods, etc).
- Practical quantitation limits or RL.
- Method detection limits (if requested)
- Definition of data qualifiers and reporting acronyms (e.g. ND).
- Sample results and units.
- QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits as applicable.
- Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets.
- A statement expressing the validity of the results, that the source methodology was followed and all results were reviewed for error.
- A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.
- A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory coordinator.
- A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Signatories are appointed by the Lab Director.
- When TNI accreditation is required, the lab shall certify that the test results meet all requirements of TNI or provide reasons and/or justification if they do not.
- The laboratory includes a cover letter.
- Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.
- When soil samples are analyzed, a specific identification as to whether soils are reported on a “wet weight” or “dry weight” basis.
- Appropriate laboratory certification number for the state of origin of the sample, if applicable.
- If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report (e.g., partial report, or how your lab identifies it). A complete report must be sent once all of the work has been completed.
- Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.
- Non-accredited tests shall be clearly identified in the case narrative when claims of accreditation to the TNI standard are made.

- Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy (No. CA-I-P-002) for details on internally applying electronic signatures of approval.
- Reports for Ohio Voluntary Action Plan work require a specific affidavit be completed and included with the report.

25.3 Reporting Level or Report Type

The laboratory offers four levels of QC reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Level I is a report with the features described in Section 25.2 above.
- Level II is a Level I report plus summary information, including results for the method blank reported to the laboratory MDL, percent recovery for laboratory control samples and matrix spike samples, and the RPD values for all MSD and sample duplicate analyses.
- Level III contains all the information supplied in Level II, but presented on the CLP-like summary forms, and relevant calibration information. A Level II report is not included, unless specifically requested. No raw data is provided.
- Level IV is the same as Level III with the addition of all raw supporting data.

In addition to the various levels of QC packaging, the laboratory also provides reports in diskette deliverable form. Initial reports may be provided to clients by facsimile. All faxed reports are followed by hardcopy. Procedures used to ensure client confidentiality are outlined in Section 25.7.

25.4 Electronic Data Deliverables (EDD)

EDDs are routinely offered as part of TestAmerica's services. Richland Laboratory offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), New Agency Standard (NAS), Format A, Excel, Dbase, GISKEY, Text Files, and other proprietary formats.

EDD specifications are submitted to the IT department by the PM for review, and undergo the contract review process. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff per SOP RL-IT-001.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.5 Supplemental Information for Test

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet TNI sample acceptance requirements such as improper container, holding time, or temperature.

Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the LD will determine if a response can be prepared. If so, the LD will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the LD, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This necessitates a limited scope of interpretation, and this work is performed by the QA Department. This is the only form of "interpretation" of data that is routinely performed by the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator. For DOE clients, client approval must be obtained prior to adding opinions and interpretations in a case narrative.

25.6 Environmental Testing Obtained From Subcontractors

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP No. CA-L-S-002).

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of TestAmerica are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.7 Client Confidentiality

In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

TestAmerica will not intentionally divulge to any person (other than the Client or any other person designated by the Client in writing) any information regarding the services provided by TestAmerica or any information disclosed to TestAmerica by the Client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Note: TestAmerica Richland laboratory does not have the facilities to protect classified information or samples, and does not accept such information or materials.

Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.7.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are faxed with a cover sheet or e-mailed with the following note that includes a confidentiality statement similar to the following:

This material is intended only for the use of the individual(s) or entity to whom it is addressed, and may contain information that is privileged and confidential. If you are not the intended recipient, or the employee or agent responsible for delivering this material to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this communication is strictly prohibited. If you have received this communication in error, please immediately by e-mail or by phone (1-509-375-3131800-765-0980) and delete this material from any computer.

25.8 Format of Reports

The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.9 Amendments to Test Reports

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

The revised report is retained on the Archive data server, as is the original report. The revised report is stored in the Archive data server under the SDG number followed by "amended". The revised report will have the word "revised" or "amended" on all pages.

When the report is re-issued due to client request, a notation of "report re-issue "is placed on the cover/signature page of the report *or at the top of the narrative page* with a brief explanation

of reason for the re-issue and a reference back to the last final report generated. *For Example*: *Report was revised on 11/3/08 to include toluene in sample NQA1504 per client's request. This final report replaces the final report generated on 10/27/08 at 10:47am.*

25.10 Policies on Client Requests for Amendments

25.10.1 Policy on Data Omissions or Reporting Limit Increases

Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise RLs and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely no possible impact on the interpretation of the analytical results and there is no possibility of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.10.2 Sample Reanalysis Policy

Because there is a certain level of uncertainty with any analytical measurement, a sample reanalysis may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. The data review SOPs address protocols for reanalysis.

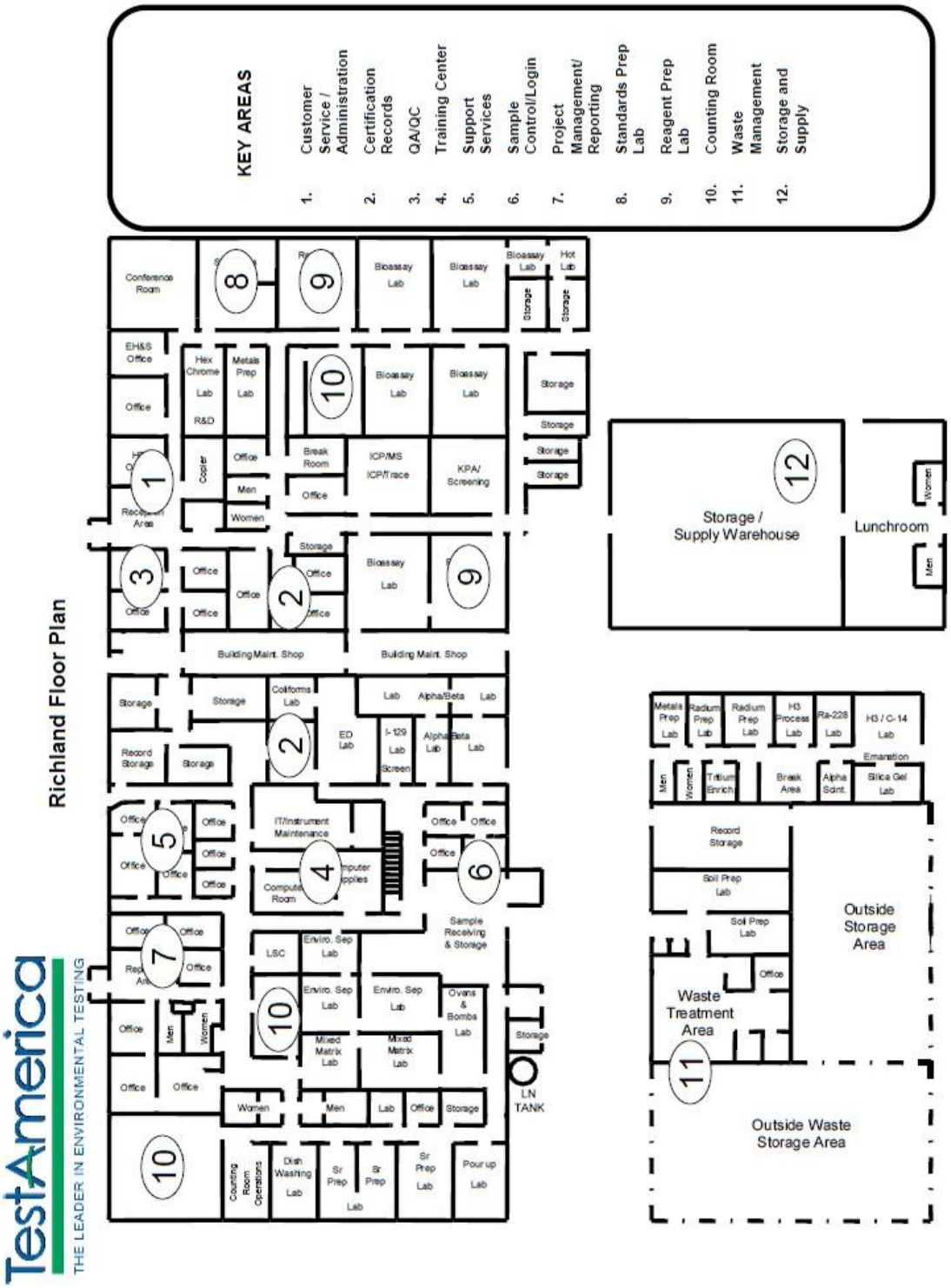
25.10.3 Client-Specific Periodic Reports

Certain clients may require reporting other than test reports, usually on a periodic basis for regulatory, QA, or other needs. Such reports are prepared according to client requirements in custom format.

25.10.4 Multiple Reports

TestAmerica does not issue multiple reports for the same work order where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1. Laboratory Floor Plan



Appendix 2. Glossary/Acronyms (EL-V1M2 Sec. 3.1)

Glossary:

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

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 which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent controls to meet the required level of quality.

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis. [TNI]

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation). [TNI]

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. [TNI]

Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples. [TNI]

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). [TNI]

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. [TNI]

1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve: The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. [TNI]

Calibration Standard: A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM): A reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute. [TNI]

Chain of Custody (COC) Form: Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses. [TNI]

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (COC and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. TNI and its representatives agree to safeguard identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to Second Column Confirmation; Alternate wavelength; Derivatization; Mass spectral interpretation; Alternative detectors or Additional Cleanup procedures. [TNI]

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction: Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis**.** No significant action is taken to change behavior, process or procedure.

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria).

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collation into a more useable form. [TNI]

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. [TNI]

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Equipment Blank: Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. [TNI]

External Standard Calibration: Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Field Blank: Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation. Note: some accrediting authorities use the term “Field of Testing”

Holding Time: The maximum time that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical test method. [TNI]

Internal Standard Calibration: Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is $\pm$ 100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps of the procedure unless otherwise noted in a reference method. It is

generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Least Squares Regression (1st Order Curve): The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit(s) of Detection (LOD) [a.k.a., Method Detection Limit (MDL)]: A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility. [TNI]

LOD Verification [a.k.a., MDL Verification]: A processed QC sample in the matrix of interest, spiked with the analyte at no more than 3X the LOD for single analyte tests and 4X the LOD for multiple analyte tests and processed through the entire analytical procedure.

Limit(s) of Quantitation (LOQ) [a.k.a., Reporting Limit]: The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. [TNI]

Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater, effluents, and TCLP or other extracts.

Drinking Water: Any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water 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 shall be grouped according to origin.

Solids: Includes soils, sediments, sludges, 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 & Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter, or other device. [TNI]

Matrix Spike (spiked sample or fortified sample): A sample prepared by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available, and then taken through all sample preparation and analytical steps of the procedure. Unless otherwise noted in a referenced method, Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A replicate matrix spike prepared and analyzed to obtain a measure of the precision of the recovery for each analyte.

Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. [TNI]

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

Non-conformance: An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Performance Audit: The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. [TNI]

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis. [TNI]

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. [TNI]

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. [TNI]

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within specified acceptance criteria. [TNI]

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type of quality needed and expected by the client. [TNI]

Quality Assurance [Project] Plan: A formal document describing the detailed QC procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control: The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality. [TNI]

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. [TNI]

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. [TNI]

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities. [TNI]

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. [TNI]

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material: Material or substance one or more properties of which are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. [TNI]

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or a given location. [TNI]

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. [TNI]

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. [TNI]

Spike: A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other QC purposes.

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organization procedures and policies. [TNI]

Standard Operating Procedure: A written document which details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. [TNI]

Storage Blank: A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for QC purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Manager: A member of the staff of an environmental laboratory who exercises actual day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. [TNI]

Trip Blank: A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty: A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

Acronyms:

CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DUP - Duplicate
EH&S – Environmental Health and Safety
EPA – Environmental Protection Agency
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
HPLC - High Performance Liquid Chromatography
ICP - Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP/MS – ICP/Mass Spectrometry
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
LOD – Limit of Detection
LOQ – Limit of Quantitation
MDL – Method Detection Limit
MDLCK – MDL Check Standard
MDLV – MDL Verification Check Standard
MRL – Method Reporting Limit Check Standard
MS – Matrix Spike
MSD – Matrix Spike Duplicate
MSDS - Material Safety Data Sheet
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
TNI – The NELAC Institute
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
RSO – Radiation Safety Officer
SD – Standard Deviation
SOP – Standard Operating Procedure
TAT – Turnaround Time
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3. Laboratory Certifications, Accreditations, Validations

TestAmerica Richland Laboratory maintains accreditations, certifications, and approvals with numerous state and national entities. Programs vary but may include on-site audits, performance testing evaluations, review of the QA Manual, SOPs, Method Detection Limits, training records, reciprocal agreements with another entity, etc. The certificates and parameter lists (which may differ) are available, upon request, from a laboratory representative and may be found on the corporate web site at www.testamericainc.com.

At the time of this QA Manual revision, the laboratory has accreditation, certification and/or licensing with the following organizations:

Authority	Program	Lab ID
Environmental Standards, Inc.	BP LaMP	TALR
L-A-B	DoD ELAP	L2291
Environmental Protection Agency	ERLN	TALR
AIHA	IHLAP	187436
USDA	USDA	P330-11-00043
Arizona	State Program	AZ0709
California	State Program	2425
Colorado	State Program	N/A
Florida	State Program	E87829
Hawaii	State Program	N/A
Nevada	State Program	WA00023
Oregon	NELAC	WA100002
Pennsylvania	State Program	68-04849
Tennessee	State Program	4011
Texas	NELAC	T104704493-10-1
Utah	State Program	QUAN8
Virginia	State Program	100
Washington	State Program	C1245
Washington	WA DOH	50D0661626
Washington	WA Rad Material License	WN-L0146-1

A current listing of accreditations with expiration dates and the ability to review certificates by state and capabilities is available online through the TotalAccess program. These can be viewed by selecting the Richland laboratory under locations on the top tab and then choosing analytical, select Richland.

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