Limited Phase II Environmental Site Assessment

Lathrop Wells Parcel -06
5240 East U.S. Highway 95
Amargosa Valley, NV 89020

-and-

Lathrop Wells Parcel -08
5700 East U.S. Highway 95
Amargosa Valley, NV 89020

Nye County
Assessor's Parcel Numbers
021-021-06 and 021-021-08

Prepared For:
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Task BC13-21
Category 54
Organizational Code 5420
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Project No. *018.17.001*

Report Date: *April 22, 2021*
Field Sampling Date: *November 19, 2020*

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Environmental Services

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STANDARD ABBREVIATIONS

ACM	Asbestos-Containing Material
AHERA	Asbestos Hazard Emergency Response Act
APN	Assessor's Parcel Number
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials
BER	Business Environmental Risk
bgs	Below Ground Surface
CEM	Certified Environmental Manager
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Chain of Custody
DI	Deionized
DQI	Data Quality Indicators
DQO	Data Quality Objective
DRO	Diesel Range Organics
EDD	Electronics Data Deliverable
EDR	Environmental Data Resources, Inc.
EPA	United States Environmental Protection Agency
ESA	Environmental Site Assessment
FAAS	Flame Atomic Absorption Spectrometry
HA	Homogenous Area
HASP	Health and Safety Plan
GRO	Gasoline Range Organics
HUD	United States Department of Housing and Urban Development
IDW	Investigation-Derived Waste
LBP	Lead-Based Paint
LCP	Lead-Containing Paint
LCS	Laboratory Control Samples
LOD	Level of Detection
MDL	Method Detection Limit
MQO	Measurements Quality Objective
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAC	Nevada Administrative Code
ND	Non-detect
NDEP	Nevada Division of Environmental Protection
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NIST	National Institute of Standards and Technology
NLLAP	National Lead Laboratory Accreditation Program
NRPP	National Radon Proficiency Program
NVLAP	National Voluntary Laboratory Accreditation Program
ORO	Oil Range Organics
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbon
Pb	Lead
PCB	Polychlorinated Biphenyl
PCS	Performance Characteristic Sheet
PLM	Polarized Light Microscopy
PPE	Personal Protective Equipment
PQL	Practical Quantitation Limit

QC	Quality Control
RC	Reportable Concentration
RDSBC	Rural Desert Southwest Brownfields Coalition
REC	Recognized Environmental Condition
RL	Reporting Limit
RPD	Relative Percentage Difference
RRP	Renovation, Repair, and Painting
SAP	Sampling and Analysis Plan
SIM	Selected Ion Monitoring
SOP	Standard Operating Procedure
SRM	Standard Reference Material
SS	Soil Sample
SVOC	Semivolatile Organic Compound
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
UST	Underground Storage Tank
VEC	Vapor Encroachment Condition
VISL	Vapor Intrusion Screening Level
VOC	Volatile Organic Compound
WRCC	Western Regional Climate Center
XRF	X-Ray Fluorescence

COMMON UNITS OF MEASURE

ft^2	Square feet
mg/cm^2	Milligrams per square centimeter
mg/ft^2	Milligrams per square foot
mg/in^2	Milligrams per square inch
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
ppm	Parts per million
pCi/L	Picocuries per liter
µg/kg	Micrograms per kilogram
µg/cm	Micrograms per centimeter
$µg/ft^2$	Micrograms per square foot
°F	Degrees Fahrenheit

EXECUTIVE SUMMARY

BEC Environmental, Inc. (BEC) prepared this Phase II Environmental Site Assessment (ESA) at the Lathrop Wells Parcels -06 and -08 (subject sites), located at 5240 East U.S. Highway 95 and 5700 East U.S. Highway 95, Amargosa Valley, Nevada 89020.

The property owner, Mr. Raman Sharma, requested assistance from the Nevada Brownfields Program (NBP) to perform assessment activities to facilitate redevelopment at the site. Activities conducted by the NBP are funded by the Environmental Protection Agency (EPA) through a Brownfields grant under Section 128(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

This Limited Phase II ESA was conducted to investigate suspected contamination of the site based on recognized environmental conditions (RECs) identified by BEC in the Phase I ESAs completed for each parcel under the Rural Desert Southwest Brownfields Coalition (RDSBC) assessment grant program. The Limited Phase II ESA was conducted in accordance with the following documents:

- American Society for Testing and Materials (ASTM) E1903-19: *Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process* (ASTM, 2019)
- *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* (2012 Edition) (HUD, 2012)
- *Sampling and Analysis Plan: Phase II Limited Environmental Site Assessment: Lathrop Wells Parcels -06 & -08* (BEC, 2019)

The Lathrop Wells Parcel -06 Phase I ESA (BEC, 2019), completed on November 27, 2019, identified the following Recognized Environmental Conditions (RECs):

- *Amargosa Valley Saloon, Facility ID: 7-000163, was located at Death Valley Junction, Highway 95 and Highway 373, Lathrop Wells, Nevada, adjacent west of the subject site. A release of petroleum hydrocarbons to soil was reported to the Nevada Division of Environmental Protection (NDEP) on March 24, 1999. NOW Construction Corporation discovered the release during the removal of two 10,000-gallon gasoline underground storage tanks (USTs), two 8,000-gallon gasoline USTs, and one 10,000-gallon diesel UST. In a follow up soil sampling event, thirteen soil borings were advanced to below 40 feet. Soil samples collected from boring location 1 at 25 feet below ground surface (bgs) and 30 feet bgs contained 4,200 mg/kg and 11,000 mg/kg diesel-range petroleum hydrocarbons (TPH-D), respectively. All other sample locations and depths were non-detect for total petroleum hydrocarbons (TPH). An "A through K" evaluation was performed in accordance with Nevada Administrative Code (NAC) 445A.227. Based on this evaluation, NDEP granted the site an A-K closure on August 18, 2000…Distance to irrigation or drinking water wells was considered not applicable in the Environmental Risk Site Evaluation (a-k) for this release. However, a well was observed on the subject site, which was located immediately adjacent-west of this release, during site reconnaissance. Based on a review of well logs, the domestic well on the Lathrop Wells Parcel -06 appeared to be Nevada well #61596, also known as U.S. Geological Survey (USGS) well # 363836116234001, which was installed in January 1964. Based on the proximity of this release to the subject site and the presence of a well on the subject site, this was considered a REC for the subject site at the time of this report.*
- *In addition, BEC considered the potential for the freestanding billboards observed on the subject site during the site reconnaissance to contain lead-based paint to be a business environmental risk (BER).*

The Lathrop Wells Parcel -08 Phase I ESA (BEC, 2019), completed on November 27, 2019, identified the following Business Environmental Risk (BER):

- *The potential exists for the billboard observed on the subject site during the site reconnaissance to contain lead-based paint. BEC considered the potential presence of LBP to be a business environmental risk (BER).*

Sample locations were planned based on the results of the September 29, 2019 Phase II Limited Site Investigation Sampling and Analysis Plan (SAP) prepared by BEC and approved by NDEP.

The groundwater sample location was at the pumphouse on the northeast portion of Lathrop Wells Parcel -06. Samples were collected and analyzed for volatile organic compounds (VOCs) and the Resource Conservation and Recovery Act (RCRA) suite of 8 metals (arsenic [As], barium [Ba], cadmium [Cd], chromium [Cr], lead [Pb], mercury [Hg], selenium [Se], silver [Ag]), plus copper (Cu), hereinafter referenced as "metals." Sample analytical data indicated VOCs were non-detect for the groundwater samples collected from the groundwater well onsite. No metals were present in excess of their individual National Primary and Secondary Drinking Water Regulations (NPDWR and NSDWR, respectively) maximum contaminant levels or NDEP screening levels in all groundwater samples collected from the well, except for arsenic. GW-01 and GW-02 had reported concentrations of 20 micrograms per liter (µg/L) and 21 µg/L, respectively, which is in excess of the NPDWR Maximum Contaminant Level of 10 µg/L. However, based on hydrologic data obtained for the region, arsenic levels reported in groundwater samples were consistent with background levels. Therefore, additional investigation does not appear to be warranted based on the analytical results.

Sampling and analysis activities included analysis for LBP on three billboards (two on one parcel) by paint chip sample collection by an EPA-Certified Lead Risk Assessor. A total of five surface coating chip samples were collected from the billboards. Of these, none contained a measurable concentration of lead above the detection limit. Therefore, additional investigation of the surface coatings does not appear to be warranted.

1 INTRODUCTION

BEC Environmental, Inc. (BEC) prepared this Limited Phase II Environmental Site Assessment (ESA) at the Lathrop Wells Parcels -06 and -08 (subject sites). The property owner, Mr. Raman Sharma, requested assistance from the Nevada Brownfields Program (NBP) to perform assessment activities to facilitate redevelopment at the site. Activities conducted by the NBP are funded by the Environmental Protection Agency (EPA) through a Brownfields grant under Section 128(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

This Limited Phase II ESA was conducted to investigate suspected contamination of the site based on recognized environmental conditions (RECs) and Business Environmental Risks (BERs) identified by BEC in the Phase I ESAs completed for Lathrop Wells Parcel -06 (BEC, 2019) and Lathrop Wells Parcel -08 (BEC, 2019) under the RDSBC program. See **Table 1-1** for location and parcel information. The approximate location of the subject sites are shown in **Appendix A**, **Figure 1 – Vicinity Map**. Photographs of sampling locations are included in **Appendix B**, **Site Photos**.

Table 1-1: Subject Sites Property Overview

Nye County APN	Address	Parcel Size	Improvements
021-021-06	5240 East U.S. Highway 95 Amargosa Valley, Nevada 89020	2.93 acres	Well pumphouse, abandoned cinderblock building, a water system, two septic systems, two freestanding billboards, two unimproved roads
021-021-08	5700 East U. S. Highway 95 Amargosa Valley, Nevada 89020	0.75 acres	One freestanding billboard

At the time of this report, both subject sites were vacant and unused. However, the Alamo Fireworks megastore and Fastrip Gas Station were located adjacent east of APN 021-021-06.

1.1 Scope of Services

The Phase II Limited Site Investigation was conducted in general accordance with ASTM E 1903-19: *Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process* and the EPA and NDEP approved Sampling and Analysis Plan (SAP) (**Appendix C**). The ASTM Standard established the industry-accepted approach and process for the execution and development of a Limited Phase II ESA.

The scope and services for this Limited Phase II ESA included:

- Review of background information; specifically, existing technical reports
- Implementing site sampling and field procedures
- Evaluation of field and analytical information
- Interpretation and reporting of results and recommendations

Prior to conducting Phase II ESA activities, BEC prepared a SAP to outline the project objectives, data quality objectives, and appropriate scope of work to satisfy those objectives (BEC, 2019). BEC conducted groundwater and paint chip investigations to screen the subject site for the presence and extent of contamination associated with historical use[s] of the property. The results of the Limited Phase II ESA are presented in this report.

1.2 Limitations and Expectations of Assessments

The environmental services described in this report have been conducted in general accordance with current regulatory guidelines and the standard of care exercised by environmental consultants performing similar work in the State of Nevada. This study was not intended to be a definitive investigation of the nature and extent of contamination at the subject site. Recommendations provided are not necessarily inclusive of all possible conditions. The assessment did not include a survey for wetlands, endangered species, or naturally occurring radioactive materials. No other warranty, express or implied, is made regarding the professional opinions in this report. This document is intended to be used in its entirety. No portion of this document, by itself, is designed to completely represent any aspect of the project described herein. Nevada Division of Environmental Protection (NDEP) or BEC should be contacted if the reader requires any additional information or has questions regarding the content, interpretations presented, or completeness of this document.

The conclusions presented in this report are professional opinions based solely upon reported data described in this report. BEC does not assume any liability for information that has been misrepresented to us by others, or for items not visible, accessible, or present on the subject site during the time of the investigation. The conclusions and recommendations are intended exclusively for the purpose outlined herein and for the site location and project indicated. This Limited Phase II ESA was prepared for use by NDEP. This report shall not be relied upon by or transferred to any additional parties, or used for any other purpose, without the express written authorization of NDEP.

1.3 Limiting Conditions and Methodologies Used

The findings, opinions, and conclusions contained herein are based on analytical results from groundwater and paint chip samples collected at the subject site. The conditions of the subject site can change with time as a result of natural processes or human activities at or in the vicinity of the subject site. Additionally, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or increased understanding of impacts to human health and the environment. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which NDEP nor BEC has any control. Neither NDEP nor BEC can warrant or guarantee that not finding indicators of any particular hazardous material means this particular hazardous material or any other hazardous materials do not exist on the subject site. Additional research, including invasive testing, can reduce the uncertainty. No techniques now commonly employed can eliminate the uncertainty altogether.

2 PHASE II SITE INVESTIGATION ACTIVITIES

Phase II sample collection was conducted by BEC on November 19, 2020. Samples were collected from groundwater and paint, and subsequently analyzed for VOCs, metals, and lead content. This section outlines the sampling activities and laboratory analysis results.

2.1 Scope of Assessment

Areas of investigation were based on information gathered during the Phase I ESAs and SAP development. The Lathrop Wells Parcel -06 Phase I ESA, completed on November 27, 2019, identified the following Recognized Environmental Conditions (RECs):

- *Amargosa Valley Saloon, Facility ID: 7-000163, was located at Death Valley Junction, Highway 95 and Highway 373, Lathrop Wells, Nevada, adjacent west of the subject site. A release of petroleum hydrocarbons to soil was reported to the Nevada Division of Environmental Protection (NDEP) on March 24, 1999. NOW Construction Corporation discovered the release during the removal of two 10,000-gallon gasoline underground storage tanks (USTs), two 8,000-gallon gasoline USTs, and one 10,000-gallon diesel UST. In a follow up soil sampling event, thirteen*

soil borings were advanced to below 40 feet. Soil samples collected from boring location 1 at 25 feet below ground surface (bgs) and 30 feet bgs contained 4,200 mg/kg and 11,000 mg/kg diesel-range petroleum hydrocarbons (TPH-D), respectively. All other sample locations and depths were non-detect for total petroleum hydrocarbons (TPH). An "A through K" evaluation was performed in accordance with Nevada Administrative Code (NAC) 445A.227. Based on this evaluation, NDEP granted the site an A-K closure on August 18, 2000…Distance to irrigation or drinking water wells was considered not applicable in the Environmental Risk Site Evaluation (a-k) for this release. However, a well was observed on the subject site, which was located immediately adjacent-west of this release, during site reconnaissance. Based on a review of well logs, the domestic well on the Lathrop Wells Parcel -06 appeared to be Nevada well #61596, also known as U.S. Geological Survey (USGS) well # 363836116234001, which was installed in January 1964. Based on the proximity of this release to the subject site and the presence of a well on the subject site, this was considered a REC for the subject site at the time of this report.

- *Lathrop Wells Parcel – 06 is located adjacent to a retail fireworks outlet that encourages customers to launch purchased fireworks on the premise. Due to the knowledge that local residents are known to use the subject site and the surrounding vicinity as a launching location and the geographic region is known to have high levels of arsenic in the groundwater, BEC will analyze groundwater samples for heavy metals.*
- *In addition, BEC considered the potential for the freestanding billboards observed on the subject site during the site reconnaissance to contain lead-based paint to be a business environmental risk (BER).*

The Lathrop Wells Parcel -08 Phase I ESA, completed on November 27, 2019, identified the following Business Environmental Risk (BER):

- *The potential exists for the billboard observed on the subject site during the site reconnaissance to contain lead-based paint. BEC considered the potential presence of LBP to be a business environmental risk (BER).*

Samples were collected from groundwater and paint. Groundwater sampling activities were conducted by Rachel Kistler (BEC). The lead inspection was conducted by Alana Holt-Hall (BEC), EPA-Certified Lead Risk Assessor (EPA License No. LBP-R-I212098-1).

2.2 Pre-field Activities

Prior to site assessment activities, a site-specific Health and Safety Plan was reviewed by all on-site BEC personnel. A walk-through of the site and structure(s) was conducted to identify potentially contaminated areas. The site-specific Health and Safety Plan is included in **Appendix D**.

2.3 Groundwater Sampling

Groundwater sampling areas were based on information obtained through the Phase I ESA and refined based on information obtained during the Phase II site investigation. Groundwater was collected from the domestic well on Parcel -06 via a stainless-steel pipe which drains water from the bladder filled by the well pump. Samples collected were analyzed for the following constituents of concern:

- VOCs using EPA Method 524.2
- Metals using EPA Methods 200.8 (As, Ba, Cd, Cr, Cu, Pb, Se, Ag) and 245.1(Hg)

Photographs of the sample location are included in **Appendix B**, **Site Photos** (Photos 11 through 12). Groundwater sample locations and detected results are represented in **Appendix A**, **Figure 2 – Sample Location Map: Lathrop Wells Parcel -06**.

2.4 Lead Paint Sampling

Paint chip sample collection was conducted on November 19, 2020, by Alana Holt-Hall, EPA Certified Lead Risk Assessor (LBP-R-I212098-1) in accordance with HUD Guidelines for Lead-Based Paint Inspections (HUD, 2012). Samples collected were analyzed for lead content by Flame Atomic Absorption Spectrometry (FAAS) by EPA Method 7000B. Photographs of the sample location are included in **Appendix B**, **Site Photos** (Photos 1 through 10). Paint chip sample locations are represented in **Appendix A**, **Figure 2 – Sample Location Map: Lathrop Wells Parcel -06** and **Appendix A**, **Figure 3 – Sample Location Map: Lathrop Wells Parcel -08**.

A total of five paint chip samples were collected on parcels -06 & -08. Three of the five paint chip samples were collected from Billboard #1 located on -06 parcel and one sample collected from Billboard #2 on -06 parcel. An additional paint chip sample was collected from Billboard #3 on parcel -08. The purpose of the investigation was to determine the existence of LBP hazards at the subject property and to determine the location, type, and magnitude of existing or potential health hazards associated with exposures to lead due to planned redevelopment site activities.

LBP is defined by US Housing and Urban Development (HUD) regulations under Title X (Residential Lead-Based Paint Hazard Reduction Act of 1992) as paint containing lead concentrations of 1.0 milligram per square centimeter (mg/cm^2) or greater when measured by a portable X-ray fluorescence (XRF) instrument or 0.5% by dry weight [5,000 ppm (parts per million) or 5,000 micrograms per gram (µg/g)] when measured by laboratory analysis. Although Title X defines LBP hazards for residential facilities, industry standards have adopted the regulation for use in defining LBP hazards in all structures.

EPA requires individuals and firms who perform LBP activities including assessment and abatement to be certified and follow specific work practices, as described in 40 CFR Part 745 Requirements for Lead-Based Paint Activities in Target Housing and Child-Occupied Facilities (EPA, 1996). Renovation, repair, and painting activities of LBP are regulated by the EPA under 40 CFR Part 745 Renovation, Repair, and Painting Program. The Renovation, Repair, and Painting Rule does not apply to office buildings, stores, or other commercial buildings unless the renovation is taking place in a child-occupied facility (EPA, 2018).

The Occupational Safety and Health Administration (OSHA) regulates work activities where an employee may be occupationally exposed to lead under 29 CFR 1926.62 (OSHA, 1993). Unlike the HUD and EPA regulations, OSHA has not established a lower threshold for lead in paint, because activities included in abatement, renovation, and demolition may entail exposures above the action levels even at extremely low concentrations of lead (OSHA, 2008). Assessment methodology is not outlined in 29 CFR 1926.62, thus, the LBP testing at this facility conformed with HUD guidelines 24 CFR 35 Section 35.930 Subpart R.

The scope of work for this project was to conduct an LBP inspection of painted surface coatings at the subject site to identify the presence and content level of lead for compliance with the OSHA and EPA regulatory requirements pertaining to worker protection and waste disposal.

This LBP inspection was performed prior to renovation activities at the site. The purpose for conducting the inspection was to determine the existence, location, and amount of LBP hazards associated with the free-standing billboards and to ensure all local, state, and federal regulations related to hazardous waste are complied with during future renovation of the subject site. BEC's scope of work for this project did not include preparation of abatement plans or renovation guidance.

2.5 Quality Assurance Review

2.5.1 Sample Receipt

The condition of samples upon receipt were evaluated initially by the laboratory and assessed by the data reviewer. There were no sample receipt issues associated with packaging, shipping time, or temperature control reported. Eurofins EMLab P&K reported all paint chip samples were received in acceptable condition.

2.5.2 Field Quality Control

2.5.2.1 Equipment Blanks

All water sampling equipment was dedicated. Therefore, an equipment rinsate blank was not required for this investigation. The reusable equipment used for collection of lead-based paint were knives and/or box cutters with retractable blades. However, the nature of lead-based paint is such that traditional equipment blanks are not sufficient for quality assurance purposes.

2.5.2.2 Field Blanks

One field blank was collected to evaluate whether contaminants were introduced into the samples during the sampling due to ambient conditions or from sample containers. The groundwater field blank samples were obtained by pouring Ultra Pure water into a sampling container at the sampling point. The field blank was preserved, packaged, and sealed in the same manner as the environmental samples. The field blank collected was submitted blind to the laboratory and subsequently analyzed for VOCs and metals.

The field blank sample, GW-03, was non-detect for all VOC analytes except methylene chloride, which had a value of 0.62 micrograms per liter (µg/L), significantly below the NDEP Reportable Concentration of 5.00 µg/L for methylene chloride. The field blank sample was non-detect for all metal analytes.

2.5.2.3 Temperature Blanks

One cooler, containing one 40-mL VOA vial marked as “temperature blank”, was shipped to the analytical laboratory.

2.5.2.4 Duplicate Samples

One duplicate groundwater sample was collected from the well and submitted to the laboratory for analysis. The duplicate sample was preserved, packaged, and sealed in the same manner as other samples of the same matrix. A separate sample number was assigned to the duplicate, recorded on the COC, and submitted blind to the laboratory.

Analytical results of the duplicate is discussed further in Section 2.7.1

2.5.3 Laboratory Quality Control

2.5.3.1 Holding Times

Holding time refers to the period of time between sample collection and the preparation and/or analysis of the sample. All laboratories stated the samples were received within the appropriate holding times from collection to receipt. Samples were also prepared and analyzed within the specified analysis holding time.

2.5.3.2 Method Blanks

Method blanks are laboratory quality control (QC) samples that are prepared and analyzed with each batch of applicable environmental samples. Method blanks were comprised of contaminant-free deionized water that is carried through all preparation procedures in batches with field samples (including the

addition of all reagents and QC monitoring compounds). Method blanks monitored potential contaminants in laboratory processes, reagents, and containers.

Weck Laboratories concluded all method blanks applied to sample analyses showed no analyte detected for VOCs and Metals. However, chromium had qualifier "B-07," meaning the analyte was found in the method blank at levels above the Method Detection Limit (MDL) but below the Method Reporting Limit of 0.20 µg/L.

Eurofins EMLab P&K did not apply method blanks to the analysis of lead paint chip samples.

2.5.3.3 Spike Samples

Spike samples are environmental matrices spiked with a subset of target compounds at known concentrations. These quality control samples were analyzed with project samples to measure laboratory accuracy and potential interference from the matrix. Two types of spike samples were analyzed with the project samples to monitor for potential interferences during analysis:

- Matrix spike (MS) and matrix spike duplicate (MSD) samples; these samples consist of aliquots of environmental samples spiked with a known quantity of target compounds. MS/MSD samples monitor potential interference from the site-specific sample matrix and its effect on target compounds.
- Blank spike samples, also known as laboratory control samples (LCS); these samples are an aliquot of reagent soil or water spiked with a known quantity of target compounds. The LCS monitors laboratory accuracy without the bias of a sample matrix. A laboratory control sample duplicate (LCSD) result was also reported.

MS/MSD and LCS results associated with each analysis are reported below. Data were qualified only if both the MS and MSD (or LCS) recovery were outside the QC limits. If either recovery in the pair was acceptable, the data were not qualified. Unless otherwise noted, all qualifications were sample qualifications.

2.5.3.3.1 Groundwater VOC Analysis

The laboratory report stated analyte recovery was within the acceptance criteria for all analytes. The relative percent difference (RPD) for the MS and MSD was within accepted laboratory limits. The laboratory report stated the LCS validated the analytical batch.

2.5.3.3.2 Groundwater Metals Analysis

The laboratory report stated analyte recovery was within the acceptance criteria for all analytes. The RPD for the MS and MSD was within accepted laboratory limits. The laboratory report stated the LCS validated the analytical batch.

2.5.3.3.3 Lead Analysis

The relative percent difference of the matrix duplicate pair was above control limits. The laboratory control sample and matrix blank were both within control limits and validated the batch.

2.5.3.4 Quantitation Less than the Practical Quantitation Limit for Stable Chemistries

The laboratory evaluated the method reporting limit (MRL) for each sample result. Each data point was assessed as nonqualified or qualified based upon the acceptance criteria. Data may be qualified as "estimated". Estimated data often result from data falling between laboratory MDL and MRL or a result exceeding a calibration range. These results would be used as positive detection at the reported concentration, with the understanding that the result is estimated. Some data may be qualified as "rejected" (R-qualified) if critical QC parameters are not met; these data are unusable for any purpose.

Sample re-analysis, for data not meeting Measurement Quality Objectives, would be considered as a possible corrective action.

No samples were reported as R-qualified during laboratory analysis. No samples were reported as estimated during laboratory analysis. One method blank was reported as estimated (B-07) because methylene chloride was found in the method blank at levels above the MDL but below the reporting limit.

2.5.3.5 Other Qualifications

In instances where the target analyte was not detected in the sample, the analyte was reported as non-detect, which is qualified as less than the concentration of the method reporting limit.

2.6 Analytical Testing

The groundwater samples were shipped under Chain of Custody (COC) protocol to Weck Laboratories for analysis. The groundwater samples were analyzed for VOCs using EPA method 524.2, and metals using EPA methods 200.8 (Ag, As, Ba, Cd, Cr, Cu, Pb, Se) and 245.1 (Hg). COCs and laboratory report documentation for the samples are provided in **Appendix E**.

The paint chip samples were delivered under Chain of Custody (COC) protocol to Eurofins EMLab P&K for analysis. The paint chip samples were analyzed for lead content using EPA method 7000B. COCs and laboratory report documentation for the samples are provided in **Appendix E**.

2.7 Analytical Results

The analytical results for chemicals of concern listed in the SAP are summarized in the following sections.

The laboratory data packages are provided in **Appendix E.**

2.7.1 Groundwater Samples

In accordance with NDEP guidance, analytical results for groundwater samples were compared to the EPA National Primary and Secondary Drinking Water Regulation (NPDWR/NSDWR) Maximum Contaminant Levels (MCLs) which are provided in **Appendix F, Regulatory Guidelines**. Sample results displayed in bold text in **Table 2-2** indicate results at or above the NPDWR MCLs. Please note, the groundwater results included in **Appendix E** show results for an anomalous radiological analysis for GW-01, which was not requested. Analytical results indicated the sample had a radiological concentration of 0.36 picocuries per liter (pCi/L), a result significantly below EPA's Radionuclide Rule for Community Water Systems (5 pCi/L).

Table 2-1: Groundwater – Volatile Organic Compounds

Analyte	Chemical Abstracts Service (CAS) Registry #	NPDWR MCLs (µg/L)	Sample ID (µg/L)		
			GW-01	GW-02 *(Duplicate of GW-01)*	GW-03 *(Field Blank)*
1,2,4-Trimethylbenzene	95-63-6	N/A	ND<0.50	ND<0.50	ND<0.50
1,2-Dichloroethane	107-06-2	5.0	ND<0.50	ND<0.50	ND<0.50

Analyte	Chemical Abstracts Service (CAS) Registry #	NPDWR MCLs (µg/L)	Sample ID (µg/L)		
			GW-01	GW-02 *(Duplicate of GW-01)*	GW-03 *(Field Blank)*
1,3,5-Trimethylbenzene	108-67-8	N/A	ND<0.50	ND<0.50	ND<0.50
Benzene	71-43-2	5.0	ND<0.50	ND<0.50	ND<0.50
Ethylbenzene	100-41-4	700	ND<0.50	ND<0.50	ND<0.50
Methyl t-butyl ether (MTBE)	1634-04-4	20	ND<2.0	ND<2.0	ND<2.0
Styrene	100-42-5	100	ND<0.50	ND<0.50	ND<0.50
Toluene	108-88-3	1,000	ND<0.50	ND<0.50	ND<0.50
Xylenes (total)	1330-20-7	10,000	ND<0.50	ND<0.50	ND<0.50

[1]Based on NDEP Draft Guidelines for Discovery Events (Ground Water RCs) **Appendix F**– Reportable Concentration in Groundwater Standards (Included in **Appendix F**.)

Table 2-2: Groundwater – Metals

Analyte	Chemical Abstracts Service (CAS) Registry #	NPDWR MCLs (µg/L)	Sample ID (µg/L)		
			GW-01	GW-02 *(Duplicate of GW-01)*	GW-03 *(Field Blank)*
Arsenic	7440-38-2	10.0	**20**	**21**	ND<0.40
Barium	7440-39-3	2,000.0	ND<1.0	ND<1.0	ND<1.0
Cadmium	7440-43-9	5.0	ND<0.20	ND<0.20	ND<0.20
Chromium	7440-47-3	100.0[1]	4.3	5.2	ND<0.20
Copper	7440-50-8	1,300.0	ND<0.50	0.58	ND<0.50
Lead	7439-92-1	150.0	ND<0.20	ND<0.20	ND<0.20
Mercury	7439-97-6	2.0	ND<0.050	ND<0.050	ND<0.050

Analyte	Chemical Abstracts Service (CAS) Registry #	NPDWR MCLs (µg/L)	Sample ID (µg/L)		
			GW-01	GW-02 *(Duplicate of GW-01)*	GW-03 *(Field Blank)*
Selenium	7782-49-2	50.0	0.77	0.73	ND<0.40
Silver	7440-22-4	100.0[2]	ND<0.20	ND<0.20	ND<0.20

[1]Based on NDEP Draft Guidelines for Discovery Events (Ground Water RCs) **Appendix F** – Reportable Concentration in Groundwater Standards (Included in **Appendix F**.)
[2]Based on National Secondary Drinking Water Regulations MCLs (Included in **Appendix F**.)

2.7.2 Paint Chip Results

A total of five paint chip samples were collected for lead analysis by Eurofins EMLab P&K. A summary of the location of the samples collected, the sample name and area, and lead content of samples are summarized in **Table 2-3: Paint Chip Sample Results**. Samples reported to contain greater than the EPA Threshold of 5,000 ppm are indicated in bold. Laboratory results for paint chip samples are available in **Appendix E**.

Table 2-3: Paint Chip Sample Results

Sample ID	Sample Location	Component	Area (in²)	EPA Threshold (ppm)	Lead (ppm)
Pb-06-01-1	Billboard #1 NE pole, 4ft 8" from ground	metal	4	5,000	ND<46
Pb-06-01-2	Billboard #1 E pole, 4ft 4" from ground	metal	4	5,000	ND<83
Pb-06-01-3	Billboard #1 NE pole, 4ft 6" from ground	metal	4	5,000	ND<36
Pb-06-02-1	Billboard #2 E frame, 5ft from ground	metal	4	5,000	ND<130
Pb-08-01-1	Billboard #1 E pole, 3ft 3" from ground	metal	4	5,000	ND<37

2.8 Deviation from the Approved Sampling and Analysis Plan

Phase II activities were conducted in general accordance with the EPA Region 9 and NDEP approved SAP. Deviations from the SAP are discussed below.

- The SAP indicated well purging would be completed by the field sampling crew prior to sampling. In the interest of time, the site owner offered to begin purging the well prior to the field crew's arrival. The purge flow rate was calculated on site, and based on the time the well pump had been turned on, the field crew was able to determine over one full casing volume had been purged, as written in the SAP.

3 DISCUSSION OF FINDINGS

The following sections summarize the findings of the Phase II sampling activities, and the conclusions made by BEC according to those findings.

3.1 Groundwater

Laboratory results of the sampling event indicate VOCs associated with petroleum releases, represented in **Table 2-1: Groundwater – Volatile Organic Compounds**, were not present in excess of their individual NPDWR/NSDWR MCLs in all groundwater samples collected from the well. Although GW-03, the field blank sample, had a concentration reported for methylene chloride, the samples from the well were non-detect and the detected concentration was significantly below the NDEP Reportable Concentration.

Laboratory results of the sampling event indicate heavy metals, represented in **Table 2-2: Groundwater – Metals**, were not present in excess of their individual NPDWR/NSDWR MCLs in any groundwater samples collected from the well, with the exception of arsenic. Both samples collected from the well were above the NPDWR/NSDWR MCLs of 10 µg/L. Arsenic ranged from 20 µg/L to 21 µg/L in both samples collected from the well onsite. According to the United States Geologic Survey (USGS) report entitled, *Water quality in basin-fill aquifers of the southwestern United States: Arizona, California, Colorado, Nevada, New Mexico, and Utah, 1993-2009*, the Basin and Range basin-fill aquifers of Nevada are known to contain concentrations of arsenic equal to or greater than the MCL (USGS, 2014). The report states, "During 1980–2009, USGS studies in the Southwest were conducted to measure arsenic in a total of 4,162 wells that tap basin-fill aquifers. About 19 percent of arsenic concentrations in these wells were greater than the MCL of 10 µg/L, consistent with data from this study." A supplemental data set from the USGS and data.gov showed a measured arsenic concentration of 25 µg/l in a well in Amargosa Valley, recorded in September 1993 (USGS, 2020). Therefore, the elevated arsenic levels in groundwater samples for this sampling event appear to be consistent with background levels.

3.2 Lead-Based Paint

The Nevada Division of Industrial Relations and the EPA define lead-based paint as paint containing 1.0 mg/cm^2 lead or 0.5 percent by weight or 5,000 ppm. OSHA defines lead containing materials as any materials which contain lead, with no minimum concentrations required.

A total of five paint chip samples were collected from portions of the billboard poles. Of these, no samples contained greater than 1.0 mg/cm^2 lead or 5,000 ppm. Further, lead was not detected above the method reporting limit in any sample. Laboratory results are summarized in **Table 2-3: Paint Chip Sample Results**.

This evaluation was completed in accordance with Lead Safe Housing Rule 24 CFR Part 35 subpart R as amended (2004).

4 REGULATORY REPORTING

Based on the referenced mineralogical maps, reports, and data from the USGS, arsenic is known to have higher background concentrations in groundwater in this geographic location. The NDEP guidelines state that arsenic detected at background levels are not reportable even if they are above the RC. As the analytical concentrations are largely within the acceptable background range, no further investigation for arsenic in groundwater is recommended.

There were no regulatory threshold exceedances for the lead paint analysis performed as a part of this sampling event.

5 RECOMMENDATIONS

5.1 Groundwater

Further groundwater investigation does not appear to be warranted based on the analytical data collected during this investigation. Arsenic removal methods or systems, including anion exchange, reverse osmosis, activated alumina, or other types of adsorptive media filters, should be considered prior to using the groundwater well for drinking water (The University of Arizona College of Agriculture and Life Sciences, 2020). Regularly scheduled domestic drinking water panels are also recommended.

5.2 Lead Paint

Sampling and analysis activities included analysis for LBP on three billboards (two on one parcel) by paint chip sample collection by an EPA-Certified Lead Risk Assessor. A total of five surface coating chip samples were collected from the billboards. Of these, none contained a measurable concentration of lead above the detection limit. Therefore, additional investigation of the lead surface coatings does not appear to be warranted.

6 CLOSING & CERTIFICATIONS

BEC has conducted this Phase II ESA in general accordance with ASTM E1903-19 *Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process* and the EPA and NDEP approved Sampling and Analysis Plan at the property known as the Lathrop Wells Parcels -06 and -08 site, located at 5240 and 5700 East U.S. Highway 95, in Nye County, Nevada (APNs 021-021-06 and 21-021-08), in general conformance with the scope and limitations of ASTM E 1903-11 and the following objectives:

- To assess potential contamination associated with groundwater contamination due to a release of petroleum hydrocarbons to soil approximately 0.05 miles southwest of the subject site on March 24, 1999, potential heavy metal groundwater contamination associated with firework launches from subject site, and lead-based paint due to the unknown installation date of the billboards on either parcel. Note that heavy metal groundwater contamination was also analyzed for metals because geological sources known to release arsenic are present in the area.

The BEC Team members responsible for the development of this report are listed below and their qualifications are provided herein (**Appendix G –Certifications**). Should you have any questions or concerns, please contact Rachel Schlick at (702) 304-9830.

Alana Holt-Hall _____ 4/22/2021

Alana Holt-Hall, Preparer — Date
Environmental Scientist
BEC Environmental, Inc.

All lead inspectors utilized by BEC Environmental, Inc. have EPA licensure, and are licensed lead risk assessors who have completed and passed the HUD Lead-based Paint Visual Assessment Training Course.

"The Federal Residential Lead-based Paint Hazard Reduction Act," 42 USC 4852d, requires sellers and landlords of most residential housing built before 1978 to disclose all available records and reports concerning lead-based paint and/or lead-based paint hazards, including the test results contained in this notice, to purchasers and tenants at the time of sale or lease upon lease renewal. This disclosure must occur even if hazard reduction or abatement has been completed. Failure to disclose these test results is a violation of the US Department of Housing and Urban Development and the US Environmental Protection Agency regulations at 24 CFR Part 35 and 40 CFR Part 745, and can result in fines for each violation. To find out more information about your obligations under federal lead-based paint requirements, call 1-800-424-LEAD or go to the web to www.epa.gov/lead.

By acceptance of this report, the receiver agrees BEC Environmental, Inc. (and by extent the risk assessor, agents and or contractor's liability) is limited to the field sampling date only identified on the front of this report. The information contained in this report is a true and accurate representation of the lead-based paint conditions at the subject property at the time of the investigation, based on the professional judgment of the person(s) who conducted and reported this lead-based paint inspection:

Alana Holt-Hall _____ 4/22/2021

Alana Holt-Hall — Date
Lead Risk Assessor LBP-R-I212098-1, exp. August 05, 2023
BEC Environmental, Inc.

Rachel Schlick
Rachel Schlick, Reviewer
Environmental Scientist
Lead Risk Assessor LBP-R-I19026-1, exp. May 18, 2022
BEC Environmental, Inc.

April 22, 2021
Date

I, Rachel Schlick, hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state, and local statutes, regulations, and ordinances.

Rachel Schlick
Rachel O. Schlick, CEM
Certified Environmental Manager, No. 2447
Expires: October 18, 2021

April 22, 2021
Date

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APPENDIX A

Figures

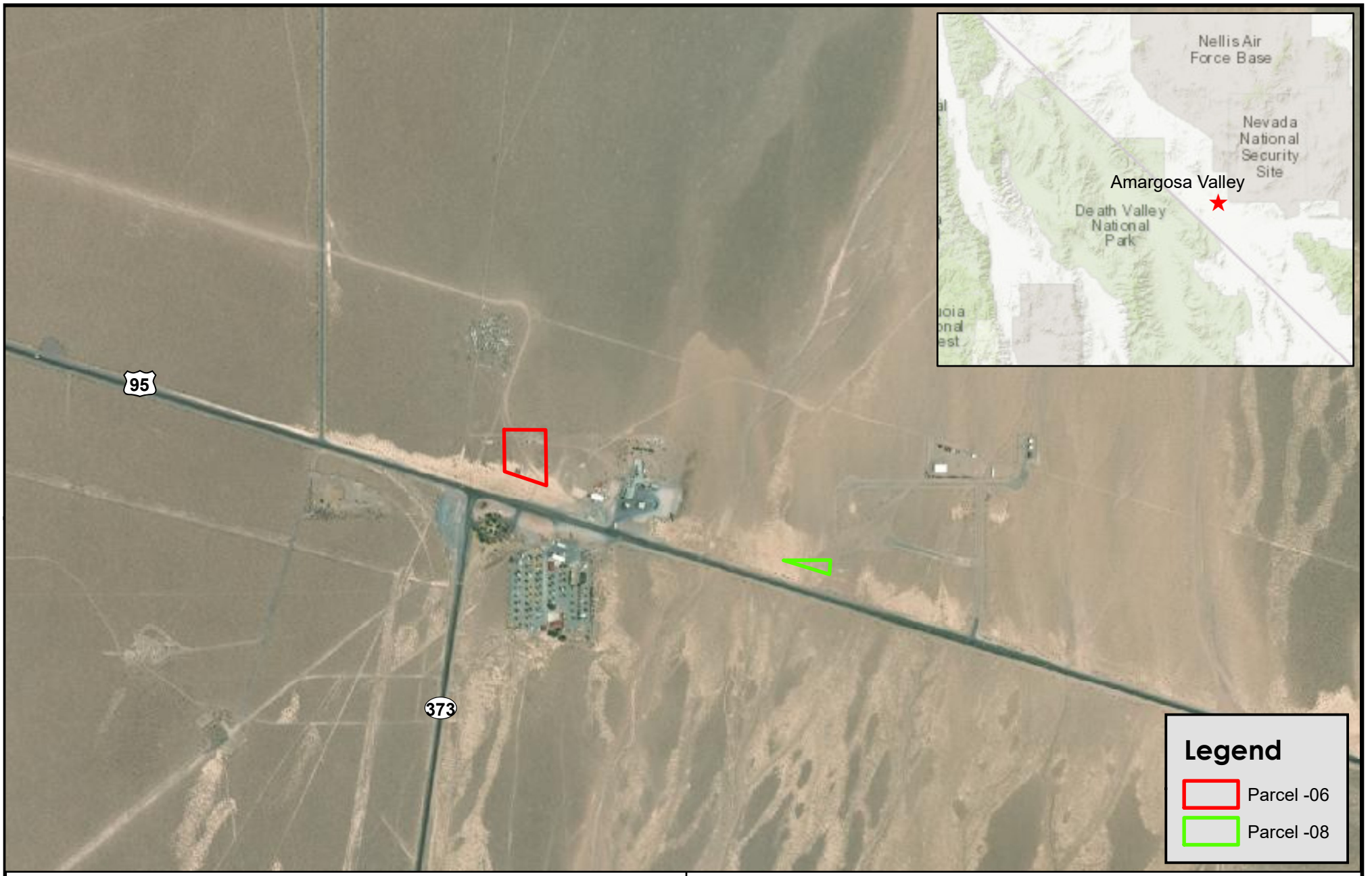

Figure 1 - Vicinity Map

Lathrop Wells Parcels -06 & -08
5240 East U.S. Highway 95
Amargosa Valley, Nevada 89020

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Environmental Services

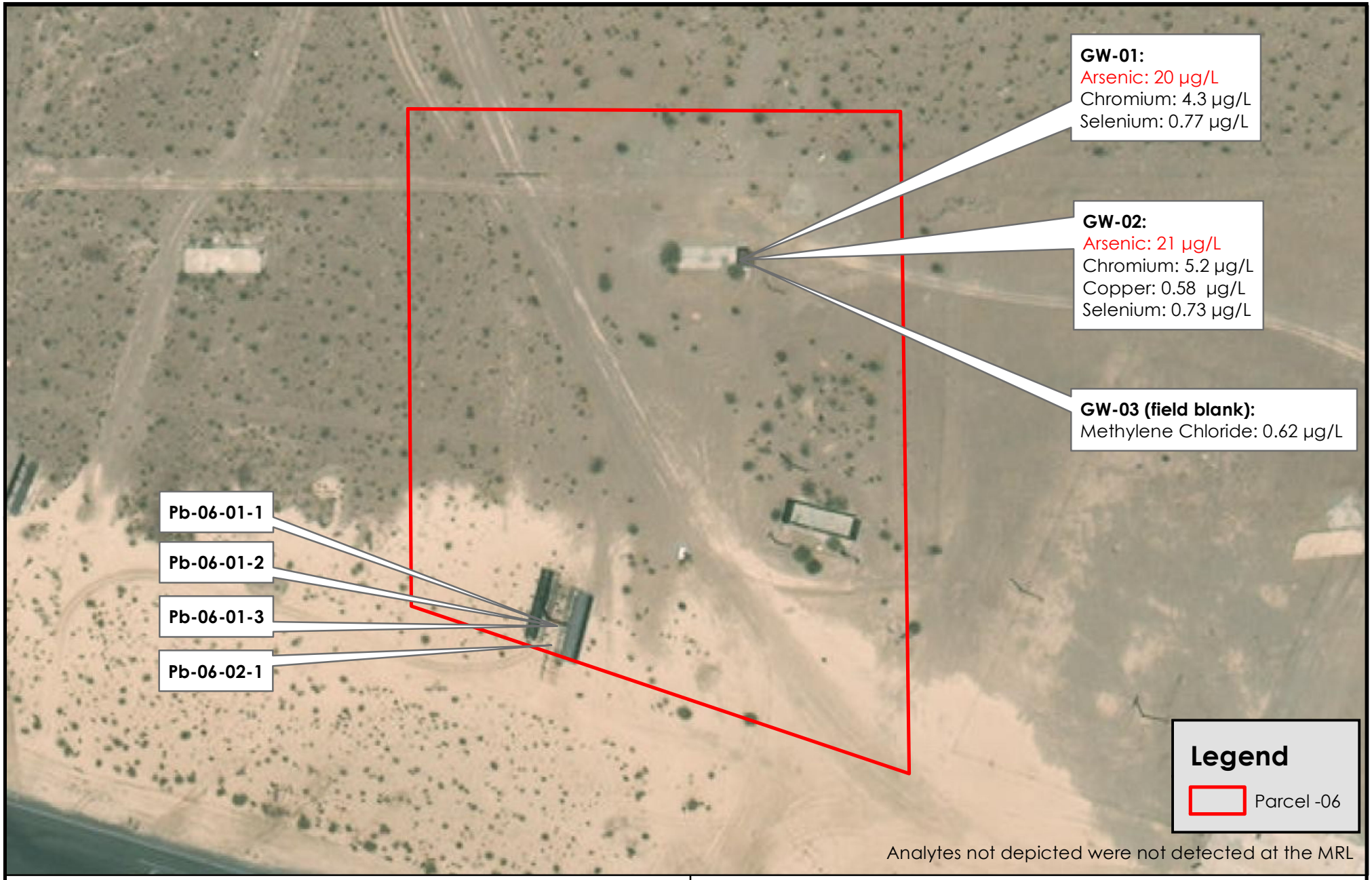


Figure 2 - Sample Location Map

Lathrop Wells Parcel -06
5240 East U.S. Highway 95
Amargosa Valley, Nevada 89020

0 100 200 400
Feet

N

bec environmental, inc.
Environmental Services

Figure 3 - Sample Location Map

Lathrop Wells Parcel -08
5700 East U.S. Highway 95
Amargosa Valley, Nevada 89020

bec environmental, inc.
Environmental Services

APPENDIX B

Site Photos

Photo 1

Billboard #1 pole located on parcel -06.

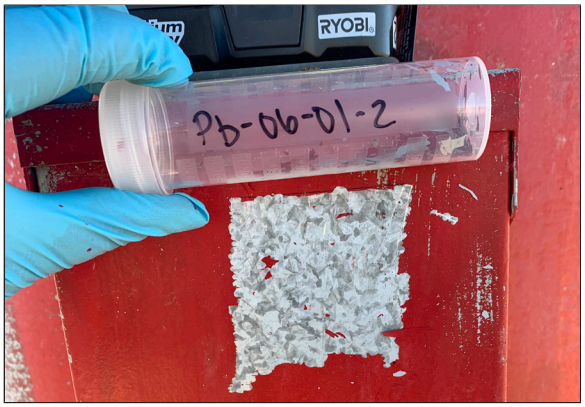
Photo 2

Sample Pb-06-01-1 located on billboard #1 pole.

Photo 3

Sample Pb-06-01-2 location on billboard #1 pole.

Photo 4

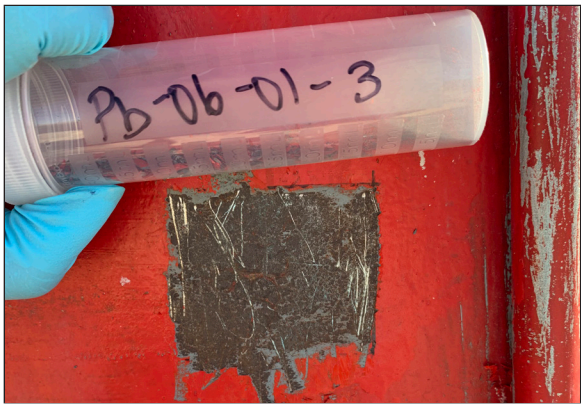


Sample Pb-06-01-2 located on billboard #1 pole.

Photo 5

Sample Pb-06-01-3 location on billboard #1 pole.

Photo 6

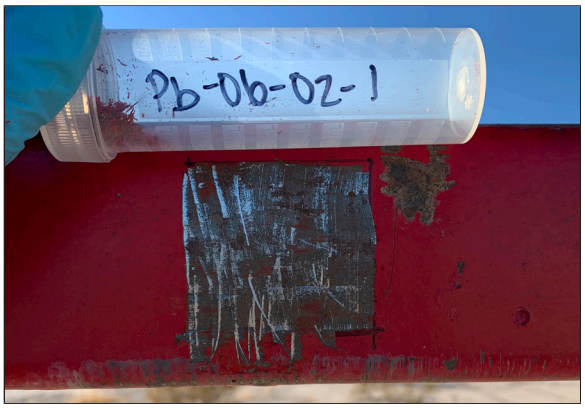


Sample Pb-06-01-3 located on billboard #1 pole.

Photo 7

Billboard #2 located on parcel -06.

Photo 8



Sample Pb-06-02-1 located on billboard #2 frame.

Photo 9

Billboard #3 located on parcel -08.

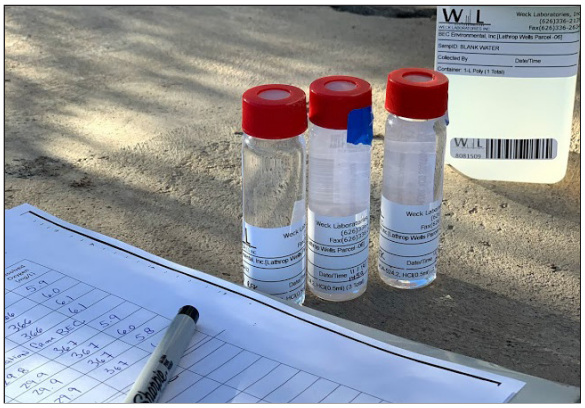
Photo 10

Sample Pb-08-01-1 located on billboard #3 pole.

Photo 11

Groundwater pipe from pump house where samples were collected.

Photo 12



Representative photo of 40-millileter vials used for groundwater sample collection.

APPENDIX C

Sampling and Analysis Plan

SAMPLING AND ANALYSIS PLAN

Phase II Limited Environmental Site Assessment

Lathrop Wells Parcel -06
5240 East U.S. Highway 95
Amargosa Valley, NV 89020

-and-

Lathrop Wells Parcel -08
5700 East U.S. Highway 95
Amargosa Valley, NV 89020

Nye County
Assessor's Parcel Numbers
021-021-06 and 021-021-08

Prepared For:
Nevada Division of Environmental Protection
Brownfields Program
901 South Stewart Street, Suite 4001
Carson City, Nevada 89701
Task BC13-21
Category 54
Organizational Code 5420
Job Number 6681717

On Behalf Of:
Area 51 Development 3 LLC
10479 Winter Grass Dr.
Las Vegas, NV 89135

Prepared By:
BEC Environmental, Inc.
7241 West Sahara Avenue, Suite 120
Las Vegas, Nevada 89117
(702)304-9830
www.becnv.com

Project No. *018.17.001*

Date: *November 15, 2020*

bec environmental, inc.
Environmental Services

Approval Page

Sampling and Analysis Plan for:

Lathrop Wells Parcels -06 & -08
Phase II Limited Environmental Site Assessment
5240 & 5700 East U.S. Highway 95
Amargosa Valley, NV 89020

Approved by: _____ 9/28/2020
Rachel Schlick — Date
BEC Project Manager

Approved by: _____ 9/28/2020
Eileen Christensen — Date
BEC Principal
Quality Assurance Officer

Approved by: _____ 11/5/20
David Friedman — Date
Brownfields Program Coordinator
NDEP

Approved by: _____ for Michael Antoine 11/5/20
Michael Antoine — Date
Brownfields Program QA Officer
NDEP

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Las Vegas, Nevada 89117

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STANDARD ABBREVIATIONS

AIHA	American Industrial Hygiene Association
APN	Assessor's Parcel Number
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials
BER	Business Environmental Risk
bgs	Below Ground Surface
CEM	Certified Environmental Manager
CFR	Code of Federal Regulations
CREC	Controlled Recognized Environmental Condition
DQI	Data Quality Indicators
DQO	Data Quality Objective
DRO	Diesel Range Organics
EDD	Electronics Data Deliverable
ESA	Environmental Site Assessment
GPS	Global Positioning System
GRO	Gasoline Range Organics
HA	Homogenous Area
HASP	Health and Safety Plan
HPLC	High Performance Liquid Chromatography
IDW	Investigation-Derived Waste
LBP	Lead-based Paint
LCP	Lead-containing Paint
LUST	Leaking Underground Storage Tank
MDL	Method Detection Limit
MQO	Measurements Quality Objective
NAC	Nevada Administrative Code
NCP	National Contingency Plan
NDEP	Nevada Division of Environmental Protection
NESHAP	National Emissions Standard for Hazardous Air Pollutants
NLLAP	National Lead Laboratory Accreditation Program
NVLAP	National Voluntary Laboratory Accreditation Program
ORO	Oil Range Organics
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyl
PAH	Polycyclic Aromatic Hydrocarbon
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
PLM	Polarized Light Microscopy
PPE	Personal Protective Equipment
PQL	Practical Quantification Limits
QA	Quality Assurance
QC	Quality Control
RC	Reportable Concentration
RDSBC	Rural Desert Southwest Brownfields Coalition
REC	Recognized Environmental Condition
RPD	Relative Percent Different
SAP	Sampling and Analysis Plan
SD	Standard Deviation
SOP	Standard Operating Procedure
SVOC	Semivolatile Organic Compound
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
UST	Underground Storage Tank
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WRCC	Western Regional Climate Center
XRF	X-Ray Fluorescence

COMMON UNITS OF MEASURE

ft	Foot
ft^2	Square feet
mL	Milliliter
mg/cm^2	Milligrams per square centimeter
mg/in^2	Milligrams per square inch
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
pCi/L	Picocuries per liter
µg/kg	Micrograms per kilogram
µg/cm	Micrograms per centimeter
$µg/ft^2$	Micrograms per square foot
°F	Degrees Fahrenheit
°C	Degrees Celsius
%	Percent

1 INTRODUCTION

BEC Environmental, Inc. (BEC) prepared this Sampling and Analysis Plan (SAP) for Phase II Environmental Site Assessment activities at the Lathrop Wells Parcels -06 and -08 (subject sites), located at 5240 East U.S. Highway 95 and 5700 East U.S. Highway 95, Amargosa Valley, Nevada 89020.

The property owner, Mr. Raman Sharma, requested assistance from the Nevada Brownfields Program (NBP) to perform assessment activities to facilitate redevelopment at the site. Activities conducted by the NBP are funded by the Environmental Protection Agency (EPA) through a Brownfields grant under Section 128(a) of the Comprehensive Environmental Response, Cleanup, and Liability Act (CERCLA). This SAP was prepared in accordance with the *Quality Assurance Program Plan for the Nevada Brownfields Program* dated January 31, 2013 (NDEP, 2013), and the EPA Region 9 *Sampling and Analysis Plan Guidance and Template*, *Version 4, Brownfields Assessment Projects* dated August 2018 (EPA, 2018).

1.1 Site History

BEC was retained by Nye County on behalf of the Rural Desert Southwest Brownfields Coalition to perform Phase I Environmental Site Assessments (ESAs) for the subject sites, as requested by the property owner, Raman Sharma, in advance of property acquisition and redevelopment to satisfy all-appropriate-inquiry requirements during the due diligence period.

The Lathrop Wells Parcel -06 Phase I ESA, completed on November 27, 2019, identified the following Recognized Environmental Conditions (RECs):

- *Amargosa Valley Saloon, Facility ID: 7-000163, was located at Death Valley Junction, Highway 95 and Highway 373, Lathrop Wells, Nevada, adjacent west of the subject site. A release of petroleum hydrocarbons to soil was reported to the Nevada Division of Environmental Protection (NDEP) on March 24, 1999. NOW Construction Corporation discovered the release during the removal of two 10,000-gallon gasoline underground storage tanks (USTs), two 8,000-gallon gasoline USTs, and one 10,000-gallon diesel UST. In a follow up soil sampling event, thirteen soil borings were advanced to below 40 feet. Soil samples collected from boring location 1 at 25 feet below ground surface (bgs) and 30 feet bgs contained 4,200 mg/kg and 11,000 mg/kg diesel-range petroleum hydrocarbons (TPH-D), respectively. All other sample locations and depths were non-detect for total petroleum hydrocarbons (TPH). An "A through K" evaluation was performed in accordance with Nevada Administrative Code (NAC) 445A.227. Based on this evaluation, NDEP granted the site an A-K closure on August 18, 2000. However, one of the evaluation criteria was proximity to water wells, which was not applicable in the initial evaluation. However, a well was noted on the subject site during site reconnaissance. Based on the proximity of this release to the subject site and the presence of a well on the subject site, this Controlled REC (CREC) was considered a REC for the subject site at the time of this report.*
- *In addition, BEC considered the potential for lead-based paint (LBP) on the freestanding billboard observed on the subject site during site reconnaissance to be a business environmental risk (BER).*

The Lathrop Wells Parcel -08 Phase I ESA, completed on November 27, 2019, identified the following Business Environmental Risk (BER):

- *The potential exists for lead-based paint (LBP) associated with the billboard. BEC considers the potential presence of LBP to be a business environmental risk (BER).*

This Limited Phase II Environmental Site Assessment will include groundwater sampling in additional to LBP analysis. Sampling activities will begin in October 2020 and will take approximately one to three days, dependent on groundwater well flow rate. Date of the field sampling event is contingent upon the project scoping team's ability to review the SAP and local weather conditions.

1.2 Site Name

Lathrop Wells Parcels -06 and -08 will be hereinafter referenced as the subject sites.

1.3 Site Location

Lathrop Wells Parcel -06 is located at 5240 East U.S. Highway 95, Amargosa Valley, Nevada 89020, on a 2.93-acre parcel at Nye County Assessor's Parcel Number (APN) 021-021-06. According to the Assessor's improvement records, the -06 subject site includes a well pumphouse, an abandoned cinderblock building, a water system, and two septic systems. According to the Nye County Assessor's Office, the land use for the subject site is zoned as "Single Family Residential with Minor Improvements – No livable structures." Two unimproved roads were observed on the subject site during the Phase I site visit.

Lathrop Wells Parcel -08 is located at 5700 East U.S. Highway 95, Amargosa Valley, Nevada 89020, on a 0.75-acre parcel at Nye County Assessor's Parcel Number (APN) 021-021-08. According to the Assessor's improvement records, the -08 subject site has no improvement and is zoned as "Vacant." One freestanding billboard was observed on the subject site during site reconnaissance.

A Vicinity Map (**Attachment 1, Figure 1**) depicts the location of both parcels addressed for the purposes of this study.

1.4 Responsible Agency

This investigation will be conducted for Nye County under the RDSBC Brownfields Coalition Assessment Grant (Cooperative Agreement Number: BF 99T-61801). The work will be performed by BEC and their subcontractors. The investigation conforms to the requirements and guidelines of the EPA's Quality Assurance (QA) Project Plan (EPA, 2001) and the EPA Region 9 Sampling and Analysis Plan Guidance and Template, Version 4, Brownfields Assessment Projects (EPA, 2018).

1.5 Project Organization

Project organization is shown in **Table 1-1**.

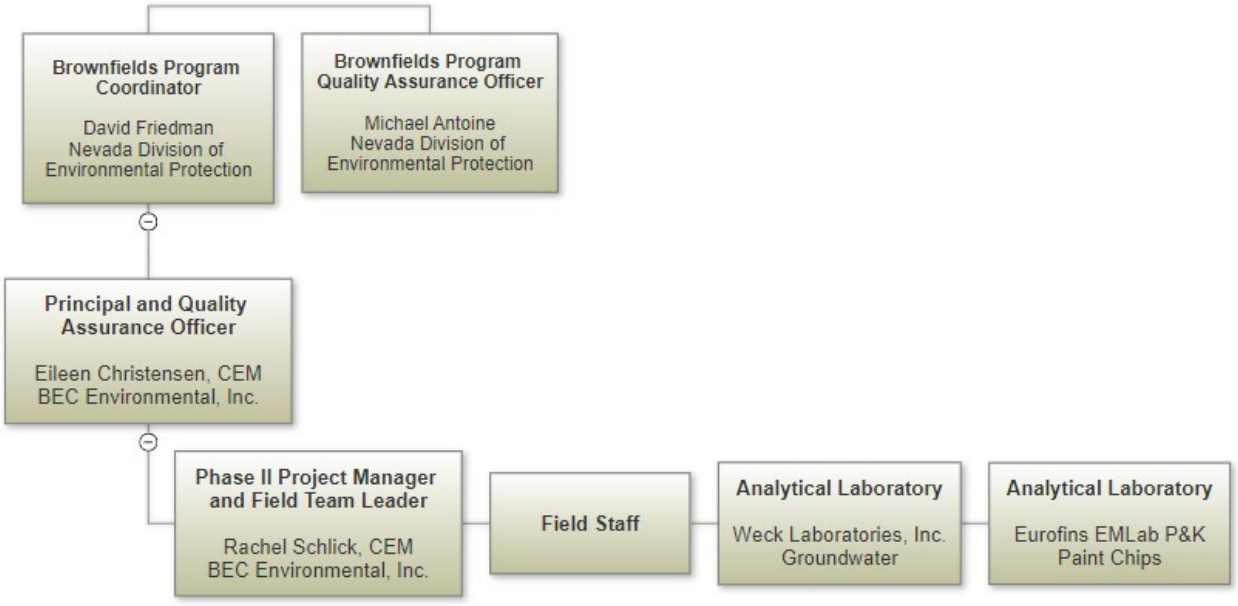
Table 1-1: Key Project Personnel Contact Information and Responsibilities

Title	Name	Phone Number Email Address	Responsibilities
NDEP			
Brownfields Program Coordinator	David Friedman	(775) 687-9572 DFriedman@ndep.nv.gov	Nevada Brownfields Program coordination
Brownfields Program Quality Assurance (QA) Officer	Michael Antoine	(775) 687-9490 MAntoine@ndep.nv.gov	NDEP QA review of the SAP and QA goals
Site Owner			
Site Owner	Raman Sharma	(678) 485-8469 SharmaRaman@att.net	Provide site access

Title	Name	Phone Number Email Address	Responsibilities
BEC Environmental, Inc.			
Project Quality Assurance Officer	Eileen Christensen	(702) 304-9830 Eileen@becnv.com	Oversight, QA/QC review, and data validation
Project Manager and Field Team Leader	Rachel Schlick	(702) 304-9830 RachelS@becnv.com	SAP planning and implementation, Project management, and data review
Project Support and Field Team Member	Rachel Kistler	(702) 304-9830 RachelK@becnv.com	Performance of field activities and report preparation
Project Support and Field Team Member	Alana Holt-Hall	(702) 304-9830 Alana@becnv.com	Performance of field activities and report preparation
Contractors/Vendors			
Eurofins EMLab P&K	Marcela Hodge	(623) 445-6111 MHodge@emlabpk.com	Lead-based paint analysis
Weck Laboratories, Inc.	Marilyn Romero	(626) 336-2139 Marilyn.Romero@wecklabs.com	Volatile Organic Compounds (VOCs) and Metals[1] analysis

[1]Metals – Resource Conservation and Recovery Act (RCRA) suite of 8 metals (arsenic, barium, cadmium, chromium, lead mercury, selenium, and silver), plus copper.

Organization Chart



1.6 Document Organization

Following the introduction, this document contains the following sections consistent with EPA guidance:

- Section 2 – Background
- Section 3 – Project and Data Quality Objectives
- Section 4 – Sampling Design and Rationale
- Section 5 – Request for Analysis
- Section 6 – Field Methods and Procedures
- Section 7 – Sample Containers, Preservation, Packaging, and Shipping
- Section 8 – Disposal of Residual Materials
- Section 9 – Sample Documentation
- Section 10 – Quality Control
- Section 11 – Field Variances
- Section 12 – Field Health and Safety Procedures

2 BACKGROUND

This section provides an overview of the location, previous investigations, and the apparent problem(s) associated with the site or sampling area.

2.1 Site Description

Lathrop Wells Parcel -06 and Parcel -08 occupy 2.93 acres and 0.75 acres, respectively, in a rural, largely undeveloped area. The regional location of the subject sites is shown in **Attachment 1, Figure 1 – Vicinity Map**.

Observations from the Lathrop Wells Parcel -06 Phase I ESA include a pumphouse with an 8-inch diameter groundwater well, a single-story cinderblock building without a roof, metal piping and electrical lines between the cinderblock building and the pump house, a pole mounted transformer with associated power lines, a seismograph station, light poles, an electrical box with a meter, two painted freestanding billboards with electrical boxes, and two unimproved roads.

Observations from the Lathrop Wells Parcel -08 Phase I ESA include a natural drainage channel and one painted, freestanding billboard.

2.2 Operational History

Presently, both subject sites are vacant and unused. Past activities at the subject sites were not determined during Phase I ESA process. The current adjoining property uses for both sites are summarized in **Table 2-1** below.

Table 2-1: Subject Sites Adjoining Property Overview

Direction	Parcel -06 Descriptions	Parcel -08 Descriptions
North:	Undeveloped land	Undeveloped land
East:	Undeveloped land, Alamo Fireworks Megastore, Fastrip Fuel Gas Station	East Science Court, North Busted Butte Street, East Technology Court
South:	U.S. Highway 95, Amargosa Valley Rest Area	U.S. Highway 95, Vacant, undeveloped land
West:	Undeveloped land, Lathrop Wells Gate Road	Fastrip Fuel Gas Station, Area 51 Alien Center, Alamo Fireworks Megastore

2.3 Previous Investigations and Regulatory Involvement

No case files with NDEP or other regulatory agencies were identified for the subject sites during the Phase I ESA process.

2.4 Scoping Meeting

A scoping meeting was scheduled to prepare for further investigation of the subject sites, including the preparation and revisions of this Sampling and Analysis Plan (SAP) following the transfer of this project from the RDSBC program to the NDEP Brownfields Program.

The scoping meeting conducted on September 15, 2020, was attended by David Friedman (NDEP), Eileen Christensen (BEC), Rachel Kistler (BEC), and Alana Holt-Hall (BEC). Discussions included clarification of requested revisions to the SAP, groundwater sampling methodology, and analyses to be performed on groundwater samples. Due to unknown conditions of groundwater at the site, Friedman noted a preliminary visit would be needed to determine well water flow rate and the well may need to be purged over the course of two to three days prior to the sampling event if the flow rate is low. If the flow rate is high, purging one well casing volume would be acceptable in addition to conducting water quality measurements immediately prior to sampling.

2.5 Geological and Meteorological Information

The Amargosa Valley lies within the Alkali Flat-Furnace Creek groundwater sub-basin within the Death Valley regional ground-water flow system (Waddell, Robinson, & R.K., 1984). The Alkali Flat-Furnace Creek sub-basin consists of two smaller sub-basins—Ash Meadows and Oasis Valley sub-basins—which together utilize the upper and lower carbonate aquifers along with an upper and lower clastic aquitard to move water toward the Death Valley system (Waddell, Robinson, & R.K., 1984). The Nevada Division of Water Resources has identified this region as Amargosa Desert Hydrographic Basin 14-230 (NDEP, 1971). Westward groundwater travel through Amargosa Valley occurs through both underflow within regional carbonate aquifer, as well as through seepage from basin-fill sediments (Stuckless & Dudley, 2002). Unsealed fractures within the Paleozoic carbonates underlying the Alkali Flat-Furnace Creek sub-basin (resulting from recent tectonic activity) provide most of the permeability for groundwater movement throughout the area including beneath the subject sites. Within Amargosa Valley, depth to water was 73 meters in a hole 467 meters deep (Waddell, Robinson, & R.K., 1984).

The dominant soil composition at land surface in the vicinity of the subject sites was based on information provided by Environmental Data Resources, Inc. (EDR), as supplied from the U.S. Department of Agriculture's Soil Conservation Service. The soil surface texture typical of the subject site is gravelly fine sandy loam. The hydrological group defined by the U.S. Department of Agriculture (USDA) is Class C, with slow infiltration rates.

The domestic well on the Lathrop Wells Parcel -06 is strongly believed to be Nevada well #61596, also known as U.S. Geological Survey (USGS) well # 363836116234001. At the last recorded measurement of the well on September 12, 1990, the depth to water was 347.7 feet (ft) below grand surface (bgs). A Nevada Division of Transportation (NDOT) monitoring well was located approximately 0.1 miles south of the subject site. This well, "NDOT Well 2" (USGS well #363835116234002), had a water level measurement of 342.3 ft bgs on September 17, 2009. Lastly, a groundwater monitoring well was drilled 0.9 miles northwest of the subject sites in 2000. This well, Nevada well #81904, is monitored by the Nye County Water District as NC-EWDP- 4PA, and had a recent water level measurement of 343.97 ft bgs on October 3, 2019. Using USGS Groundwater Field measurements from nearby wells, it was determined localized groundwater flows downgradient toward the south southeast. Groundwater Field measurements are provided in **Attachment 2 – Groundwater Information.**

2.6 Impact on Human Health and/or the Environment

No reported or documented adverse human health effects associated with the RECs were discovered through the Phase I ESA process.

An orphan site discovered through the Lathrop Wells Parcel -06 Phase I ESA was the Amargosa Valley Saloon (NDEP Facility ID 7-000163), located 0.05 miles southwest of the subject site. A release of petroleum hydrocarbons to soil was reported to NDEP on March 24, 1999. NOW Construction Corporation discovered the release during the removal of two 10,000-gallon gasoline USTs, two 8,000-gallon gasoline USTs, and one 10,000-gallon diesel UST. In a follow up soil sampling event, thirteen soil borings were advanced to below 40 ft. Soil samples collected from Boring Location 1 at 25 ft bgs and 30 ft bgs contained 4,200 milligrams per kilogram (mg/kg) and 11,000 mg/kg TPH-D, respectively. All other sample locations and depths were non-detect for TPH. An "A through K" evaluation was performed in accordance with NAC 445A.227. Based on this evaluation, NDEP granted the site an A-K closure on August 18, 2000. However, one of the evaluation criteria was proximity to drinking water wells. A groundwater well was present on the Parcel -06 subject site, which may be used for drinking water in the future. Based on the proximity to the subject site and the pumphouse observed during site reconnaissance, this CREC was considered a REC for the subject site.

Additionally, it is unclear when the billboards on either parcel were installed or if they underwent renovations. LBP is suspected of coating the billboards on both the -06 and -08 parcels, which would pose a potential health risk to future occupants of the site and installation or demolition workers.

3 PROJECT AND DATA QUALITY OBJECTIVES

The Data Quality Objective (DQO) process is a systematic planning tool used to establish performance or acceptance criteria to clarify study objectives (EPA, 2006). These criteria, in turn, serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study.

3.1 Project Task and Problem Definition

The purpose of this environmental investigation will be to sample for the presence of volatile organic compounds (VOCs) in groundwater at the Parcel -06 subject site due to nearby petroleum contamination allowed to be left in place at the time of regulatory closure. Semivolatile organic compounds (SVOCs) will not be evaluated as a part of this investigation. The case file associated with nearby contamination indicated although petroleum contamination reached a depth of 30 ft bgs, the groundwater in the area is 347.7 ft bgs. SVOCs have a high affinity for attaching to soil particles and would likely not have reached the groundwater in this location. Additionally, the vast majority of SVOCs with regulatory thresholds for groundwater are not associated with petroleum products or biproducts. Therefore, analysis of SVOCs is not applicable for this investigation.

The presence of heavy metals in the groundwater at the Parcel -06 subject site will also be evaluated due to the parcel being adjacent to a retail fireworks outlet which encourages customers to launch their purchased fireworks on the premise. Additionally, local residents have been known to use the subject site and surrounding vicinity to launch fireworks. Heavy metals used in the fireworks manufacturing process are then released to the environment upon explosion. Additionally, the geographic region is known to have high background levels of arsenic in groundwater. Therefore, groundwater will be collected and analyzed for the RCRA suite of 8 metals (arsenic [As], barium [Ba], cadmium [Cd], chromium [Cr], lead [Pb], mercury [Hg], selenium [Se], silver [Ag]), plus copper (Cu), hereinafter referenced as "metals," as the groundwater well on site may be used as a potable water supply in the future. Lastly, presence of LBP on the billboards at each of the subject sites will be evaluated. The results will facilitate a more informed decision on the viability of the sites for the proposed reuse. The principal study question is, "are potential

contaminants present at the sites at levels that exceed appropriate health-risk-based screening levels for future occupants of the sites based on the intended reuse?"

To assess the presence of contaminants in groundwater at the Parcel -06 subject site due to known upgradient contamination, groundwater samples will be collected from the domestic well at the Parcel -06 subject site. As the regulatory closure of the upgradient leaking underground storage tank (LUST) site included a stipulation for proximity to drinking water, drinking water standards will be used to compare results from the well. These levels are more conservative than those for commercial/industrial use and residents in the vicinity obtain their drinking water from groundwater wells that are not otherwise regulated. If contamination is found in excess of screening levels protective of human and animal health and/or the environment, then options for further site characterization, remediation, or alternative uses of the site will be considered.

To assess the presence of LBP on the billboard structures of both sites, paint chip samples will be collected and utilized for LBP analysis.

3.2 Data Quality Objectives

3.2.1 Step 1: State the Problem

Problem Description. The primary problem is how to sufficiently characterize the nature of groundwater contamination at the Parcel -06 subject site. The secondary problem is how to adequately determine the presence and quantity of LBP in building materials at both the Parcel -06 and -08 subject sites.

Planning Team. The planning team includes the EPA Region 9 Project Manager and QA Manager; the property owner, Mr. Raman Sharma, who will provide the planned future use of the subject sites; the Grantee Program Technical Coordinator; and the Qualified Environmental Professional team.

Conceptual Model of the Potential Hazard. Lathrop Wells Parcel -06 is a vacant, unused 2.93-acre parcel with an abandoned cinderblock building and a groundwater well pumphouse. Future reuse plans have not yet been established. However, the owner operates a commercial facility nearby and uses water from a groundwater well further away. He would like to use groundwater from the well on Parcel -06 as a potable water supply to direct expansion of commercial operations. Information obtained from this sampling event will directly advise what future redevelopment is feasible.

Observations from the Phase I ESA report indicate one closed LUST case file 0.05 miles upgradient of the Parcel -06 subject site. Contamination was allowed to remain in place at this former gas station site, and an "A through K" evaluation was performed in accordance with NAC 445A.227. Based on this evaluation, NDEP granted the site an A-K closure on August 18, 2000. However, one of the evaluation criteria was proximity to water wells, which was not applicable in the initial evaluation.

Additionally, Parcel -06 is adjacent to a fireworks manufacturing facility in which metals are known to be used in the manufacturing process. Local residents have been known to use the subject site and surrounding vicinity to launch fireworks. Lastly, the region is known to have high background levels of arsenic in groundwater due to local geology.

As there is a groundwater well on the Parcel -06 subject site with drinking water consumption as a proposed future use, and due to potential contaminants at the LUST site and contaminants related to local fireworks manufacturing and usage potentially impacting groundwater, there is a potential health risk to future users of the site.

Lastly, observations made during the site visits for each parcel indicate the billboards may be coated with LBP. The presence and quantity of any LBP should be determined prior to demolition or renovation.

3.2.2 Step 2: Identify the Goals of the Study

Primary Question:

- Is there VOC contamination in the groundwater from the upgradient, closed former gas station present at levels that exceed appropriate health-risk-based screening levels for future occupants and users?
- Are metals present in groundwater above health-risk-based screening levels for future occupants and users?

Alternative Actions:

- Take no action (i.e., do not redevelop this site).
- Conduct groundwater sampling and analyze for VOCs and metals. Determine if there is sufficient information to proceed with estimating various remedial options.

Decision Statement:

- Conduct groundwater sampling. If contamination is not found in excess of screening levels protective of human health or the environment, redevelopment may begin, or additional characterization may be required. If contamination is found in excess of screening levels protective of human health and/or the environment, then options for further site characterization, remediation, or alternative uses of the site will be considered.

Secondary Question:

- Is LBP present?

Alternative Actions:

- Take no action (e.g., do not evaluate for the presence of LBP).
- Perform LBP inspection and mitigate/abate in advance of redevelopment.
- Perform LBP inspection and develop plans to manage-in-place in advance of redevelopment.

Decision Statement:

- Determine the location and quantity of LBP and provide information to facilitate mitigation or management-in-place in advance of redevelopment.

3.2.3 Step 3: Identify Information Inputs

Information Needed to Resolve the Decision Statement. Analytical data for collected samples will be evaluated to determine if concentrations exceed applicable regulatory thresholds. Groundwater samples will be collected at the domestic well on the Parcel -06 subject site to determine the effect on drinking water at the site. Groundwater will be sampled from this well into vessels recommended by the laboratory and sent for analysis under chain of custody protocol. Analytical data for collected samples will be evaluated to determine if concentrations exceed applicable regulatory thresholds and pose a risk to human health or the environment. The proposed analytical method, method detection limit, and reportable

concentrations are presented in **Table 3-1**. Unless otherwise noted, reportable concentrations were based off the National Primary and Secondary Drinking Water Standards (**Attachment 3**).

Groundwater samples will be analyzed for the following constituents of concern:

- VOCs using EPA Method 524.2
- Metals using EPA Methods 200.8 (As, Ba, Cd, Cr, Cu, Pb, Se, Ag) and 245.1(Hg)

Bulk paint chip samples will be collected from paint-substrate combinations from each of the billboards. Samples will be analyzed by Flame Atomic Absorption Spectrometry (FAAS) by EPA Method 7000B. Lead data for paint samples will be compared to levels established in 40 CFR part 745 and Toxic Substances Control Act (TSCA) 402 (c). The proposed analytical method, method detection limit, and residential screening level are presented in **Table 3-2**.

Table 3-1: Groundwater Contaminants of Concern, Methods, and Screening Levels Matrix

Group	Analyte Name	EPA Method	Method Reporting Limit	Method Detection Limit	Groundwater Reportable Concentration
VOCs	1,2,4-Trimethylbenzene	**524.2**	0.5 µg/L	0.20 µg/L	N/A
	1,2-Dichloroethane	**524.2**	0.5 µg/L	0.12 µg/L	5.0 µg/L
	1,3,5-Trimethylbenzene	**524.2**	0.5 µg/L	0.17 µg/L	N/A
	Benzene	**524.2**	0.5 µg/L	0.15 µg/L	5.0 µg/L
	Ethylbenzene	**524.2**	0.5 µg/L	0.21 µg/L	700 µg/L
	Methyl t-butyl ether (MTBE)	**524.2**	2.0 µg/L	0.19 µg/L	20 µg/L
	Styrene	**524.2**	0.5 µg/L	0.19 µg/L	100 µg/L
	Toluene	**524.2**	0.5 µg/L	0.14 µg/L	1,000 µg/L
	Xylenes (total)	**524.2**	0.5 µg/L	0.33 µg/L	10,000 µg/L
	Xylenes (total)	**524.2**	0.5 µg/L	0.33 µg/L	10,000 µg/L
RCRA 10 Metals	Arsenic	**200.8**	0.4 µg/L	0.074 µg/L	10.0 µg/L
	Barium	**200.8**	0.5 µg/L	0.071 µg/L	2,000.0 µg/L
	Cadmium	**200.8**	0.1 µg/L	0.041 µg/L	5.0 µg/L
	Chromium	**200.8**	0.20 µg/L	0.035 µg/L	100 µg/L[1]
	Copper	**200.8**	0.5 µg/L	0.13 µg/L	1,300.0 µg/L
	Lead	**200.8**	0.2 µg/L	0.031 µg/L	150.0 µg/L
	Mercury	**245.1**	0.05 µg/L	0.017 µg/L	2.0 µg/L
	Nickel	**200.8**	0.8 µg/L	0.045 µg/L	N/A
	Selenium	**200.8**	0.4 µg/L	0.14 µg/L	50.0 µg/L
	Silver	**200.8**	0.2 µg/L	0.062 µg/L	100.0 µg/L[2]
	Copper	**200.8**	0.5 µg/L	0.13 µg/L	1,300.0 µg/L

[1]Based on NDEP Draft Guidelines for Discovery Events (Ground Water RCs) Appendix B – Reportable Concentration in Groundwater Standards (Included in **Attachment 3**.)

Table 3-2: Building Materials Contaminants of Concern, Methods, and Screening Levels Matrix

Group	Analysis	EPA Method	Practical Quantitation Limit	Screening Level Residential
LEAD BASED PAINT (Weight %)				
LBP	Lead FAAS	**7000B**	0.02 weight %	0.5 weight %

3.2.4 Step 4: Define Study Boundaries

Sample collection will occur within the boundary of the subject sites as defined in Section 2.1 of this Plan and as shown on **Figures 2 and 3 – Sample Location Maps** (**Attachment 1**). Sampling will be limited to VOCs and metals for groundwater and collection of paint chips from the billboards for LBP analysis.

3.2.5 Step 5: Develop the Analytic Approach

Decision rules from sampling activities will be based on the analytical results obtained, in comparison to regulatory thresholds specified in **Table 3-1** and **Table 3-2**. These comparisons will be used to evaluate if additional assessment and/or remediation action is required (i.e., if the reported concentrations exceed regulatory thresholds). Data may also be used to assist in determining an appropriate approach to remediation methodology and/or institutional controls.

Residential screening levels will be used to correspond with the proposed reuse of the site because these screening levels are more conservative than those for commercial/industrial use, and the property owner intends to use groundwater from the onsite well as a potable water supply, pending results of this sampling event. If contaminants of concern are not detected above screening levels, then no further action will be required.

If VOCs or metals are detected in groundwater above the groundwater reportable concentrations (RCs) as outlined in **Table 3-1**, BEC with coordinate with EPA and NDEP to identify and implement appropriate next steps and/or mitigation measures, if necessary.

If paint chip samples are determined to contain LBP or lead-containing paint (LCP), then recommendations for management in place or removal will be evaluated.

3.2.6 Step 6: Specify Performance or Acceptance Criteria

Groundwater sampling will not be a statistically based study. Groundwater will be analyzed from one domestic well located on the Parcel -06 subject site. Results from this well will be compared to the RCs in **Table 3-1**.

Sampling of LBP will comply with 40 CFR Part 745 Lead-Based Paint Poisoning Prevention in Certain Residential Structures, Subpart L, and Department of Housing and Urban Development (HUD) requirements at 24 CFR Part 35, Subpart R. This facility is not a multi-family dwelling, thus random sampling would not be required.

3.2.7 Step 7: Optimize Sample Design

The number of samples will be determined in the field relying on professional judgment such that samples are representative of site conditions.

3.3 Measurement Quality Objectives

Data quality indicators (DQIs) (precision, accuracy, representativeness, completeness, comparability, and sensitivity [PARCCS] parameters) refer to quality control (QC) criteria established for various aspects of data gathering, sampling, and/or analysis. The DQIs are as follows:

- **Precision:** the degree of mutual agreement between or among independent measurements of a similar property (reported as standard deviation [SD] or relative percent difference [RPD]) and relates to the analysis of duplicate laboratory or field samples.
- **Accuracy:** the degree of agreement of a measurement with a known or true value and is determined by comparing the reported laboratory value for a sample to a known or true concentration (i.e. matrix spikes, surrogate spikes, laboratory control samples, and performance samples).
- **Representativeness:** the expression of the degree to which data accurately and precisely represent a characteristic of an environmental condition or population and relates to the method of collecting samples and determining sample locations.
- **Completeness:** expressed as the percent of valid usable data obtained compared to the amount that was expected.
- **Comparability:** expresses the confidence with which one data set can be compared with another.
- **Sensitivity:** the adequacy of laboratory reporting limits for this investigation when compared to screening levels utilized for this project.

3.3.1 Precision and Accuracy

DQOs will be met through adhering to required sampling methodology, required laboratory analytical methods, and data review. Data are accepted and rejected based on the DQOs. If the data are near the regulatory limit and could be affected by variability and accuracy measures, such as low recovery for spikes or surrogates, then further evaluation will be made. Audits will be initiated when DQOs are not being met.

3.3.1.1 Groundwater

Constituents of concern in groundwater may include VOCs and metals. A review of the laboratory's internal QC results will include an evaluation of laboratory duplicates, matrix spike, duplicate percent recoveries, method blanks, and laboratory control standards. Specific QC methods for determining the accuracy and precision for sampling and analysis of each of these constituents are discussed on the following page.

- Accuracy: Accuracy is determined for laboratory measures through field blanks, lab matrix spikes, certified reference materials, and laboratory control samples.
- Precision: Precision measurements are typically determined by the resolution of the instrument, and through evaluation of field and laboratory duplicates or splits. Field duplicates account for both precision of sampling techniques and laboratory analysis, as well as environmental variability. Laboratory duplicates are used to evaluate precision of the laboratory process.

If the results of blind field blanks or field duplicates are outside the control limits, corrective action and/or data qualification will be determined after a review by the QA Officer. All analyses performed for this project must reference QC results to enable reviewers to validate the data. Sample analysis data, when reported by the laboratory, will include QC results. All data will be reviewed for internal consistency.

3.3.1.2 Lead-based Paint

Field procedures and documentation, sample custody control, and laboratory requirements for sample preservation and holding time will be reviewed to verify appropriate sample preservation and holding times are achieved. A review of the laboratory's internal QC results will include an evaluation of laboratory duplicates, matrix spike, duplicate percent recoveries, method blanks, and laboratory control standards. Appropriate qualifiers will be applied to the data, as necessary, based on the data validation review.

3.3.2 Representativeness

The project goal is to obtain an adequate number of samples to characterize site conditions.

3.3.3 Completeness

There will be two groundwater samples collected from the domestic well onsite, subject to professional judgment in the field. The number of paint chip samples collected from each of the two billboards will be determined based on professional judgement in the field.

During field activities, there is potential for sample contamination associated with human error, instrument failure, environmental conditions, and other circumstances which may interfere with laboratory analysis and associated validity of analytical results. Additionally, sample containers may be broken, lost, or otherwise invalidated. However, BEC expects the number of valid results from the analysis to be equal to or greater than 90%. This percentage will allow for the appropriate level of decision making in determining if the collected data is sufficient to characterize the site or if additional data are required.

3.3.4 Comparability

Comparability expresses the confidence with which one data set can be compared with another. Comparability of data will be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data. Field and weather variations at the time of sample collection should not decrease comparability to any studies performed in the future.

3.3.5 Sensitivity

The laboratory reporting limits are adequate for this investigation when compared to screening levels utilized for this project. Constituents of potential concern, analytical methods, method detection limits, and reportable concentrations or screening levels are presented in **Table 3-1** and **Table 3-2**.

3.4 Data Review and Validation

The limited scope of this investigation warrants the use of a Tier 1A data validation effort.

Data verification is the process of evaluating the completeness, correctness, conformance, and compliance of a specific data set against the method, procedural, or contractual requirements. Data verification evaluates whether sampling protocols, standard operating procedures (SOPs), and analytical methods were followed during data generation. Verification also involves examining the data for errors or omissions. Field and laboratory staff will verify that the work is producing appropriate outputs.

Data validation is a systematic process for reviewing a body of data against a pre-established set of acceptance criteria defined in this plan. Data validation is an analyte- and sample-specific process that extends the evaluation of data beyond data verification and is performed to evaluate the analytical quality of a specific data set. This involves a detailed examination of the data package to determine whether measurement quality objectives (MQOs) for precision, accuracy, and sensitivity have been met. For this

assessment, the intent of the data review and validation process is to verify the specified levels of precision, accuracy, reproducibility, completeness, comparability, and analytical sensitivity of the final results are achieved, with respect to the project MQOs, and the data fulfills project DQOs.

A verification-level validation will be performed on all field documentation and analytical data reports. The data validation process will be used to verify the data quality. The following QC elements will be reviewed, as appropriate, for sampling activities associated with VOCs, metals, and LBP analyses:

- Analytical holding times
- Preparation blank contamination
- Check standard precision
- Analytical accuracy (blank, matrix spike, and control sample recoveries)
- Analytical precision (comparison of replicate sample results)

BEC's QA Officer will supervise or perform data quality assessment tasks. BEC will consistently evaluate and document data to monitor consistency with MQOs, quantitatively assess data quality, and identify potential limitations on data use. BEC will review field and analytical laboratory data generated for this project, including the following:

- Chain of Custody documentation
- Laboratory batch QC frequency
- Results of batch and field QC analysis

The laboratory will generate and review all laboratory data. Each data point will be assessed as nonqualified or qualified based upon the acceptance criteria. Data may be qualified as "estimated" (J-qualified); these data are considered estimates. J-qualified data often result from data falling between laboratory method detection limits (MDL) and practical quantification limits (PQL) or a result exceeding a calibration range. These results will be used as positive detection at the reported concentration, with the understanding that the result is estimated. Some data may be qualified as "rejected" (R-qualified) if critical QC parameters are not met; these data are unusable for any purpose. Sample re-analysis, for data not meeting MQOs, will be considered as a possible corrective action. Third-party data validation will not be performed.

3.5 Data Management

Data management systems and procedures will be used to establish and maintain efficient organization and reporting of the environmental information collected. Procedures and standards for conducting specific data management tasks (i.e., acquisition, handling, storage, and distribution of the data) will be documented in a project log. Essential elements of data management and reporting activities associated with this assessment are discussed in the following section.

3.5.1 Field Data

The main documentation of field activities will consist of daily field records (a combination of field logbooks, field forms, global positioning system [GPS] records, and Chain of Custody forms), including sample location and selection justification. Upon completion of sampling activities, hardcopy notes and forms will be scanned to develop an electronic record for use in preparing the Phase II Limited Environmental Site Assessment). Information on sampling locations, dates, depths, equipment, sample identifiers, and other relevant conditions will be entered into the project log. BEC's QA Officer will ensure 100% of hand-entered data is verified based on digital records. Electronic QA checks to identify anomalous values will also be conducted following data entry.

3.5.2 Laboratory Data

The analytical laboratories will each submit data in electronic format. The project manager or designated data manager will provide the desired format for Electronic Data Deliverables (EDDs) to the laboratories, and the project data manager and laboratory coordinator will discuss these specifications with laboratory QA managers prior to data delivery and tailor them as necessary to specific laboratory capabilities. QA checks of format and consistency will be applied to EDDs received from the laboratory.

3.5.3 Reporting

Qualitative (e.g., field logs, observations) and quantitative (e.g., sample results, measurements) will be evaluated, analyzed, and reported in the final Phase II Environmental Site Assessment. BEC's QA Officer will perform a technical review of the qualitative and quantitative data presented in the report, to ensure the technical information is accurately reported and discussed within each report. BEC will perform a secondary professional review to ensure grammar, formatting, and narrative components of the report are correct prior to final report submittal.

3.6 Assessment Oversight

The SAP and Site-Specific Health and Safety Plan (HASP) will be reviewed by the Project Team prior to commencing with field work. The BEC Project Manager will oversee QC of field activities. If modifications to the proposed sampling program are necessitated by field conditions, the Project Manager will be notified and consulted for direction. Modifications to the SAP will be documented in the field logs and in the Phase II Environmental Site Assessment as "deviations from the SAP".

4 SAMPLING DESIGN AND RATIONALE

The following sections describe the method used in determining the sampling design, including location of samples and constituents of concern.

4.1 Soil Sampling

Not applicable to this project.

4.2 Sediment Sampling

Not applicable to this project.

4.3 Water Sampling

Groundwater will be collected at the domestic well located on the Parcel -06 subject site to evaluate whether concentrations of potential contaminants of concern are present in ground water in excess of NDEP RCs for groundwater (which are consistent with the National Primary Drinking Water Regulations).

4.4 Soil Vapor Sampling

Not applicable to this project.

4.5 Other Sampling

4.5.1 Lead-Based Paint Sampling

A certified Lead Risk Assessor licensed by the EPA will conduct LBP sampling to identify the presence of materials containing lead-based paint pursuant to 40 CFR Part 745, Subpart L – Lead-based Paint Activities.

The purpose of the survey will be to aid in identifying building materials to assist with property renovation, debris disposal, and for compliance with OSHA inorganic lead standard 29 CFR 1926.62. An estimated five paint chip samples are anticipated to be collected from paint-substrate combinations. Paint chip samples will be submitted to Forensic Analytical Laboratory for analysis by FAAS, EPA method 7000B.

4.6 Cultural Resource Discoveries

For the purposes of this sampling event, there will be no ground disturbing activities which would reveal previously unidentified cultural resources. Cultural resources are artifacts, relics, or other physical traces, regardless of condition, that may be associated with prehistoric or indigenous occupation and use of the site and may possess archeological significance or be of importance to existing tribes. Although no ground disturbing activities will take place during this sampling event, a copy of the Plan and Procedures for the Unanticipated Discovery of Cultural Resources and Human Skeletal Remains is provided in **Attachment 4** for reference.

5 REQUEST FOR ANALYSIS

Sample media, analytical methods, and laboratory information is discussed in Section 5.1 and Section 5.2.

5.1 Analyses Narratives

A total of one groundwater sample will be collected from the domestic well onsite and will be submitted to Weck Laboratories, Inc. for VOC analysis by EPA Method 524.2 and metals using EPA Methods 200.8 (As, Br, Cd, Cr, Cu, Pb, Se, Ag) and 245.1 (Hg). This information is summarized in **Table 5-1**.

An estimate of five approximately 2-inch square bulk paint chip samples will be collected in rigid plastic centrifuge tubes and submitted to Eurofins EMLab P&K. Paint chip samples will be analyzed by FAAS using method EPA Method 7000B. This information is summarized in **Table 5-2**.

Table 5-1: Groundwater Analytical Services Matrix

Sample Matrix		**Groundwater**	
Analyte:		**VOCs**	**Metals**
EPA Analytical Method:		**524.2**	**200.8 & 245.1**
Sample Number	**Sample Location**		**Special Designation**
GW-01	Parcel -06 Domestic Well		--
GW-02	Parcel -06 Duplicate		X
GW-03	Parcel -06 Field Blank with organic-free water		X
Total number Groundwater Samples, excluding QC		1	
Total number Groundwater Samples, including QC		3	

Table 5-2: Building Materials Analytical Services Matrix

Sample Number	Sample Location	Special Designation	Analytical Methods
			FAAS - EPA Method 7000B
Pb-06-01-(1-3)	LW-06 Billboard 1	--	x
Pb-06-02-1	LW-06 Billboard 2	--	x
Pb-08-01-1	LW-08 Billboard 1	--	x
Total number Paint Chip Samples[1]			5

[1]By nature of analysis, paint chip collection does not require collection of QC samples.

5.2 Analytical Laboratory

BEC proposes to use Eurofins EMLab P&K to perform the laboratory analysis of suspect LBP chips. Analytical testing and sampling, including container types and preservation methods, will be conducted in accordance with the Eurofins EMLab P&K Quality Assurance Manual (**Attachment 6**). Eurofins EMLab P&K is accredited through the American Industrial Hygiene Association (AIHA) Laboratory Accreditation Program for industrial hygiene, environmental lead, environmental microbiology and unique scopes, and listed on the EPA National Lead Laboratory Accreditation Program (NLLAP) List for March 2020.

BEC proposes to use Weck Laboratories, Inc. to perform the laboratory analysis for VOCs and metals concentrations in groundwater. Analytical testing and sample handling, including container types and preservation methods, will be conducted in accordance with Weck Laboratories, Inc. Quality Assurance Manual (**Attachment 6 – Laboratory Quality Assurance Manuals and Certificates**). Weck Laboratories, Inc. is a State of Nevada certified analytical laboratory for EPA Methods 524.2, 200.8, and 245.1.

Additional information regarding analytical method, sample containers, sample quantity, sample preservation, and sample holding times are presented in **Table 5-3**.

Table 5-3: Sample Method and Container Information

Analyte	EPA Method	Matrix	Container Type	Quantity	Preservation	Holding Time
Lead-based Paint	7000B	Paint Chips	Rigid plastic centrifuge tube	Minimum 0.05 grams (~1 square inches)	None	N/A
VOCs	524.2	Groundwater	40-milliliter (mL) pre-weighed preserved VOA-524 vial with 0.5mL hydrochloric acid (HCl)	(3) 40-mL samples	pH<2, HCl, Sulfite (if Cl_2), <6ºC	14 days
RCRA 10 Metals	200.8, 245.1 (Hg)	Groundwater	250-mL Poly bottle with HNO_3	250 mL	HNO_3	180 days[1]

[1]14 days for extraction, 40 days for analysis

6 FIELD METHODS AND PROCEDURES

The following sections describe the procedures and equipment, including personal protective equipment, to be used to collect groundwater and paint chip samples at the subject sites.

6.1 Field Equipment

This section outlines the necessary field equipment for sample collection. Sample logs are provided in **Attachment 7**. Chains of Custody forms are provided in **Attachment 8**.

6.1.1 List of Equipment Needed

Table 6-1: Field and Sampling Equipment

Description of Equipment	Material (if applicable)	Dedicated (Yes/No)
LBP sampling blades	Stainless Steel	Yes
Field logbook and field data sheets	Paper	No
Personal protective equipment (PPE) (Level D)	Nitrile	No
Heat-gun	Metal/Electrical	No
Knife/box cutter with retractable blade	Metal/Plastic	No
Tape measure	Plastic/Metal	No
Camera	Metal/Electrical	No
Zip-top plastic bags	Plastic	No
Sample containers and labels	Glass/Plastic	Yes
Chain of Custody forms	Paper	No
Decontamination Equipment (spray bottles with DI water, and DI water and Liquinox solution)	Plastic	No
Shipping labels	Paper	No
Regular and indelible ink pens	Plastic	No
Plastic bucket for groundwater	Plastic	No
Hose for well purging	Plastic/Metal	No
Water quality meter	Plastic/Electrical	No
40mL vial or water bottle for temperature blank	Glass/plastic	No
HPLC organic-free water	Glass Jar	No

6.1.2 Calibration of Field Equipment

The water quality meter will be calibrated according to manufacturer's guidelines and specifications before and after every day of field use and will be decontaminated before and after use.

Calibration of equipment used for paint chip sampling is not applicable to this project.

6.2 Field Screening

Not applicable for this project.

6.3 Soil Sampling

Not applicable for this project.

6.4 Sediment Sampling

Not applicable for this project.

6.5 Water Sampling

This subsection contains procedures for water level measurements, well purging, and well sampling.

6.5.1 Water Level Measurements

Based on observations during the Phase I ESA site visit, the well head does not have a sampling port and will not be accessible for depth sounding. Therefore, depth to water and total well depth will not be collected for the purposes of this investigation. Casing volume will be estimated based on information from the driller's log (Nevada #61596) for the onsite well.

The following information about each well will be recorded in a field notebook at the time of sampling: well diameter (in inches), an estimate of the total casing/slab stickup above ground surface, and an estimate of the elevation of ground level at each well from either a survey, resource grade GPS, or elevation from Google Earth. Additionally, photos of each well will be collected at the time of sampling.

6.5.2 Purging

The well will be purged prior to sampling. The site owner indicated the well pump is turned on for 30 to 45 minutes per day. Therefore, as a well that is used regularly, NDEP's recommendation is to purge one casing volume prior to sampling. Purging will occur through a tap near the pump house. Purge water will be directed to a downgradient location through a hose. As there is no drainage system at the site, the purge water will be released to the ground surface in such a manner to not affect the structures on site or on surrounding sites.

Casing volumes will be calculated based on total well depth, standing water level, and casing diameter, using information provided in the driller's log. One casing volume will be calculated as:

$$\boldsymbol{V = \frac{\pi d^2 h}{77.01}}$$

where: V is the volume of one well casing of water (in gallons) (1 cubic foot [ft^3] = 7.48 gallons);
d is the inner diameter of the well casing (in inches);
h is the length of water in the well (in feet), which is the total well depth minus depth to water.

Source: (EPA, 2018)

According to the driller's log: d = 9-inch diameter; *total well depth* = 535 ft; *standing water level* = 365 ft

$$h = 535 \text{ ft} - 365 \text{ ft} = 170 \text{ ft}$$

$$\boldsymbol{V = \frac{\pi(9)^2(170)}{77.01}}$$

$$\boldsymbol{V \cong 561.74 \text{ gallons}}$$

Water will initially be collected into a measured container to record the purge volume while determining the flow rate. The calculated flow rate will be used to purge the well over a sufficient amount of time to ensure at least one casing volume, approximately 562 gallons, has been purged. Flow rate will be monitored throughout the purging process in the event that a significant decrease in flow rate is observed, indicating dewatering. If a well dewaters during purging and one casing volume has not been purged, the well will be allowed to recharge up to 80% of the static water column and dewatered once more. After water levels have recharged to 80% of the static water column, groundwater samples will be collected.

Stable water quality parameter (temperature, pH and specific conductance) measurements will be used to indicate representative sampling is obtainable. Water quality will be considered stable if for three consecutive readings:

- Temperature range is no more than +1 degrees Celsius (°C);
- The pH varies by no more than 0.2 pH units;
- Specific conductance readings are within 10% of the average.

As the well casing volume will be estimated based on the driller's log, water quality parameter measurements will be taken at the start of purging, in the middle of purging, and at the end of purging. If water quality parameters are not stable by the end of purging the first casing volume, and are not stable in the 30 minutes following the first casing volume, purging will cease, which will be noted in the logbook, and ground water samples will be taken. The water quality measurements and purge volumes will be entered in the logbook. The water in which measurements were taken will not be used to fill sample bottles.

6.5.3 Well Sampling

At the sampling location, all bottles designated for a particular analysis (e.g., volatile organic compounds) will be filled sequentially before bottles designated for the next analysis are filled. If a duplicate sample is to be collected at this location, all bottles designated for a particular analysis for both sample designations will be filled sequentially before bottles for another analysis are filled. In the filling sequence for duplicate samples, bottles with the two different sample designations will alternate (e.g., volatile organic compounds designation GW-1, volatile organic compounds designation GW-2 [duplicate of GW-1], metals designation GW-1, and metals designation GW-2 [duplicate of GW-1]). Vials for volatile organic compound analysis will be filled first to minimize the effect of aeration on the water sample. Groundwater samples will be transferred directly into the appropriate sample containers with preservative, if required, chilled if appropriate, and processed for shipment to the laboratory. See **Section 7.3** for detailed information regarding sample containers, preservation, and shipping procedures.

All groundwater samples will be collected directly from the tap after removing the purge hose by reducing the tap to a low, steady flow to reduce aeration. Filtration of water samples will not be required.

6.6 *Other Sampling*

This section describes the methods used for collection and transportation of paint chips for LBP analysis.

6.6.1 Lead-based Paint Sampling

An LBP inspection will be conducted at the subject sites to determine which billboard components contain lead-based paint. The survey will include a visual assessment to identify testing combinations (paint-substrate equivalent) suspected of containing lead. Suspect paint will be physically assessed for evidence of damage or degradation.

A list of all testing combinations on all exterior surfaces will be developed. Specific testing locations will be determined in the field based on professional judgment. However, locations where the paint appears thickest will be selected for sample collection.

All paint chip samples will be analyzed by a laboratory recognized under the EPA's NLLAP for analysis of lead in paint, and collected in accordance with ASTM E1729-16, Standard Practice for Field Collection of Dried Paint Samples for Subsequent Lead Determination. Professional judgment will be utilized for collection of samples. All samples will be two square inches (or as required by the analytical laboratory) and collected from painted surfaces using a clean scraping tool. Paint chip samples will contain all layers of paint (not just peeled layers). The samples will be placed in a sealable rigid container which will be sealed and labeled prior to delivery to the receiving laboratory.

6.7 Decontamination Procedures

Decontamination of non-dedicated equipment will be performed in accordance with EPA Region 9 approved procedures. Decontamination will occur prior to and after each us of a piece of non-dedicated equipment.

Decontamination of sampling equipment will be conducted consistently to ensure the quality of samples collected. All material that comes into contact with potentially contaminated media will be decontaminated. Dedicated, disposable equipment intended for one-time use will not be decontaminated but will be packaged for appropriate disposal at the conclusion of sampling activities with other investigation derived waste. **Table 6-1** outlines the equipment planned for use during sampling activities.

The following EPA Region 9 recommended procedure will be used to decontaminate non-dedicated sampling equipment:

1. Non-phosphate detergent (e.g., Liquinox) and tap water wash, using a spray bottle and a brush if necessary.
2. Triple rinse with deionized or distilled water.

Equipment will be decontaminated in a pre-designated area on pallets or plastic sheeting, and clean bulky equipment will be stored on plastic sheeting in uncontaminated areas. Cleaned small equipment will be stored in plastic bags. Materials to be stored more than a few hours will also be covered.

7 SAMPLE CONTAINERS, PRESERVATION, PACKAGING, AND SHIPPING

The quantity and type of sample containers, required sample volumes, and preservatives are listed in Section 5 of this plan. Sample containers will be provided by the selected analytical laboratory. Each container will be pre-cleaned and will not be rinsed prior to sample collection. Preservatives, if required, will be added by the laboratory to the containers prior to shipment of the containers to BEC. Groundwater sample containers will be labeled with laboratory provided sample labels (**Attachment 9 – Sample Labels**). Lead paint chip samples will be labeled with indelible ink pens on their rigid plastic centrifuge tubes.

7.1 Soil Samples

Not applicable for this project.

7.2 Sediment Samples

Not applicable for this project.

7.3 Water Samples

7.3.1 Volatile Organic Compounds

Low concentration water samples to be analyzed for VOCs will be collected in 40-mL glass vials pre-treated with ascorbic acid and hydrochloric acid by the laboratory. The sample bottles will be filled so that there is no headspace. The bottles will be inverted and checked for air bubbles to ensure zero headspace. The samples will be chilled to <6°C immediately upon collection. Two vials for each water sample are required for laboratory analysis.

7.3.2 Metals

Water samples collected for metals analysis will be collected in 250-mL polyethylene bottles pretreated with nitric acid (HNO_3) by the laboratory. The sample bottles will be filled so that there is no headspace. The bottles will be inverted and checked for air bubbles to ensure zero headspace. If a bubble appears, the bottle will be discarded, and a new sample will be collected. The samples will be chilled to <6°C immediately upon collection. One bottle for each water sample is required for laboratory analysis.

7.4 Other Samples

All other samples do not require chemical or temperature preservation. Care will be taken to prevent deterioration or damage to samples during transit.

7.5 Packaging and Shipping

All sample containers will be placed in a strong-outside shipping container. The following outlines the packaging procedures that will be followed for low concentration samples:

1. When ice is used, pack it in zip-lock, double plastic bags. Seal the drain plug of the cooler with tape to prevent melting ice from leaking out of the cooler.
2. The bottom of the cooler should be lined with bubble wrap to prevent breakage during shipment.
3. Check screwcaps for tightness, and if not full, mark the sample volume level of liquid samples on the outside of sample bottles with indelible ink.
4. Secure bottle/container tops with clear tape and custody seal all container tops.
5. Affix sample labels onto the containers with clear tape.
6. Wrap all glass sample containers in bubble wrap to prevent breakage.
7. Seal all sample containers in heavy duty plastic zip-lock bags. Write the sample number on the outside of the plastic bags with indelible ink.
8. Place samples in a sturdy cooler lined with a large plastic trash bag. Enclose the appropriate Chain of Custody forms in a zip-lock bag affixed to the underside of the cooler lid.
9. Fill empty space in the cooler with bubble wrap or Styrofoam peanuts to prevent movement and breakage during shipment. An absorbent material should be placed in the cooler to absorb spills if they occur.
10. Ice used to cool samples will be double sealed in two zip lock bags and placed on top and around the samples to chill them to the correct temperature.
11. Each ice chest will be securely taped shut with shipping tape, and custody seals will be affixed to the front, right, and back of each cooler.

8 DISPOSAL OF RESIDUAL MATERIALS

As a result of the sampling process, different types of potentially contaminated investigation-derived wastes (IDW) will be generated, including the following:

- Used PPE
- Disposable sampling equipment
- Decontamination fluids
- Purged groundwater and excess groundwater collected for sample container filling

The EPA's National Contingency Plan (NCP) requires that management of IDW generated during sampling comply with all applicable or relevant and appropriate requirements (ARARs) to the extent practicable. The sampling plan will follow the *Office of Emergency and Remedial Response (OERR) Directive 9345.3-02* (May 1991), which provides the guidance for the management of IDW (EPA, 1991). In addition, other legal and practical considerations that may affect the handling of IDW will be considered.

Listed below are the procedures that should be followed for handling the IDW.

- Used PPE and disposable equipment will be double bagged and placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill. Any PPE and disposable equipment that is to be disposed of which can still be reused will be rendered inoperable before disposal in the refuse dumpster.
- Decontamination fluids that will be generated in the sampling event will consist of deionized water, residual contaminants, and water with non-phosphate detergent. The volume and concentration of the decontamination fluid will be sufficiently low to allow disposal at the site or sampling area. The water (and water with detergent) will be poured onto the ground or into a storm drain.
- Purged groundwater will be disposed onsite as it will be collected from a domestic water supply.

Depending upon the degree of groundwater contamination, site-specific conditions, and applicable federal, state, and local regulations, disposal methods will vary. Disposal methods can also vary for purge water from different wells sampled during the same sampling event.

9 SAMPLE DOCUMENTATION

9.1 Field Notes

This section discusses record keeping in the field, which may include a combination of logbooks, preprinted forms, photographs, or other documentation. Information to be maintained is provided below.

9.1.1 Field Logbooks

Field logs will be completed describing all field activities. At a minimum, the following information will be recorded during the collection of each sample:

- Sample location and description
- Site or sampling area sketch showing sample location
- Sampler's name(s)
- Date and time of sample collection
- Designation of sample as composite or grab
- Type of sample (soil, sediment or water)
- Type of sampling equipment used
- Field instrument readings and calibration
- Analyte (suspect-ACM, TPH, etc.)

- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.)
- Preliminary sample descriptions (e.g., for soils: clay loam, very wet; for water: clear water with strong ammonia-like odor)
- Sample preservation
- Lot numbers of the sample containers, sample identification numbers and any explanatory codes, and chain-of-custody form numbers
- Shipping arrangements (overnight air bill number)
- Name(s) of recipient laboratory(ies)

In addition to the sampling information, the following specific information will also be recorded in the field logbook for each day of sampling:

- Team members and their responsibilities
- Time of arrival/entry on site and time of site departure
- Daily weather, including temperature and wind speeds, and weather events
- Other personnel on site
- Summary of any meetings or discussions with tribal, contractor, or federal agency personnel
- Deviations from sampling plans, site safety plans, and SAP procedures
- Changes in personnel and responsibilities with reasons for the changes
- Levels of safety protection
- Calibration readings for any equipment used and equipment model and serial number

9.1.2 Photographs

Photographs will be taken at the sampling locations and at other areas of interest on site or sampling area. They will serve to verify information entered in the field logbook. For each photograph taken, the time, date, location, and a description of the subject will be written in the logbook or recorded in a separate field photography log.

9.2 Sample Labeling

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. A copy of the sample labels are included in **Attachment 9**. The samples will have pre-assigned, identifiable, and unique numbers. At a minimum, the sample labels will contain the following information: sample ID, sample location, date of collection, and analytical parameters(s). Every sample, including samples collected from a single location but going to separate laboratories, will be assigned a unique sample number.

Lead-Based Paint Samples: Parcel Number – Billboard Number – Sample Number
Examples:
Pb-06-01-01
Pb-08-01-01

Groundwater Samples: Groundwater Sample Number
Examples:
GW-01
GW-02

Duplicate samples will be given a unique sample number which does not connect it with the primary sample but will be noted as a duplicate in the field sampling form and the sampler's copy of the Chain of

Custody. The identification of a sample as a duplicate will not be made on the Chain of Custody record that accompanies the samples to the laboratory.

9.3 Sample Chain-of-Custody Forms and Custody Seals

All sample shipments for analyses will be accompanied by a chain-of-custody record. A copy of the form is found in **Attachment 9**. Form(s) will be completed and sent with the samples for each laboratory and each shipment (i.e., each day). If multiple coolers are sent to a single laboratory on a single day, form(s) will be completed and sent with the samples for each cooler.

The chain-of-custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is in someone's custody if it is either in someone's physical possession, in someone's view, locked up, or kept in a secured area that is restricted to authorized personnel. Until the samples are shipped, the custody of the samples will be the responsibility of BEC. The sampling team leader or designee will sign the chain-of-custody form in the "relinquished by" box and note date, time, and air bill number.

10 QUALITY CONTROL

This section describes the steps taken to ensure QC throughout the sampling process.

10.1 Field Quality Control Samples

Samples will be collected in accordance with industry standard procedures. Field QC samples are intended to accomplish two primary goals: the evaluation of field contamination and the evaluation of sampling variability.

10.1.1 Assessment of Field Contamination (Blanks)

Field contamination arising from inadequately decontaminated sampling equipment is generally evaluated through the use of equipment blanks collected in the field. Field blanks are sample containers filled in the field. They help assess contamination from ambient conditions, sample containers, transit, and the laboratory. Trip blanks are prepared by the laboratory and shipped to and from the field. They help assess contamination from shipping and the laboratory and are for volatile organic compounds only.

10.1.1.1 Equipment Blanks

The only equipment proposed for reuse are the knives and/or box cutters with retractable blades used to collect LBP. However, the nature of LBP is such that traditional equipment blanks are not sufficient for quality assurance purposes and are not specifically addressed in the Sampling and Analysis Plan Guidance and Template, Version 4, Brownfields Assessment Projects, dated August 2018. Quality control for LBP is further discussed in Section 10.4.

10.1.1.2 Field Blanks

Field blanks will be collected to evaluate whether contaminants have been introduced into the samples during the sampling due to ambient conditions or from sample containers. Field blank samples will be obtained by pouring High Performance Liquid Chromatography (HPLC) organic-free water (for organics) and/or deionized water (for inorganics) into a sampling container at the sampling point. The field blanks that are collected will be analyzed for VOCs and metals.

The field blanks will be preserved, packaged, and sealed in the manner described for the environmental samples. A separate sample number and station number will be assigned to each sample, and it will be submitted blind to the laboratory.

10.1.1.3 Temperature Blanks

For each cooler that is shipped or transported to an analytical laboratory a 40-ml VOA vial or a small water bottle will be included that is marked "temperature blank". This blank will be used by the sample custodian to check the temperature of samples upon receipt.

10.1.2 Assessment of Field Variability (Field Duplicate or Collocated Samples)

At the discretion of the on-site Certified Environmental Manager (CEM), duplicate samples may be collected at locations of moderate or significant contamination based on visual and field screening evaluation. However, a minimum number of duplicate samples, consistent with at least 5% of the total number of testing combinations for lead based paint, will be collected for analysis by each proposed analytical method. At least one duplicate should be collected for each sample matrix.

Duplicate water samples will be collected for the water sample collected at the Parcel -06 subject site. Duplicate samples will be collected from this location as it is the only sample location, and it is suspected to exhibit moderate concentrations of contaminants.

When collecting duplicate water samples, bottles with the two different sample identification numbers will alternate in the filling sequence (e.g., a typical filling sequence might be, VOCs designation GW-01, VOCs designation GW-02 [duplicate of GW-01]; metals, designation GW-01, metals, designation GW-02 [duplicate of GW-01], etc.) Note that bottles for one type of analysis will be filled before bottles for the next analysis are filled. Volatiles will always be filled first.

Duplicate samples will be preserved, packaged, and sealed in the same manner as other samples of the same matrix. A separate sample number and station number will be assigned to each duplicate, each will be recorded on the Chain of Custody, and each will be submitted blind to the laboratory.

10.2 Background Samples

Background samples will not be collected for this investigation. With the exception of arsenic, which is known to have a higher concentration in this geographic location, there is no expectation that native or ambient levels of the target analytes will be present. Due to the remoteness of the location, there is no groundwater well upgradient from the release source which could be sampled to determine the background level of arsenic for this study.

10.3 Field Screening, Including Confirmation Samples, and Split Samples

Not required for this investigation.

10.4 Laboratory Quality Control Samples

Laboratory QC (e.g., matrix spike/matrix spike duplicate samples) samples will be analyzed to monitor the precision and accuracy of its analytical parameters. Specific laboratory QC procedures are provided in **Attachment 5**.

For groundwater, sample volumes required for analysis are adequate for the laboratory to use for QC purposes. Double volumes will not be required for this sampling plan.

Lead-based paint results will be compared to the laboratory's internal QC results including an evaluation of laboratory duplicates, matrix spike, duplicate percent recoveries, method blanks, and laboratory control standards. Appropriate qualifiers will be applied to the data, as necessary, based on the data validation review.

11 FIELD VARIANCES

As conditions in the field may vary, it may become necessary to implement minor modifications to sampling as presented in this plan. When appropriate, the QA Office will be notified, and a verbal approval will be obtained before implementing the changes. Modifications to the approved plan will be documented in the sampling project report.

12 FIELD HEALTH AND SAFETY PROCEDURES

A site-specific HASP is provided in **Attachment 10**. The HASP will be reviewed and signed by on-site personnel prior to commencing work.

13 REFERENCES

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ATTACHMENT 1

Figures

Figure 1 - Vicinity Map

Lathrop Wells Parcels -06 & -08
5240 & 5700 East U.S. Highway 95
Amargosa Valley, Nevada 89020

bec environmental, inc.
Environmental Services

Figure 2 - Sample Location Map

Lathrop Wells Parcel -06
5240 East U.S. Highway 95
Amargosa Valley, Nevada 89020

Figure 3 - Sample Location Map

Lathrop Wells Parcel -08
5700 East U.S. Highway 95
Amargosa Valley, Nevada 89020

bec environmental, inc.
Environmental Services

ATTACHMENT 2

Groundwater Information

X

Log No. 615916
Rec. 19
Well No.
Permit No. 10 0 M
Do not fill in

WELL LOG AND REPORT TO THE STATE ENGINEER OF NEVADA

PLEASE COMPLETE THIS FORM IN ITS ENTIRETY

Owner John Kay (Property) Driller L. C. Cook

Address Lathrop Wells, Nev. Address Box 244 Lathrop Wells, Nev. Lic. No 279

Location of well: S.W. 1/4 S.W. 1/4 Sec. 18, T. 15 N/S, R. 50 E, in Nye County

or

Water will be used for Domestic Total depth of well 535'

Size of drilled hole 9" Weight of casing per linear foot

Thickness of casing 8 Gage Temp. of water Warm

Diameter and length of casing 9" O.D. 535'
(Casing 12" in diameter and under give inside diameter; casing 12" in diameter give outside diameter.)

If flowing well give flow in c.f.s. or g.p.m. and pressure

If nonflowing well give depth of standing water from surface 365'

If flowing well describe control works
(Type and size of valve, etc.)

Date of commencement of well Dec. 9, 1963 Date of completion of well Jan. 3, 1964

Type of well rig Rotary

LOG OF FORMATIONS

From feet	To feet	Thickness feet	Type of material
00'	3'	3'	Sandy Loam
3'	70'	67'	Sand, Gravel & Boulders
70'	309'	239'	Hard Compacted Sand & Gravel
309'	334'	25'	Brown Sandy Clay
334'	360'	26'	Hard Compacted Sand & Gravel
360'	375'	15'	Gray Sandy Clay
375'	405'	30'	Course Sand & Gravel
405'	430'	25'	Hard Compacted Sand
430'	490'	60'	Brown Bentonetic Clay
490'	505'	15'	Sand Gravel & Boulders
505'	535'	30'	Brown Bentonetic Clay

(OVER)

Water-bearing Formation, Casing Perforations, Etc.

Chief aquifer (water-bearing formation)

from 375 to 405 ft.

Other aquifers 490' to 505'

First water at 375 feet.

Casing perforated

from 359' to 485' ft.
511' to 535'

Size of perforations

Field Perf. App. 1/8" X 10"

919

LOG OF FORMATIONS—*Continued*

From feet	To feet	Thickness	Type of material

CASING RECORD

Diam. casing	From feet	To feet	Length	"Remarks"—Seals, Grouting, Etc.
09"	00'	535'	535'	Top 50' Cemented

GENERAL INFORMATION—Pumping Test, Quality of Water, Etc.

Well bailed of heavy mud.
10 H. P. Submergible Pump Set, No test.

WELL DRILLER'S STATEMENT

This well was drilled under my jurisdiction and the above information is true to my best information and belief.

Signed Lewis C. Cook
Well Driller

By .....

License No. 279

Dated Jan 23, 1964, 19.....

(Not to be filled in by Driller)

RECEIVED
JAN 27 1964
WATER RESOURCES
BRANCH OFFICE
LAS VEGAS, NEVADA

National Water Information System: Web Interface

USGS Water Resources

Data Category: Groundwater ▼ Geographic Area: United States ▼ GO

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- **Notice** - The USGS Water Resources Mission Area's priority is to maintain the safety and well-being of our communities, including providing critical situational awareness in times of flooding in all 50 U.S. states and additional territories. Our hydrologic monitoring stations continue to send data in near real-time to NWISWeb, and we are continuing critical water monitoring activities to protect life and property on a case-by-case basis. The health and safety of the public and our employees are our highest priorities, and we continue to follow guidance from the White House, the CDC, and state and local authorities.

- Introducing The Next Generation of USGS Water Data for the Nation
- Full News

Groundwater levels for the Nation

Search Results -- 1 sites found

site_no list =

- 363836116234001

Minimum number of levels = 1

Save file of selected sites to local disk for future upload

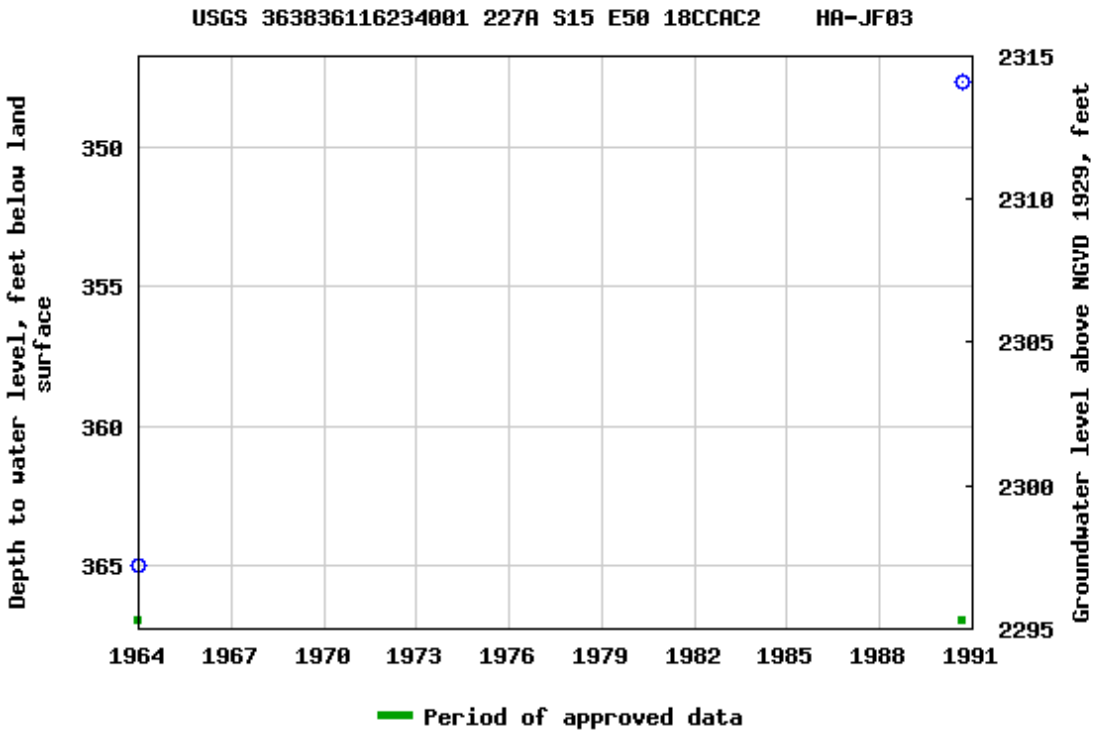
USGS 363836116234001 227A S15 E50 18CCAC2 HA-JF03

Available data for this site Groundwater: Field measurements ▼ GO

Nye County, Nevada
Hydrologic Unit Code 18090202
Latitude 36°38'42", Longitude 116°23'53" NAD27
Land-surface elevation 2,662 feet above NGVD29
The depth of the well is 535 feet below land surface.
The depth of the hole is 535 feet below land surface.

Output formats

Table of data
Tab-separated data
Graph of data
Reselect period



Breaks in the plot represent a gap of at least one year between field measurements.
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U.S. Department of the Interior | U.S. Geological Survey

Title: Groundwater for USA: Water Levels
URL: https://nwis.waterdata.usgs.gov/nwis/gwlevels?

Page Contact Information: USGS Water Data Support Team
Page Last Modified: 2020-05-04 20:44:49 EDT
0.57 0.49 nadww01

ATTACHMENT 3

Regulatory Guidelines

National Primary Drinking Water Regulations

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
Acrylamide	TT[4]	Nervous system or blood problems; increased risk of cancer	Added to water during sewage/ wastewater treatment	zero
Alachlor	0.002	Eye, liver, kidney, or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops	zero
Alpha/photon emitters	15 picocuries per Liter (pCi/L)	Increased risk of cancer	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation	zero
Antimony	0.006	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder	0.006
Arsenic	0.010	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	Erosion of natural deposits; runoff from orchards; runoff from glass & electronics production wastes	0
Asbestos (fibers >10 micrometers)	7 million fibers per Liter (MFL)	Increased risk of developing benign intestinal polyps	Decay of asbestos cement in water mains; erosion of natural deposits	7 MFL
Atrazine	0.003	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops	0.003
Barium	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits	2
Benzene	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills	zero
Benzo(a)pyrene (PAHs)	0.0002	Reproductive difficulties; increased risk of cancer	Leaching from linings of water storage tanks and distribution lines	zero
Beryllium	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries	0.004
Beta photon emitters	4 millirems per year	Increased risk of cancer	Decay of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation	zero
Bromate	0.010	Increased risk of cancer	Byproduct of drinking water disinfection	zero
Cadmium	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints	0.005
Carbofuran	0.04	Problems with blood, nervous system, or reproductive system	Leaching of soil fumigant used on rice and alfalfa	0.04

LEGEND

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
Carbon tetrachloride	0.005	Liver problems; increased risk of cancer	Discharge from chemical plants and other industrial activities	**zero**
Chloramines (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort; anemia	Water additive used to control microbes	**MRDLG=4[1]**
Chlordane	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide	**zero**
Chlorine (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort	Water additive used to control microbes	**MRDLG=4[1]**
Chlorine dioxide (as ClO_2)	MRDL=0.8[1]	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Water additive used to control microbes	**MRDLG=0.8[1]**
Chlorite	1.0	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Byproduct of drinking water disinfection	**0.8**
Chlorobenzene	0.1	Liver or kidney problems	Discharge from chemical and agricultural chemical factories	**0.1**
Chromium (total)	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits	**0.1**
Copper	TT[5]; Action Level=1.3	Short-term exposure: Gastrointestinal distress. Long-term exposure: Liver or kidney damage. People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level	Corrosion of household plumbing systems; erosion of natural deposits	**1.3**
Cryptosporidium	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	**zero**
Cyanide (as free cyanide)	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer factories	**0.2**
2,4-D	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops	**0.07**
Dalapon	0.2	Minor kidney changes	Runoff from herbicide used on rights of way	**0.2**
1,2-Dibromo-3-chloropropane (DBCP)	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards	**zero**
o-Dichlorobenzene	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories	**0.6**
p-Dichlorobenzene	0.075	Anemia; liver, kidney, or spleen damage; changes in blood	Discharge from industrial chemical factories	**0.075**
1,2-Dichloroethane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	**zero**

LEGEND DISINFECTANT | DISINFECTION BYPRODUCT | INORGANIC CHEMICAL | MICROORGANISM | ORGANIC CHEMICAL | RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
1,1-Dichloroethylene	0.007	Liver problems	Discharge from industrial chemical factories	**0.007**
cis-1,2-Dichloroethylene	0.07	Liver problems	Discharge from industrial chemical factories	**0.07**
trans-1,2, Dichloroethylene	0.1	Liver problems	Discharge from industrial chemical factories	**0.1**
Dichloromethane	0.005	Liver problems; increased risk of cancer	Discharge from industrial chemical factories	**zero**
1,2-Dichloropropane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	**zero**
Di(2-ethylhexyl) adipate	0.4	Weight loss, liver problems, or possible reproductive difficulties	Discharge from chemical factories	**0.4**
Di(2-ethylhexyl) phthalate	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories	**zero**
Dinoseb	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables	**0.007**
Dioxin (2,3,7,8-TCDD)	0.00000003	Reproductive difficulties; increased risk of cancer	Emissions from waste incineration and other combustion; discharge from chemical factories	**zero**
Diquat	0.02	Cataracts	Runoff from herbicide use	**0.02**
Endothall	0.1	Stomach and intestinal problems	Runoff from herbicide use	**0.1**
Endrin	0.002	Liver problems	Residue of banned insecticide	**0.002**
Epichlorohydrin	TT[4]	Increased cancer risk; stomach problems	Discharge from industrial chemical factories; an impurity of some water treatment chemicals	**zero**
Ethylbenzene	0.7	Liver or kidney problems	Discharge from petroleum refineries	**0.7**
Ethylene dibromide	0.00005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Discharge from petroleum refineries	**zero**
Fecal coliform and *E. coli*	MCL[6]	Fecal coliforms and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Microbes in these wastes may cause short term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a special health risk for infants, young children, and people with severely compromised immune systems.	Human and animal fecal waste	**zero[6]**

LEGEND

DISINFECTANT | DISINFECTION BYPRODUCT | INORGANIC CHEMICAL | MICROORGANISM | ORGANIC CHEMICAL | RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
Fluoride	4.0	Bone disease (pain and tenderness of the bones); children may get mottled teeth	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories	**4.0**
Giardia lamblia	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	**zero**
Glyphosate	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use	**0.7**
Haloacetic acids (HAA5)	0.060	Increased risk of cancer	Byproduct of drinking water disinfection	**n/a[9]**
Heptachlor	0.0004	Liver damage; increased risk of cancer	Residue of banned termiticide	**zero**
Heptachlor epoxide	0.0002	Liver damage; increased risk of cancer	Breakdown of heptachlor	**zero**
Heterotrophic plate count (HPC)	TT[7]	HPC has no health effects; it is an analytic method used to measure the variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.	HPC measures a range of bacteria that are naturally present in the environment	**n/a**
Hexachlorobenzene	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories	**zero**
Hexachloro-cyclopentadiene	0.05	Kidney or stomach problems	Discharge from chemical factories	**0.05**
Lead	TT[5]; Action Level=0.015	Infants and children: Delays in physical or mental development; children could show slight deficits in attention span and learning abilities; Adults: Kidney problems; high blood pressure	Corrosion of household plumbing systems; erosion of natural deposits	**zero**
Legionella	TT[7]	Legionnaire's Disease, a type of pneumonia	Found naturally in water; multiplies in heating systems	**zero**
Lindane	0.0002	Liver or kidney problems	Runoff/leaching from insecticide used on cattle, lumber, and gardens	**0.0002**
Mercury (inorganic)	0.002	Kidney damage	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands	**0.002**
Methoxychlor	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, and livestock	**0.04**
Nitrate (measured as Nitrogen)	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	**10**

LEGEND

DISINFECTANT | DISINFECTION BYPRODUCT | INORGANIC CHEMICAL | MICROORGANISM | ORGANIC CHEMICAL | RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
Nitrite (measured as Nitrogen)	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	1
Oxamyl (Vydate)	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes	0.2
Pentachlorophenol	0.001	Liver or kidney problems; increased cancer risk	Discharge from wood-preserving factories	zero
Picloram	0.5	Liver problems	Herbicide runoff	0.5
Polychlorinated biphenyls (PCBs)	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals	zero
Radium 226 and Radium 228 (combined)	5 pCi/L	Increased risk of cancer	Erosion of natural deposits	zero
Selenium	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum and metal refineries; erosion of natural deposits; discharge from mines	0.05
Simazine	0.004	Problems with blood	Herbicide runoff	0.004
Styrene	0.1	Liver, kidney, or circulatory system problems	Discharge from rubber and plastic factories; leaching from landfills	0.1
Tetrachloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners	zero
Thallium	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories	0.0005
Toluene	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories	1
Total Coliforms	5.0 percent[8]	Coliforms are bacteria that indicate that other, potentially harmful bacteria may be present. See fecal coliforms and *E. coli*	Naturally present in the environment	zero
Total Trihalomethanes (TTHMs)	0.080	Liver, kidney, or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection	n/a[9]
Toxaphene	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticide used on cotton and cattle	zero
2,4,5-TP (Silvex)	0.05	Liver problems	Residue of banned herbicide	0.05
1,2,4-Trichlorobenzene	0.07	Changes in adrenal glands	Discharge from textile finishing factories	0.07

LEGEND

DISINFECTANT | DISINFECTION BYPRODUCT | INORGANIC CHEMICAL | MICROORGANISM | ORGANIC CHEMICAL | RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
1,1,1-Trichloroethane	0.2	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories	**0.2**
1,1,2-Trichloroethane	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories	**0.003**
Trichloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from metal degreasing sites and other factories	**zero**
Turbidity	TT[7]	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites, and some bacteria. These organisms can cause short term symptoms such as nausea, cramps, diarrhea, and associated headaches.	Soil runoff	**n/a**
Uranium	30µg/L	Increased risk of cancer, kidney toxicity	Erosion of natural deposits	**zero**
Vinyl chloride	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories	**zero**
Viruses (enteric)	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	**zero**
Xylenes (total)	10	Nervous system damage	Discharge from petroleum factories; discharge from chemical factories	**10**

LEGEND DISINFECTANT | DISINFECTION BYPRODUCT | INORGANIC CHEMICAL | MICROORGANISM | ORGANIC CHEMICAL | RADIONUCLIDES

NOTES

1 Definitions
- **Maximum Contaminant Level Goal (MCLG):** The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.
- **Maximum Contaminant Level (MCL):** The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.
- **Maximum Residual Disinfectant Level Goal (MRDLG):** The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- **Maximum Residual Disinfectant Level (MRDL):** The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- **Treatment Technique (TT):** A required process intended to reduce the level of a contaminant in drinking water.

2 Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million (ppm).

3 Health effects are from long-term exposure unless specified as short-term exposure.

4 Each water system must certify annually, in writing, to the state (using third-party or manufacturers certification) that when it uses acrylamide and/or epichlorohydrin to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows: Acrylamide = 0.05 percent dosed at 1 mg/L (or equivalent); Epichlorohydrin = 0.01 percent dosed at 20 mg/L (or equivalent).

5 Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10 percent of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

6 A routine sample that is fecal coliform-positive or E. coli-positive triggers repeat samples--if any repeat sample is total coliform-positive, the system has an acute MCL violation. A routine sample that is total coliform-positive and fecal coliform-negative or E. coli-negative triggers repeat samples--if any repeat sample is fecal coliform-positive or E. coli-positive, the system has an acute MCL violation. See also Total Coliforms.

7 EPA's surface water treatment rules require systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:
- ***Cryptosporidium*:** 99 percent removal for systems that filter. Unfiltered systems are required to include Cryptosporidium in their existing watershed control provisions.
- **Giardia lamblia:** 99.9 percent removal/inactivation
- **Viruses:** 99.9 percent removal/inactivation
- ***Legionella*:** No limit, but EPA believes that if *Giardia* and viruses are removed/inactivated, according to the treatment techniques in the surface water treatment rule, *Legionella* will also be controlled.
- **Turbidity:** For systems that use conventional or direct filtration, at no time can turbidity (cloudiness of water) go higher than 1 nephelometric turbidity unit (NTU), and samples for turbidity must be less than or equal to 0.3 NTU in at least 95 percent of the samples in any month. Systems that use filtration other than the conventional or direct filtration must follow state limits, which must include turbidity at no time exceeding 5 NTU.
- **HPC:** No more than 500 bacterial colonies per milliliter
- **Long Term 1 Enhanced Surface Water Treatment:** Surface water systems or ground water systems under the direct influence of surface water serving fewer than 10,000 people must comply with the applicable Long Term 1 Enhanced Surface Water Treatment Rule provisions (e.g. turbidity standards, individual filter monitoring, *Cryptosporidium* removal requirements, updated watershed control requirements for unfiltered systems).
- **Long Term 2 Enhanced Surface Water Treatment:** This rule applies to all surface water systems or ground water systems under the direct influence of surface water. The rule targets additional *Cryptosporidium* treatment requirements for higher risk systems and includes provisions to reduce risks from uncovered finished water storages facilities and to ensure that the systems maintain microbial protection as they take steps to reduce the formation of disinfection byproducts. (Monitoring start dates are staggered by system size. The largest systems (serving at least 100,000 people) will begin monitoring in October 2006 and the smallest systems (serving fewer than 10,000 people) will not begin monitoring until October 2008. After completing monitoring and determining their treatment bin, systems generally have three years to comply with any additional treatment requirements.)
- **Filter Backwash Recycling:** The Filter Backwash Recycling Rule requires systems that recycle to return specific recycle flows through all processes of the system's existing conventional or direct filtration system or at an alternate location approved by the state.

8 No more than 5.0 percent samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or E. coli. If two consecutive TC-positive samples, and one is also positive for E. coli or fecal coliforms, system has an acute MCL violation.

9 Although there is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants:
- **Haloacetic acids:** dichloroacetic acid (zero); trichloroacetic acid (0.3 mg/L)
- **Trihalomethanes:** bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg/L)

NATIONAL SECONDARY DRINKING WATER REGULATION

National Secondary Drinking Water Regulations are non-enforceable guidelines regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, some states may choose to adopt them as enforceable standards.

Contaminant	Secondary Maximum Contaminant Level
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	Noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

FOR MORE INFORMATION ON EPA'S SAFE DRINKING WATER:

visit: **epa.gov/safewater**

call: **(800) 426-4791**

ADDITIONAL INFORMATION:

To order additional posters or other ground water and drinking water publications, please contact the National Service Center for Environmental Publications at: **(800) 490-9198**, or email: **nscep@bps-lmit.com**.

NDEP Draft Guidelines for Discovery Events (Ground Water RCs)

Appendix B--Reportable Concentrations in Groundwater* Version: 1/28/2009

Analyte	CAS No.	Reportable Concentrations ** (ug/L)
Alachlor	15972-60-8	2.00E+00
Antimony (metallic) ***	7440-36-0	6.00E+00
Arsenic, Inorganic ***	7440-38-2	1.00E+01
Atrazine	1912-24-9	3.00E+00
Barium ***	7440-39-3	2.00E+03
Benzene	71-43-2	5.00E+00
Benzo[a]pyrene	50-32-8	2.00E-01
Beryllium and compounds ***	7440-41-7	4.00E+00
Bis(2-ethylhexyl)phthalate	117-81-7	6.00E+00
Bromate ***	15541-45-4	1.00E+01
Cadmium (Water) ***	7440-43-9	5.00E+00
Carbofuran	1563-66-2	4.00E+01
Carbon Tetrachloride	56-23-5	5.00E+00
Chlordane	12789-03-6	2.00E+00
Chlorobenzene	108-90-7	1.00E+02
Copper ***	7440-50-8	1.30E+03
Cyanide (CN-)	57-12-5	2.00E+02
Dalapon	75-99-0	2.00E+02
Di(2-ethylhexyl)adipate	103-23-1	4.00E+02
Dibromo-3-chloropropane, 1,2-	96-12-8	2.00E-01
Dibromoethane, 1,2- (EDB)	106-93-4	5.00E-02
Dichlorobenzene, 1,2-	95-50-1	6.00E+02
Dichlorobenzene, 1,4-	106-46-7	7.50E+01
Dichloroethane, 1,2- (EDC)	107-06-2	5.00E+00
Dichloroethylene, 1,1-	75-35-4	7.00E+00
Dichloroethylene, 1,2-cis-	156-59-2	7.00E+01
Dichloroethylene, 1,2-trans-	156-60-5	1.00E+02
Dichlorophenoxy Acetic Acid, 2,4-	94-75-7	7.00E+01
Dichloropropane, 1,2-	78-87-5	5.00E+00
Dinoseb	88-85-7	7.00E+00
Diquat	85-00-7	2.00E+01
Endothall	145-73-3	1.00E+02
Endrin	72-20-8	2.00E+00
Ethylbenzene	100-41-4	7.00E+02
Fluorine (Soluble Fluoride) ***	7782-41-4	4.00E+03
Glyphosate	1071-83-6	7.00E+02
Heptachlor	76-44-8	4.00E-01
Heptachlor Epoxide	1024-57-3	2.00E-01
Hexachlorobenzene	118-74-1	1.00E+00
Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	2.00E-01
Hexachlorocyclopentadiene	77-47-4	5.00E+01
Lead and Compounds ***	7439-92-1	1.50E+01
Methoxychlor	72-43-5	4.00E+01
Methylene Chloride	75-09-2	5.00E+00
Methyl tert-Butyl Ether (MTBE)	1634-04-4	2.00E+01
Mercury (elemental) ***	7439-97-6	2.00E+00
Nitrate ***	14797-55-8	1.00E+04
Nitrite ***	14797-65-0	1.00E+03
Oxamyl	23135-22-0	2.00E+02
Pentachlorophenol	87-86-5	1.00E+00
Picloram	1918-02-1	5.00E+02
Polychlorinated Biphenyls	1336-36-3	5.00E-01

NDEP Draft Guidelines for Discovery Events (Ground Water RCs)

Appendix B--Reportable Concentrations in Groundwater* Version: 1/28/2009

Analyte	CAS No.	Reportable Concentrations ** (ug/L)
Selenium ***	7782-49-2	5.00E+01
Simazine	122-34-9	4.00E+00
Styrene	100-42-5	1.00E+02
TCDD, 2,3,7,8-	1746-01-6	3.00E-05
Tetrachloroethylene (PCE)	127-18-4	5.00E+00
Thallium (Soluble Salts) ***	7440-28-0	2.00E+00
Toluene	108-88-3	1.00E+03
Toxaphene	8001-35-2	3.00E+00
Trichlorobenzene, 1,2,4-	120-82-1	7.00E+01
Trichloroethane, 1,1,1-	71-55-6	2.00E+02
Trichloroethane, 1,1,2-	79-00-5	5.00E+00
Trichloroethylene (TCE)	79-01-6	5.00E+00
Trichlorophenoxy) Propionic Acid, 2(2,4,5-	93-72-1	5.00E+01
Vinyl Chloride	75-01-4	2.00E+00
Xylene, Mixture	1330-20-7	1.00E+04

Footnotes:

*-This table is only applicable to the discovery of contaminants in groundwater. Any observed release to ***surface water*** is reportable at the time of observation. If a release to surface water is not observed but is discovered through visual indications or sampling, the release is reportable based on the presence of a visible sheen or concentrations above surface water standards established in NAC 445A.11704 to 445A.225.

**-The reportable concentrations in this table are all based on federal Maximum Contaminant Levels (MCL) with the exception of MTBE, which has an NDEP-derived level. However, reporting requirements for groundwater are not limited to constituents with a promulgated MCL. In determining whether the discovery in groundwater of a pollutant or contaminant without an MCL is reportable, a facility owner may rely on background concentrations, secondary standards, or EPA tap water Regional Screening Levels.

***-Background concentrations are not reportable regardless of whether they are above reportable concentrations.

ATTACHMENT 4

Unanticipated Discovery Plan

bec environmental, inc.
Environmental Services

BEC ENVIRONMENTAL, INC. PLAN AND PROCEDURES FOR THE UNANTICIPATED DISCOVERY OF CULTURAL RESOURCES AND HUMAN SKELETAL REMAINS

Introduction

This plan stipulates the procedures to be used for unanticipated cultural discoveries during field work conducted by BEC Environmental, Inc. (BEC) personnel. It specifies different procedures for the treatment of possible human remains and the treatment of other classes of archaeological discoveries. It also stipulates the different procedures to be used for the treatment of archaeological discoveries within the project areas.

1. Recognizing Cultural Resources

Items to be treated as discoveries will include:

- Human remains
- Prehistoric cultural features, including stained basins, stone circles, dense heat- altered rock concentrations, and bone beds or other bone concentrations
    - Lenses, layers, and patches of prehistoric culturally stained sediment
    - Historic cultural features such as foundations, cellars, or privy holes
    - Culturally modified bone and/or stone artifact concentrations
    - Temporally diagnostic artifacts or obsidian artifact concentrations

Items that will not be treated as discoveries include:

- Isolated artifacts or low density artifact scatters, not including temporally diagnostic artifacts or obsidian artifact concentrations
- Patches of discolored sediment and/or charcoal that are not definitively cultural in origin
- Non-human bone that is not clearly culturally modified or culturally introduced into the deposit

Archaeological resources and human remains are protected under a number of state and national statutes including, but not limited to, the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), the Archaeological Resource Protection Act (ARPA), the Native American Graves Protection and Repatriation Act (NAGPRA), and American Indian Religious Freedom Act (AIRFA). All care must be taken by BEC, its subcontractors, and other personnel on site to adhere to the mandates of legislation regarding the protection of cultural resources within the each of the project areas of potential effect (APE). The State Historic Preservation Office (SHPO) will be consulted concerning any discoveries deemed as eligible for inclusion in the National Register of Historic Places (NRHP).

Some historic properties are determined to be significant and worthy of protection considerations, as established by the NHPA and its implementing regulations. The steps to identifying, evaluating the significance of, and assessing the effects on historic properties are clearly identified in 36 CFR 800. .

2. On-Site Responsibilities

- STOP WORK. If any BEC Staff, Occasional Field Staff or site visitor believes that he or she has located or uncovered any cultural resource at any point in the project, all work within 50 feet of the discovery must stop. The BEC Field Safety Supervisor (FSS) will ensure the following actions are taken:

1. Stop work immediately if they observe any indication of the presence of cultural materials (artifacts or other man-made features), animal bone, or possibly human bone.
2. If there is an archaeological monitor for the project, notify that person. If there is a monitoring plan in place, follow its provisions. C. Comply with unanticipated discovery procedures.
3. Treat human remains with dignity and respect.

In the event of an unanticipated discovery, the excavation activity that resulted in the exposure of the discovery will be immediately halted, followed as soon as possible by the cessation of all other ground-disturbing activity within 50ft (15m) of the discovery. After all activity within 50ft (15m) area of the discovery has been halted, the following steps will be taken to ensure that no further disturbance occurs to the discovery:

1. Secure an area at least 50ft (15m) in each direction from the discovery, as necessary, with clearly visible barricading of an appropriate type to prohibit entry to the vicinity.
2. Prevent vehicle traffic through the area immediately surrounding the discovery.

In all cases, EPA (or the Client's project officer) will be notified by the BEC representative immediately by phone or in person, followed by written notification of any discoveries of archaeological materials. The Nevada State Historic Preservation Office (SHPO) would also be notified by EPA or BEC regarding any unanticipated discovery. Discovery situations will be handled in an expedited and respectful manner, so as to not interfere with the work/project schedule any more than is necessary. In all discovery situations, work will be redirected away from the discovery, or halted by BEC's designated official at the discovery location for a period of time adequate to assess the nature of the discovery and to determine the necessary course of action as determined by the EPA and the SHPO.

Work will not resume in the area of discovery until such time as authorized by EPA.

Human Remains

Human remains and associated artifacts may be discovered during excavation activities. If human remains are discovered under any circumstances, they will be secured and protected until such time as appropriate disposition has been determined in accordance with applicable local, state, and Federal statutes. Pursuant to federal laws, upon the discovery of any human remains, regardless of land ownership the appropriate **County Sheriff and coroner** shall be immediately notified in case such remains might represent a crime scene. The Sheriff and appropriate specialists will determine if the remains are modern or archaeological. Work activities in the immediate vicinity of the discovery 100ft (30.5 m) will cease immediately, but may continue elsewhere in the APE. Immediately upon discovery, the area will secured with appropriate security and avoidance measures. Protective measures, such as covering the area with a tarp, will occur in adverse weather conditions. In all instances the goal shall be to prevent deterioration of or further damage to the remains and the area associated with those remains. It may be necessary to provide 24-hour, on-site security for NAGPRA-associated discoveries or for other discoveries as determined by EPA.

Procedure When Human Remains and/or Potentially Human Skeletal Materials are Observed

Human remains are physical remains of a human body or bodies including, but not limited to, bones, teeth, hair, ashes, and preserved soft tissues (mummified or otherwise preserved) of an individual. Remains may be articulated or disarticulated bones or teeth.

Any suspected human skeletal remains encountered during the project will be treated in accordance with applicable local, state, and Federal statutes, including the Native American Graves Protection and Repatriation Act:

- Workers will treat all human remains with dignity and respect.
- Immediately stop work in the vicinity of an unanticipated discovery involving potentially human remains.
- Immediately notify the FSS about the find.
- If the FSS believes that potentially human skeletal remains have been found, he/she will stop all ground-disturbing activities within the area of the potential discovery.
    - Protect and secure the evidence of the discovery.
    - Delineate the area with flagging or safety fencing.

Testing to Determine Site NRHP Eligibility and/or Project Effect

Should further testing under this section be required, the Client will make arrangements, or direct BEC to arrange for a qualified archeologist to conduct these tests.

Subsurface testing may be required to obtain data necessary to evaluate the NRHP eligibility of discovery sites or to assess the project's effect on historic properties. It will be conducted before excavation and reclamation have been resumed. Such testing may result in recommendations for data recovery excavations to mitigate adverse effects to NRHP eligible sites if excavation were to resume prior to such actions. In some cases, it is likely that this testing stage may lead to recommendations that the discoveries are not eligible or do not contribute to a historic property's eligibility.

Testing of the potentially eligible discoveries during the excavation phase of the project will be limited to assessing the potential for impacting intact portions of significant discoveries that may be disturbed by continuing excavation, potentially resulting in further adverse effects to the discovery. It will involve the excavation of systematic arrays of auger probes on a 1 x 1-m or 2 x 2-m grid (depending on the nature and size of discovery). Formal test units may also be excavated to better assess the nature of positive auger probes.

Any test excavations will adhere to standard field and laboratory procedures. All excavated deposits will be screened using 1/8-inch mesh hardware cloth except in cases of clay soils, where 1/4-inch mesh hardware cloth may be used. Test units will be excavated in arbitrary 10-cm levels. Features will be excavated as discrete elements, and will be documented with plan maps, profiles, and photographs, as appropriate. Feature fill samples will be taken for the purpose of radiometric and plant macrofossil analysis.

Disposition of Collected Material

Curation of all records and other items resulting from identification and data recovery efforts shall be completed by the archeologist in accordance with 36 CFR Part 79, and the provisions of the Native American Graves Protection and Repatriation Act (PL 101-601). Documentation of the curation of collected materials shall be provided to EPA and SHPO within 30 calendar-days of completion of the project. All non-funerary artifacts collected will be curated at the Nevada State Museum in Carson City, Nevada.

Key Contacts

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ATTACHMENT 5

Standard Operating Procedures

METHOD 200.8

DETERMINATION OF TRACE ELEMENTS IN WATERS AND WASTES BY INDUCTIVELY COUPLED PLASMA - MASS SPECTROMETRY

Revision 5.4
EMMC Version

S.E. Long (Technology Applications Inc.), T.D. Martin, and E.R. Martin - Method 200.8, Revisions 4.2 and 4.3 (1990)

S.E. Long (Technology Applications Inc.) and T.D. Martin - Method 200.8, Revision 4.4 (1991)

J.T. Creed, C.A. Brockhoff, and T.D. Martin - Method 200.8, Revision 5.4 (1994)

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268
METHOD 200.8

DETERMINATION OF TRACE ELEMENTS IN WATERS AND WASTES BY INDUCTIVELY COUPLED PLASMA - MASS SPECTROMETRY

1.0 SCOPE AND APPLICATION

1.1 This method provides procedures for determination of dissolved elements in ground waters, surface waters and drinking water. It may also be used for determination of total recoverable element concentrations in these waters as well as wastewaters, sludges and soils samples. This method is applicable to the following elements:

Analyte		Chemical Abstract Services Registry Number (CASRN)
Aluminum	(Al)	7429-90-5
Antimony	(Sb)	7440-36-0
Arsenic	(As)	7440-38-2
Barium	(Ba)	7440-39-3
Beryllium	(Be)	7440-41-7
Cadmium	(Cd)	7440-43-9
Chromium	(Cr)	7440-47-3
Cobalt	(Co)	7440-48-4
Copper	(Cu)	7440-50-8
Lead	(Pb)	7439-92-1
Manganese	(Mn)	7439-96-5
Mercury	(Hg)	7439-97-6
Molybdenum	(Mo)	7439-98-7
Nickel	(Ni)	7440-02-0
Selenium	(Se)	7782-49-2
Silver	(Ag)	7440-22-4
Thallium	(Tl)	7440-28-0
Thorium	(Th)	7440-29-1
Uranium	(U)	7440-61-1
Vanadium	(V)	7440-62-2
Zinc	(Zn)	7440-66-6

Estimated instrument detection limits (IDLs) for these elements are listed in Table 1. These are intended as a guide to instrumental limits typical of a system optimized for multielement determinations and employing commercial instrumentation and pneumatic nebulization sample introduction. However, actual method detection limits (MDLs) and linear working ranges will be dependent on the sample matrix, instrumentation and selected operating conditions. Given in Table 7 are typical MDLs for both total recoverable determinations by "direct analysis" and where sample digestion is employed.

1.2 For reference where this method is approved for use in compliance monitoring programs [e.g., Clean Water Act (NPDES) or Safe Drinking Water Act (SDWA)] consult both the appropriate sections of the Code of Federal Regulation (40 CFR Part 136 Table 1B for NPDES, and Part 141 § 141.23 for drinking water), and the latest Federal Register announcements.

1.3 Dissolved elements are determined after suitable filtration and acid preservation. In order to reduce potential interferences, dissolved solids should not exceed 0.2% (w/v) (Section 4.1.4).

1.4 With the exception of silver, where this method is approved for the determination of certain metal and metalloid contaminants in drinking water, samples may be analyzed directly by pneumatic nebulization without acid digestion if the samples have been properly preserved with acid and have turbidity of <1 NTU at the time of analysis. This total recoverable determination procedure is referred to as "direct analysis".

1.5 For the determination of total recoverable analytes in aqueous and solid samples a digestion/extraction is required prior to analysis when the elements are not in solution (e.g., soils, sludges, sediments and aqueous samples that may contain particulate and suspended solids). Aqueous samples containing suspended or particulate material ≥1% (w/v) should be extracted as a solid type sample (Section 11.2.2).

1.6 The total recoverable sample digestion procedure given in this method is not suitable for the determination of volatile organo-mercury compounds. However, for "direct analysis" of drinking water (turbidity <1 NTU), the combined concentrations of inorganic and organo-mercury in solution can be determined by "direct analysis" pneumatic nebulization provided gold is added to both samples and standards alike to eliminate memory interference effects.

1.7 Silver is only slightly soluble in the presence of chloride unless there is a sufficient chloride concentration to form the soluble chloride complex. Therefore, low recoveries of silver may occur in samples, fortified sample matrices and even fortified blanks if determined as a dissolved analyte or by "direct analysis" where the sample has not been processed using the total recoverable mixed acid digestion. For this reason it is recommended that samples be digested prior to the determination of silver. The total recoverable sample digestion procedure given in this method is suitable for the determination of silver in aqueous samples containing concentrations up to 0.1 mg/L. For the analysis of wastewater samples containing higher concentrations of silver, succeeding smaller volume, well mixed sample aliquots must be prepared until the analysis solution contains <0.1 mg/L silver. The extraction of solid samples containing concentrations of silver >50 mg/kg should be treated in a similar manner.

1.8 The total recoverable sample digestion procedure given in this method will solubilize and hold in solution only minimal concentrations of barium in the presence of free sulfate. For the analysis of barium in samples having varying

and unknown concentrations of sulfate, analysis should be completed as soon as possible after sample preparation.

1.9 This method should be used by analysts experienced in the use of inductively coupled plasma mass spectrometry (ICP-MS), the interpretation of spectral and matrix interferences and procedures for their correction. A minimum of six months experience with commercial instrumentation is recommended.

1.10 Users of the method data should state the data-quality objectives prior to analysis. Users of the method must document and have on file the required initial demonstration performance data described in Section 9.2 prior to using the method for analysis.

2.0 SUMMARY OF METHOD

2.1 An aliquot of a well mixed, homogeneous aqueous or solid sample is accurately weighed or measured for sample processing. For total recoverable analysis of a solid or an aqueous sample containing undissolved material, analytes are first solubilized by gentle refluxing with nitric and hydrochloric acids. After cooling, the sample is made up to volume, is mixed and centrifuged or allowed to settle overnight prior to analysis. For the determination of dissolved analytes in a filtered aqueous sample aliquot, or for the "direct analysis" total recoverable determination of analytes in drinking water where sample turbidity is <1 NTU, the sample is made ready for analysis by the appropriate addition of nitric acid, and then diluted to a predetermined volume and mixed before analysis.

2.2 The method describes the multi-element determination of trace elements by ICP-MS.[1-3] Sample material in solution is introduced by pneumatic nebulization into a radiofrequency plasma where energy transfer processes cause desolvation, atomization and ionization. The ions are extracted from the plasma through a differentially pumped vacuum interface and separated on the basis of their mass-to-charge ratio by a quadrupole mass spectrometer having a minimum resolution capability of 1 amu peak width at 5% peak height. The ions transmitted through the quadrupole are detected by an electron multiplier or Faraday detector and the ion information processed by a data handling system. Interferences relating to the technique (Section 4.0) must be recognized and corrected for. Such corrections must include compensation for isobaric elemental interferences and interferences from polyatomic ions derived from the plasma gas, reagents or sample matrix. Instrumental drift as well as suppressions or enhancements of instrument response caused by the sample matrix must be corrected for by the use of internal standards.

3.0 DEFINITIONS

3.1 **Calibration Blank** - A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to calibrate the ICP instrument (Section 7.6.1).

3.2 **Calibration Standard (CAL)** - A solution prepared from the dilution of stock standard solutions. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration (Section 7.4).

3.3 **Dissolved Analyte** - The concentration of analyte in an aqueous sample that will pass through a 0.45 µm membrane filter assembly prior to sample acidification (Section 11.1).

3.4 **Field Reagent Blank (FRB)** - An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to the sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FRB is to determine if method analytes or other interferences are present in the field environment (Section 8.5).

3.5 **Instrument Detection Limit (IDL)** - The concentration equivalent to the analyte signal which is equal to three times the standard deviation of a series of 10 replicate measurements of the calibration blank signal at the selected analytical mass(es). (Table 1).

3.6 **Internal Standard** - Pure analyte(s) added to a sample, extract, or standard solution in known amount(s) and used to measure the relative responses of other method analytes that are components of the same sample or solution. The internal standard must be an analyte that is not a sample component (Sections 7.5 and 9.4.5).

3.7 **Laboratory Duplicates (LD1 and LD2)** - Two aliquots of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of LD1 and LD2 indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

3.8 **Laboratory Fortified Blank (LFB)** - An aliquot of LRB to which known quantities of the method analytes are added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements (Sections 7.9 and 9.3.2).

3.9 **Laboratory Fortified Sample Matrix (LFM)** - An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations (Section 9.4).

3.10 **Laboratory Reagent Blank (LRB)** - An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples. The LRB is used to determine if method analytes or other interferences

are present in the laboratory environment, reagents, or apparatus (Sections 7.6.2 and 9.3.1).

3.11 **Linear Dynamic Range (LDR)** - The concentration range over which the instrument response to an analyte is linear (Section 9.2.2).

3.12 **Method Detection Limit (MDL)** - The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero (Section 9.2.4 and Table 7).

3.13 **Quality Control Sample (QCS)** - A solution of method analytes of known concentrations which is used to fortify an aliquot of LRB or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check either laboratory or instrument performance (Sections 7.8 and 9.2.3).

3.14 **Solid Sample** - For the purpose of this method, a sample taken from material classified as either soil, sediment or sludge.

3.15 **Stock Standard Solution** - A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source (Section 7.3).

3.16 **Total Recoverable Analyte** - The concentration of analyte determined either by "direct analysis" of an unfiltered acid preserved drinking water sample with turbidity of <1 NTU (Section 11.2.1), or by analysis of the solution extract of a solid sample or an unfiltered aqueous sample following digestion by refluxing with hot dilute mineral acid(s) as specified in the method (Sections 11.2 and 11.3).

3.17 **Tuning Solution** - A solution which is used to determine acceptable instrument performance prior to calibration and sample analyses (Section 7.7).

3.18 **Water Sample** - For the purpose of this method, a sample taken from one of the following sources: drinking, surface, ground, storm runoff, industrial or domestic wastewater.

4.0 INTERFERENCES

4.1 Several interference sources may cause inaccuracies in the determination of trace elements by ICP-MS. These are:

4.1.1 Isobaric elemental interferences - Are caused by isotopes of different elements which form singly or doubly charged ions of the same nominal mass-to-charge ratio and which cannot be resolved by the mass spectrometer in use. All elements determined by this method have, at a minimum, one isotope free of isobaric elemental interference. Of the analytical isotopes recommended for use with this method (Table 4), only molybdenum-98 (ruthenium) and selenium-82 (krypton) have isobaric elemental interferences. If alternative analytical isotopes having higher

natural abundance are selected in order to achieve greater sensitivity, an isobaric interference may occur. All data obtained under such conditions must be corrected by measuring the signal from another isotope of the interfering element and subtracting the appropriate signal ratio from the isotope of interest. A record of this correction process should be included with the report of the data. It should be noted that such corrections will only be as accurate as the accuracy of the isotope ratio used in the elemental equation for data calculations. Relevant isotope ratios should be established prior to the application of any corrections.

4.1.2 Abundance sensitivity - Is a property defining the degree to which the wings of a mass peak contribute to adjacent masses. The abundance sensitivity is affected by ion energy and quadrupole operating pressure. Wing overlap interferences may result when a small ion peak is being measured adjacent to a large one. The potential for these interferences should be recognized and the spectrometer resolution adjusted to minimize them.

4.1.3 Isobaric polyatomic ion interferences - Are caused by ions consisting of more than one atom which have the same nominal mass-to-charge ratio as the isotope of interest, and which cannot be resolved by the mass spectrometer in use. These ions are commonly formed in the plasma or interface system from support gases or sample components. Most of the common interferences have been identified[3], and these are listed in Table2 together with the method elements affected. Such interferences must be recognized, and when they cannot be avoided by the selection of alternative analytical isotopes, appropriate corrections must be made to the data. Equations for the correction of data should be established at the time of the analytical run sequence as the polyatomic ion interferences will be highly dependent on the sample matrix and chosen instrument conditions. In particular, the common ^{82}Kr interference that affects the determination of both arsenic and selenium, can be greatly reduced with the use of high purity krypton free argon.

4.1.4 Physical interferences - Are associated with the physical processes which govern the transport of sample into the plasma, sample conversion processes in the plasma, and the transmission of ions through the plasma-mass spectrometer interface. These interferences may result in differences between instrument responses for the sample and the calibration standards. Physical interferences may occur in the transfer of solution to the nebulizer (e.g., viscosity effects), at the point of aerosol formation and transport to the plasma (e.g., surface tension), or during excitation and ionization processes within the plasma itself. High levels of dissolved solids in the sample may contribute deposits of material on the extraction and/or skimmer cones reducing the effective diameter of the orifices and therefore ion transmission. Dissolved solids levels not exceeding 0.2% (w/v) have been recommended[3] to reduce such effects. Internal standardization may be effectively used to compensate for many physical interference effects.[4] Internal standards ideally should have similar

analytical behavior to the elements being determined.

4.1.5 Memory interferences - Result when isotopes of elements in a previous sample contribute to the signals measured in a new sample. Memory effects can result from sample deposition on the sampler and skimmer cones, and from the buildup of sample material in the plasma torch and spray chamber. The site where these effects occur is dependent on the element and can be minimized by flushing the system with a rinse blank between samples (Section 7.6.3). The possibility of memory interferences should be recognized within an analytical run and suitable rinse times should be used to reduce them. The rinse times necessary for a particular element should be estimated prior to analysis. This may be achieved by aspirating a standard containing elements corresponding to 10 times the upper end of the linear range for a normal sample analysis period, followed by analysis of the rinse blank at designated intervals. The length of time required to reduce analyte signals to within a factor of 10 of the method detection limit, should be noted. Memory interferences may also be assessed within an analytical run by using a minimum of three replicate integrations for data acquisition. If the integrated signal values drop consecutively, the analyst should be alerted to the possibility of a memory effect, and should examine the analyte concentration in the previous sample to identify if this was high. If a memory interference is suspected, the sample should be reanalyzed after a long rinse period. In the determination of mercury, which suffers from severe memory effects, the addition of 100 µg/L gold will effectively rinse 5 µg/L mercury in approximately two minutes. Higher concentrations will require a longer rinse time.

5.0 SAFETY

5.1 The toxicity or carcinogenicity of reagents used in this method have not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable. Each laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method.[5,8] A reference file of material data handling sheets should also be available to all personnel involved in the chemical analysis. Specifically, concentrated nitric and hydrochloric acids present various hazards and are moderately toxic and extremely irritating to skin and mucus membranes. Use these reagents in a fume hood whenever possible and if eye or skin contact occurs, flush with large volumes of water. Always wear safety glasses or a shield for eye protection, protective clothing and observe proper mixing when working with these reagents.

5.2 The acidification of samples containing reactive materials may result in the release of toxic gases, such as cyanides or sulfides. Acidification of samples should be done in a fume hood.

5.3 All personnel handling environmental samples known to contain or to have been

in contact with human waste should be immunized against known disease causative agents.

5.4 Analytical plasma sources emit radiofrequency radiation in addition to intense UV radiation. Suitable precautions should be taken to protect personnel from such hazards. The inductively coupled plasma should only be viewed with proper eye protection from UV emissions.

5.5 It is the responsibility of the user of this method to comply with relevant disposal and waste regulations. For guidance see Sections 14.0 and 15.0.

6.0 EQUIPMENT AND SUPPLIES

6.1 Inductively coupled plasma mass spectrometer:

6.1.1 Instrument capable of scanning the mass range 5-250 amu with a minimum resolution capability of 1 amu peak width at 5% peak height. Instrument may be fitted with a conventional or extended dynamic range detection system.

Note: If an electron multiplier detector is being used, precautions should be taken, where necessary, to prevent exposure to high ion flux. Otherwise changes in instrument response or damage to the multiplier may result.

6.1.2 Radio-frequency generator compliant with FCC regulations.

6.1.3 Argon gas supply - High purity grade (99.99%). When analyses are conducted frequently, liquid argon is more economical and requires less frequent replacement of tanks than compressed argon in conventional cylinders (Section 4.1.3).

6.1.4 A variable-speed peristaltic pump is required for solution delivery to the nebulizer.

6.1.5 A mass-flow controller on the nebulizer gas supply is required. A water-cooled spray chamber may be of benefit in reducing some types of interferences (e.g., from polyatomic oxide species).

6.1.6 If an electron multiplier detector is being used, precautions should be taken, where necessary, to prevent exposure to high ion flux. Otherwise changes in instrument response or damage to the multiplier may result. Samples having high concentrations of elements beyond the linear range of the instrument and with isotopes falling within scanning windows should be diluted prior to analysis.

6.2 Analytical balance, with capability to measure to 0.1 mg, for use in weighing solids, for preparing standards, and for determining dissolved solids in digests or extracts.

6.3 A temperature adjustable hot plate capable of maintaining a temperature of 95°C.

6.4 (Optional) A temperature adjustable block digester capable of maintaining a temperature of 95°C and equipped with 250 mL constricted digestion tubes.

6.5 (Optional) A steel cabinet centrifuge with guard bowl, electric timer and brake.

6.6 A gravity convection drying oven with thermostatic control capable of maintaining 105°C ± 5°C.

6.7 (Optional) An air displacement pipetter capable of delivering volumes ranging from 0.1-2500 µL with an assortment of high quality disposable pipet tips.

6.8 Mortar and pestle, ceramic or nonmetallic material.

6.9 Polypropylene sieve, 5-mesh (4 mm opening).

6.10 Labware - For determination of trace levels of elements, contamination and loss are of prime consideration. Potential contamination sources include improperly cleaned laboratory apparatus and general contamination within the laboratory environment from dust, etc. A clean laboratory work area designated for trace element sample handling must be used. Sample containers can introduce positive and negative errors in the determination of trace elements by (1) contributing contaminants through surface desorption or leaching, (2) depleting element concentrations through adsorption processes. All reusable labware (glass, quartz, polyethylene, PTFE, FEP, etc.) should be sufficiently clean for the task objectives. Several procedures found to provide clean labware include soaking overnight and thoroughly washing with laboratory-grade detergent and water, rinsing with tap water, and soaking for four hours or more in 20% (V/V) nitric acid or a mixture of dilute nitric and hydrochloric acid (1+2+9), followed by rinsing with reagent grade water and storing clean.

Note: Chromic acid must not be used for cleaning glassware.

6.10.1 Glassware - Volumetric flasks, graduated cylinders, funnels and centrifuge tubes (glass and/or metal free plastic).

6.10.2 Assorted calibrated pipettes.

6.10.3 Conical Phillips beakers (Corning 1080-250 or equivalent), 250 mL with 50 mm watch glasses.

6.10.4 Griffin beakers, 250 mL with 75 mm watch glasses and (optional) 75 mm ribbed watch glasses.

6.10.5 (Optional) PTFE and/or quartz beakers, 250 mL with PTFE covers.

6.10.6 Evaporating dishes or high-form crucibles, porcelain, 100 mL capacity.

6.10.7 Narrow-mouth storage bottles, FEP (fluorinated ethylene propylene) with ETFE (ethylene tetrafluorethylene) screw closure, 125-250 mL capacities.

6.10.8 One-piece stem FEP wash bottle with screw closure, 125 mL capacity.

7.0 REAGENTS AND STANDARDS

7.1 Reagents may contain elemental impurities that might affect the integrity of analytical data. Owing to the high sensitivity of ICP-MS, high-purity reagents should be used whenever possible. All acids used for this method must be of ultra high-purity grade. Suitable acids are available from a number of manufacturers or may be prepared by sub-boiling distillation. Nitric acid is preferred for ICP-MS in order to minimize polyatomic ion interferences. Several polyatomic ion interferences result when hydrochloric acid is used (Table 2), however, it should be noted that hydrochloric acid is required to maintain stability in solutions containing antimony and silver. When hydrochloric acid is used, corrections for the chloride polyatomic ion interferences must be applied to all data.

7.1.1 Nitric acid, concentrated (sp.gr. 1.41).

7.1.2 Nitric acid (1+1) - Add 500 mL conc. nitric acid to 400 mL of regent grade water and dilute to 1 L.

7.1.3 Nitric acid (1+9) - Add 100 mL conc. nitric acid to 400 mL of reagent grade water and dilute to 1 L.

7.1.4 Hydrochloric acid, concentrated (sp.gr. 1.19).

7.1.5 Hydrochloric acid (1+1) - Add 500 mL conc. hydrochloric acid to 400 mL of reagent grade water and dilute to 1 L.

7.1.6 Hydrochloric acid (1+4) - Add 200 mL conc. hydrochloric acid to 400 mL of reagent grade water and dilute to 1 L.

7.1.7 Ammonium hydroxide, concentrated (sp.gr. 0.902).

7.1.8 Tartaric acid (CASRN 87-69-4).

7.2 Reagent water - All references to reagent grade water in this method refer to ASTM Type I water (ASTM D1193).[9] Suitable water may be prepared by passing distilled water through a mixed bed of anion and cation exchange resins.

7.3 Standard Stock Solutions - Stock standards may be purchased from a reputable commercial source or prepared from ultra high-purity grade chemicals or metals (99.99-99.999% pure). All salts should be dried for one hour at 105°C, unless otherwise specified. Stock solutions should be stored in FEP bottles. Replace stock standards when succeeding dilutions for preparation of the multielement stock standards can not be verified.

CAUTION: Many metal salts are extremely toxic if inhaled or swallowed. Wash hands thoroughly after handling.

The following procedures may be used for preparing standard stock solutions:

Note: Some metals, particularly those which form surface oxides require cleaning prior to being weighed. This may be achieved by pickling the surface of the metal in acid. An amount in excess of the desired weight should be pickled repeatedly, rinsed with water, dried and weighed until the desired weight is achieved.

7.3.1 Aluminum solution, stock 1 mL = 1000 µg Al: Pickle aluminum metal in warm (1+1) HCl to an exact weight of 0.100 g. Dissolve in 10 mL conc. HCl and 2 mL conc. nitric acid, heating to effect solution. Continue heating until volume is reduced to 4 mL. Cool and add 4 mL reagent grade water. Heat until the volume is reduced to 2 mL. Cool and dilute to 100 mL with reagent grade water.

7.3.2 Antimony solution, stock 1 mL = 1000 µg Sb: Dissolve 0.100 g antimony powder in 2 mL (1+1) nitric acid and 0.5 mL conc. hydrochloric acid, heating to effect solution. Cool, add 20 mL reagent grade water and 0.15 g tartaric acid. Warm the solution to dissolve the white precipitate. Cool and dilute to 100 mL with reagent grade water.

7.3.3 Arsenic solution, stock 1 mL = 1000 µg As: Dissolve 0.1320 g As_2O_3 in a mixture of 50 mL reagent grade water and 1 mL conc. ammonium hydroxide. Heat gently to dissolve. Cool and acidify the solution with 2 mL conc. nitric acid. Dilute to 100 mL with reagent grade water.

7.3.4 Barium solution, stock 1 mL = 1000 µg Ba: Dissolve 0.1437 g $BaCO_3$ in a solution mixture of 10 mL reagent grade water and 2 mL conc. nitric acid. Heat and stir to effect solution and degassing. Dilute to 100 mL with reagent grade water.

7.3.5 Beryllium solution, stock 1 mL = 1000 µg Be: Dissolve 1.965 g $BeSO_4 \bullet 4H_2O$ (DO NOT DRY) in 50 mL reagent grade water. Add 1 mL conc. nitric acid. Dilute to 100 mL with reagent grade water.

7.3.6 Bismuth solution, stock 1 mL = 1000 µg Bi: Dissolve 0.1115 g Bi_2O_3 in 5 mL conc. nitric acid. Heat to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.7 Cadmium solution, stock 1 mL = 1000 µg Cd: Pickle cadmium metal in (1+9) nitric acid to an exact weight of 0.100 g. Dissolve in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.8 Chromium solution, stock 1 mL = 1000 µg Cr: Dissolve 0.1923 g CrO_3 in a solution mixture of 10 mL reagent grade water and 1 mL conc. nitric

acid. Dilute to 100 mL with reagent grade water.

7.3.9 Cobalt solution, stock 1 mL = 1000 µg Co: Pickle cobalt metal in (1+9) nitric acid to an exact weight of 0.100 g. Dissolve in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.10 Copper solution, stock 1 mL = 1000 µg Cu: Pickle copper metal in (1+9) nitric acid to an exact weight of 0.100 g. Dissolve in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.11 Gold solution, stock 1 mL = 1000 µg Au: Dissolve 0.100 g high purity (99.9999%) Au shot in 10 mL of hot conc. nitric acid by dropwise addition of 5 mL conc. HCl and then reflux to expel oxides of nitrogen and chlorine. Cool and dilute to 100 mL with reagent grade water.

7.3.12 Indium solution, stock 1 mL = 1000 µg In: Pickle indium metal in (1+1) nitric acid to an exact weight of 0.100 g. Dissolve in 10 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.13 Lead solution, stock 1 mL = 1000 µg Pb: Dissolve 0.1599 g $PbNO_3$ in 5 mL (1+1) nitric acid. Dilute to 100 mL with reagent grade water.

7.3.14 Magnesium solution, stock 1 mL = 1000 µg Mg: Dissolve 0.1658 g MgO in 10 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.15 Manganese solution, stock 1 mL = 1000 µg Mn: Pickle manganese flake in (1+9) nitric acid to an exact weight of 0.100 g. Dissolve in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.16 Mercury solution, stock, 1 mL = 1000 µg Hg: DO NOT DRY. **CAUTION**: highly toxic element. Dissolve 0.1354 g $HgCl_2$ in reagent water. Add 5.0 mL concentrated HNO_3 and dilute to 100 mL with reagent water.

7.3.17 Molybdenum solution, stock 1 mL = 1000 µg Mo: Dissolve 0.1500 g MoO_3 in a solution mixture of 10 mL reagent grade water and 1 mL conc. ammonium hydroxide., heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.18 Nickel solution, stock 1 mL = 1000 µg Ni: Dissolve 0.100 g nickel powder in 5 mL conc. nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.19 Scandium solution, stock 1 mL = 1000 µg Sc: Dissolve 0.1534 g Sc_2O_3 in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to

100 mL with reagent grade water.

7.3.20 Selenium solution, stock 1 mL = 1000 µg Se: Dissolve 0.1405 g SeO_2 in 20 mL ASTM Type I water. Dilute to 100 mL with reagent grade water.

7.3.21 Silver solution, stock 1 mL = 1000 µg Ag: Dissolve 0.100 g silver metal in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water. Store in dark container.

7.3.22 Terbium solution, stock 1 mL = 1000 µg Tb: Dissolve 0.1176 g Tb_4O_7 in 5 mL conc. nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.23 Thallium solution, stock 1 mL = 1000 µg Tl: Dissolve 0.1303 g $TlNO_3$ in a solution mixture of 10 mL reagent grade water and 1 mL conc. nitric acid. Dilute to 100 mL with reagent grade water.

7.3.24 Thorium solution, stock 1 mL = 1000 µg Th: Dissolve 0.2380 g $Th(NO_3)_4 \cdot 4H_2O$ (DO NOT DRY) in 20 mL reagent grade water. Dilute to 100 mL with reagent grade water.

7.3.25 Uranium solution, stock 1 mL = 1000 µg U: Dissolve 0.2110 g $UO_2(NO_3)_2 \cdot 6H_2O$ (DO NOT DRY) in 20 mL reagent grade water and dilute to 100 mL with reagent grade water.

7.3.26 Vanadium solution, stock 1 mL = 1000 µg V: Pickle vanadium metal in (1+9) nitric acid to an exact weight of 0.100 g. Dissolve in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.27 Yttrium solution, stock 1 mL = 1000 µg Y: Dissolve 0.1270 g Y_2O_3 in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.3.28 Zinc solution, stock 1 mL = 1000 µg Zn: Pickle zinc metal in (1+9) nitric acid to an exact weight of 0.100 g. Dissolve in 5 mL (1+1) nitric acid, heating to effect solution. Cool and dilute to 100 mL with reagent grade water.

7.4 Multielement Stock Standard Solutions - Care must be taken in the preparation of multielement stock standards that the elements are compatible and stable. Originating element stocks should be checked for the presence of impurities which might influence the accuracy of the standard. Freshly prepared standards should be transferred to acid cleaned, not previously used FEP fluorocarbon bottles for storage and monitored periodically for stability. The following combinations of elements are suggested:

Standard Solution A		Standard Solution B
Aluminum	Mercury	Barium
Antimony	Molybdenum	Silver
Arsenic	Nickel	
Beryllium	Selenium	
Cadmium	Thallium	
Chromium	Thorium	
Cobalt	Uranium	
Copper	Vanadium	
Lead	Zinc	
Manganese		

Except for selenium and mercury, multielement stock standard solutions A and B (1 mL = 10 µg) may be prepared by diluting 1.0 mL of each single element stock standard in the combination list to 100 mL with reagent water containing 1% (v/v) nitric acid. For mercury and selenium in solution A, aliquots of 0.05 mL and 5.0 mL of the respective stock standards should be diluted to the specified 100 mL (1 ml = 0.5 µg Hg and 50 µg Se). Replace the multielement stock standards when succeeding dilutions for preparation of the calibration standards cannot be verified with the quality control sample.

7.4.1 Preparation of calibration standards - fresh multielement calibration standards should be prepared every two weeks or as needed. Dilute each of the stock multielement standard solutions A and B to levels appropriate to the operating range of the instrument using reagent water containing 1% (v/v) nitric acid. The element concentrations in the standards should be sufficiently high to produce good measurement precision and to accurately define the slope of the response curve. Depending on the sensitivity of the instrument, concentrations ranging from 10-200 µg/L are suggested, except mercury, which should be limited to ≤5 µg/L. It should be noted the selenium concentration is always a factor of 5 greater than the other analytes. If the direct addition procedure is being used (Method A, Section 10.3), add internal standards (Section 7.5) to the calibration standards and store in FEP bottles. Calibration standards should be verified initially using a quality control sample (Section 7.8).

7.5 Internal Standards Stock Solution - 1 mL = 100 µg. Dilute 10 mL of scandium, yttrium, indium, terbium and bismuth stock standards (Section 7.3) to 100 mL with reagent water, and store in a FEP bottle. Use this solution concentrate for addition to blanks, calibration standards and samples, or dilute by an appropriate amount using 1% (v/v) nitric acid, if the internal standards are being added by peristaltic pump (Method B, Section 10.3).

Note: If mercury is to be determined by the "direct analysis" procedure, add an aliquot of the gold stock standard (Section 7.3.11) to the internal standard solution sufficient to provide a concentration of 100 µg/L in final the dilution of all blanks, calibration standards, and samples.

7.6 Blanks - Three types of blanks are required for this method. A calibration blank is used to establish the analytical calibration curve, the laboratory reagent blank is used to assess possible contamination from the sample preparation procedure and to assess spectral background and the rinse blank is used to flush the instrument between samples in order to reduce memory interferences.

7.6.1 Calibration blank - Consists of 1% (v/v) nitric acid in reagent grade water. If the direct addition procedure (Method A, Section 10.3) is being used, add internal standards.

7.6.2 Laboratory reagent blank (LRB) - Must contain all the reagents in the same volumes as used in processing the samples. The LRB must be carried through the same entire preparation scheme as the samples including digestion, when applicable. If the direct addition procedure (Method A, Section 10.3) is being used, add internal standards to the solution after preparation is complete.

7.6.3 Rinse blank - Consists of 2% (v/v) nitric acid in reagent grade water.

Note: If mercury is to be determined by the "direct analysis" procedure, add gold (Section 7.3.11) to the rinse blank to a concentration of 100 µg/L.

7.7 Tuning Solution - This solution is used for instrument tuning and mass calibration prior to analysis. The solution is prepared by mixing beryllium, magnesium, cobalt, indium and lead stock solutions (Section 7.3) in 1% (v/v) nitric acid to produce a concentration of 100 µg/L of each element. Internal standards are not added to this solution. (Depending on the sensitivity of the instrument, this solution may need to be diluted 10-fold.)

7.8 Quality Control Sample (QCS) - The QCS should be obtained from a source outside the laboratory. The concentration of the QCS solution analyzed will depend on the sensitivity of the instrument. To prepare the QCS dilute an appropriate aliquot of analytes to a concentration ≤100 µg/L in 1% (v/v) nitric acid. Because of lower sensitivity, selenium may be diluted to a concentration of <500 µg/L, however, in all cases, mercury should be limited to a concentration of ≤5 µg/L. If the direct addition procedure (Method A, Section 10.3) is being used, add internal standards after dilution, mix and store in a FEP bottle. The QCS should be analyzed as needed to meet data-quality needs and a fresh solution should be prepared quarterly or more frequently as needed.

7.9 Laboratory Fortified Blank (LFB) - To an aliquot of LRB, add aliquots from multielement stock standards A and B (Section 7.4) to prepared the LFB. Depending on the sensitivity of the instrument, the fortified concentration used should range from 40-100 µg/L for each analyte, except selenium and mercury. For selenium the concentration should range from 200-500 µg/L, while the concentration range mercury should be limited to 2-5 µg/L. The LFB must be carried through the same entire preparation scheme as the samples including sample digestion, when applicable. If the direct addition procedure (Method A, Section 10.3) is being used, add internal standards to this solution after

preparation has been completed.

8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

8.1 Prior to the collection of an aqueous sample, consideration should be given to the type of data required, (i.e., dissolved or total recoverable), so that appropriate preservation and pretreatment steps can be taken. The pH of all aqueous samples **must** be tested immediately prior to aliquoting for processing or "direct analysis" to ensure the sample has been properly preserved. If properly acid preserved, the sample can be held up to 6 months before analysis.

8.2 For the determination of dissolved elements, the sample must be filtered through a 0.45 µm pore diameter membrane filter at the time of collection or as soon thereafter as practically possible. Use a portion of the sample to rinse the filter flask, discard this portion and collect the required volume of filtrate. Acidify the filtrate with (1+1) nitric acid immediately following filtration to pH <2.

8.3 For the determination of total recoverable elements in aqueous samples, samples are **not** filtered, but acidified with (1+1) nitric acid to pH <2 (normally, 3 mL of (1+1) acid per liter of sample is sufficient for most ambient and drinking water samples). Preservation may be done at the time of collection, however, to avoid the hazards of strong acids in the field, transport restrictions, and possible contamination it is recommended that the samples be returned to the laboratory within two weeks of collection and acid preserved upon receipt in the laboratory. Following acidification, the sample should be mixed, held for 16 hours, and then verified to be pH <2 just prior withdrawing an aliquot for processing or "direct analysis". If for some reason such as high alkalinity the sample pH is verified to be >2, more acid must be added and the sample held for 16 hours until verified to be pH <2. See Section 8.1.

Note: When the nature of the sample is either unknown or known to be hazardous, acidification should be done in a fume hood. See Section 5.2.

8.4 Solid samples require no preservation prior to analysis other than storage at 4°C. There is no established holding time limitation for solid samples.

8.5 For aqueous samples, a field blank should be prepared and analyzed as required by the data user. Use the same container and acid as used in sample collection.

9.0 QUALITY CONTROL

9.1 Each laboratory using this method is required to operate a formal quality control (QC) program. The minimum requirements of this program consist of an initial demonstration of laboratory capability, and the periodic analysis of laboratory reagent blanks, fortified blanks and calibration solutions as a continuing check on performance. The laboratory is required to maintain performance records that define the quality of the data thus generated.

9.2 Initial Demonstration of Performance (mandatory)

9.2.1 The initial demonstration of performance is used to characterize instrument performance (determination of linear calibration ranges and analysis of quality control samples) and laboratory performance (determination of method detection limits) prior to analyses conducted by this method.

9.2.2 Linear calibration ranges - Linear calibration ranges are primarily detector limited. The upper limit of the linear calibration range should be established for each analyte by determining the signal responses from a minimum of three different concentration standards, one of which is close to the upper limit of the linear range. Care should be taken to avoid potential damage to the detector during this process. The linear calibration range which may be used for the analysis of samples should be judged by the analyst from the resulting data. The upper LDR limit should be an observed signal no more than 10% below the level extrapolated from lower standards. Determined sample analyte concentrations that are greater than 90% of the determined upper LDR limit must be diluted and reanalyzed. The LDRs should be verified whenever, in the judgement of the analyst, a change in analytical performance caused by either a change in instrument hardware or operating conditions would dictate they be redetermined.

9.2.3 Quality control sample (QCS) - When beginning the use of this method, on a quarterly basis or as required to meet data-quality needs, verify the calibration standards and acceptable instrument performance with the preparation and analyses of a QCS (Section 7.8). To verify the calibration standards the determined mean concentration from three analyses of the QCS must be within ±10% of the stated QCS value. If the QCS is used for determining acceptable on-going instrument performance, analysis of the QCS prepared to a concentration of 100 µg/L must be within ±10% of the stated value or within the acceptance limits listed in Table 8, whichever is the greater. (If the QCS is not within the required limits, an immediate second analysis of the QCS is recommended to confirm unacceptable performance.) If the calibration standards and/or acceptable instrument performance cannot be verified, the source of the problem must be identified and corrected before either proceeding on with the initial determination of method detection limits or continuing with on-going analyses.

9.2.4 Method detection limits (MDL) should be established for all analytes, using reagent water (blank) fortified at a concentration of two to five times the estimated detection limit.[7] To determine MDL values, take seven replicate aliquots of the fortified reagent water and process through the entire analytical method. Perform all calculations defined in the method and report the concentration values in the appropriate units. Calculate the MDL as follows:

$$MDL = (t) \times (S)$$

where:

t = Student's t value for a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom [t = 3.14 for seven replicates]

S = standard deviation of the replicate analyses

Note: If additional confirmation is desired, reanalyze the seven replicate aliquots on two more nonconsecutive days and again calculate the MDL values for each day. An average of the three MDL values for each analyte may provide for a more appropriate MDL estimate. If the relative standard deviation (RSD) from the analyses of the seven aliquots is <10%, the concentration used to determine the analyte MDL may have been inappropriately high for the determination. If so, this could result in the calculation of an unrealistically low MDL. Concurrently, determination of MDL in reagent water represents a best case situation and does not reflect possible matrix effects of real world samples. However, successful analyses of LFMs (Section 9.4) can give confidence to the MDL value determined in reagent water. Typical single laboratory MDL values using this method are given in Table 7.

The MDLs must be sufficient to detect analytes at the required levels according to compliance monitoring regulation (Section 1.2). MDLs should be determined annually, when a new operator begins work or whenever, in the judgement of the analyst, a change in analytical performance caused by either a change in instrument hardware or operating conditions would dictate they be redetermined.

9.3 Assessing Laboratory Performance (mandatory)

9.3.1 Laboratory reagent blank (LRB) - The laboratory must analyze at least one LRB (Section 7.6.2) with each batch of 20 or fewer of samples of the same matrix. LRB data are used to assess contamination from the laboratory environment and to characterize spectral background from the reagents used in sample processing. LRB values that exceed the MDL indicate laboratory or reagent contamination should be suspected. When LRB values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable LRB values have been obtained.

9.3.2 Laboratory fortified blank (LFB) - The laboratory must analyze at least one LFB (Section 7.9) with each batch of samples. Calculate accuracy as percent recovery using the following equation:

$$R = \frac{LFB - LRB}{s} \times 100$$

where:

R = percent recovery
LFB = laboratory fortified blank
LRB = laboratory reagent blank
s = concentration equivalent of analyte added to fortify the LBR solution

If the recovery of any analyte falls outside the required control limits of 85-115%, that analyte is judged out of control, and the source of the problem should be identified and resolved before continuing analyses.

9.3.3 The laboratory must use LFB analyses data to assess laboratory performance against the required control limits of 85-115% (Section 9.3.2). When sufficient internal performance data become available (usually a minimum of 20-30 analyses), optional control limits can be developed from the mean percent recovery (x) and the standard deviation (S) of the mean percent recovery. These data can be used to establish the upper and lower control limits as follows:

$$\text{UPPER CONTROL LIMIT} = x + 3S$$
$$\text{LOWER CONTROL LIMIT} = x - 3S$$

The optional control limits must be equal to or better than the required control limits of 85-115%. After each five to ten new recovery measurements, new control limits can be calculated using only the most recent 20-30 data points. Also, the standard deviation (S) data should be used to establish an on-going precision statement for the level of concentrations included in the LFB. These data must be kept on file and be available for review.

9.3.4 Instrument performance - For all determinations the laboratory must check instrument performance and verify that the instrument is properly calibrated on a continuing basis. To verify calibration run the calibration blank and calibration standards as surrogate samples immediately following each calibration routine, after every ten analyses and at the end of the sample run. The results of the analyses of the standards will indicate whether the calibration remains valid. The analysis of all analytes within the standard solutions must be within ±10% of calibration. If the calibration cannot be verified within the specified limits, the instrument must be recalibrated. (The instrument responses from the calibration check may be used for recalibration purposes, however, it must be verified before continuing sample analysis.) If the continuing calibration check is not confirmed within ±15%, the previous 10 samples must be reanalyzed after recalibration. If the sample matrix is responsible for the calibration drift, it is recommended that the previous 10 samples are reanalyzed in groups of five between calibration checks to prevent a similar drift situation from occurring.

9.4 Assessing Analyte Recovery and Data Quality

9.4.1 Sample homogeneity and the chemical nature of the sample matrix can affect analyte recovery and the quality of the data. Taking separate aliquots from the sample for replicate and fortified analyses can in some cases assess the effect. Unless otherwise specified by the data user, laboratory or program, the following laboratory fortified matrix (LFM) procedure (Section 9.4.2) is required.

9.4.2 The laboratory must add a known amount of analyte to a minimum of 10% of the routine samples. In each case the LFM aliquot must be a duplicate of the aliquot used for sample analysis and for total recoverable determinations added prior to sample preparation. For water samples, the added analyte concentration must be the same as that used in the laboratory fortified blank (Section 7.9). For solid samples, the concentration added should be 100 mg/kg equivalent (200 µg/L in the analysis solution) except silver which should be limited to 50 mg/kg (Section 1.8). Over time, samples from all routine sample sources should be fortified.

9.4.3 Calculate the percent recovery for each analyte, corrected for background concentrations measured in the unfortified sample, and compare these values to the designated LFM recovery range of 70-130%. Recovery calculations are not required if the concentration of the analyte added is less than 30% of the sample background concentration. Percent recovery may be calculated in units appropriate to the matrix, using the following equation:

$$R = \frac{C_s - C}{s} \times 100$$

where:

R = percent recovery
C_s = fortified sample concentration
C = sample background concentration
s = concentration equivalent of analyte added to fortify the sample

9.4.4 If recovery of any analyte falls outside the designated range and laboratory performance for that analyte is shown to be in control (Section 9.3), the recovery problem encountered with the fortified sample is judged to be matrix related, not system related. The data user should be informed that the result for that analyte in the unfortified sample is suspect due to either the heterogeneous nature of the sample or an uncorrected matrix effect.

9.4.5 Internal standards responses - The analyst is expected to monitor the responses from the internal standards throughout the sample set being

analyzed. Ratios of the internal standards responses against each other should also be monitored routinely. This information may be used to detect potential problems caused by mass dependent drift, errors incurred in adding the internal standards or increases in the concentrations of individual internal standards caused by background contributions from the sample. The absolute response of any one internal standard must not deviate more than 60-125% of the original response in the calibration blank. If deviations greater than these are observed, flush the instrument with the rinse blank and monitor the responses in the calibration blank. If the responses of the internal standards are now within the limit, take a fresh aliquot of the sample, dilute by a further factor of two, add the internal standards and reanalyze. If after flushing the response of the internal standards in the calibration blank are out of limits, terminate the analysis and determine the cause of the drift. Possible causes of drift may be a partially blocked sampling cone or a change in the tuning condition of the instrument.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Operating conditions - Because of the diversity of instrument hardware, no detailed instrument operating conditions are provided. The analyst is advised to follow the recommended operating conditions provided by the manufacturer. It is the responsibility of the analyst to verify that the instrument configuration and operating conditions satisfy the analytical requirements and to maintain quality control data verifying instrument performance and analytical results. Instrument operating conditions which were used to generate precision and recovery data for this method (Section 13.0) are included in Table 6.

10.2 Precalibration routine - The following precalibration routine must be completed prior to calibrating the instrument until such time it can be documented with periodic performance data that the instrument meets the criteria listed below without daily tuning.

10.2.1 Initiate proper operating configuration of instrument and data system. Allow a period of not less than 30 minutes for the instrument to warm up. During this process conduct mass calibration and resolution checks using the tuning solution. Resolution at low mass is indicated by magnesium isotopes 24, 25, and 26. Resolution at high mass is indicated by lead isotopes 206, 207, and 208. For good performance adjust spectrometer resolution to produce a peak width of approximately 0.75 amu at 5% peak height. Adjust mass calibration if it has shifted by more than 0.1 amu from unit mass.

10.2.2 Instrument stability must be demonstrated by running the tuning solution (Section 7.7) a minimum of five times with resulting relative standard deviations of absolute signals for all analytes of less than 5%.

10.3 Internal Standardization - Internal standardization must be used in all analyses to correct for instrument drift and physical interferences. A list of acceptable

internal standards is provided in Table 3. For full mass range scans, a minimum of three internal standards must be used. Procedures described in this method for general application, detail the use of five internal standards; scandium, yttrium, indium, terbium and bismuth. These were used to generate the precision and recovery data attached to this method. Internal standards must be present in all samples, standards and blanks at identical levels. This may be achieved by directly adding an aliquot of the internal standards to the CAL standard, blank or sample solution (Method A, Section 10.3), or alternatively by mixing with the solution prior to nebulization using a second channel of the peristaltic pump and a mixing coil (Method B, Section 10.3). The concentration of the internal standard should be sufficiently high that good precision is obtained in the measurement of the isotope used for data correction and to minimize the possibility of correction errors if the internal standard is naturally present in the sample. Depending on the sensitivity of the instrument, a concentration range of 20-200 µg/L of each internal standard is recommended. Internal standards should be added to blanks, samples and standards in a like manner, so that dilution effects resulting from the addition may be disregarded.

10.4 Calibration - Prior to initial calibration, set up proper instrument software routines for quantitative analysis. The instrument must be calibrated using one of the internal standard routines (Method A or B) described in Section 10.3. The instrument must be calibrated for the analytes to be determined using the calibration blank (Section 7.6.1) and calibration standards A and B (Section 7.4.1) prepared at one or more concentration levels. A minimum of three replicate integrations are required for data acquisition. Use the average of the integrations for instrument calibration and data reporting.

10.5 The rinse blank should be used to flush the system between solution changes for blanks, standards and samples. Allow sufficient rinse time to remove traces of the previous sample (Section 4.1.5). Solutions should be aspirated for 30 seconds prior to the acquisition of data to allow equilibrium to be established.

11.0 PROCEDURE

11.1 Aqueous Sample Preparation - Dissolved Analytes

11.1.1 For the determination of dissolved analytes in ground and surface waters, pipet an aliquot (≥20 mL) of the filtered, acid preserved sample into a 50 mL polypropylene centrifuge tube. Add an appropriate volume of (1+1) nitric acid to adjust the acid concentration of the aliquot to approximate a 1% (v/v) nitric acid solution (e.g., add 0.4 mL (1+1) HNO_3 to a 20 mL aliquot of sample). If the direct addition procedure (Method A, Section 10.3) is being used, add internal standards, cap the tube and mix. The sample is now ready for analysis (Section 1.2). Allowance for sample dilution should be made in the calculations.

Note: If a precipitate is formed during acidification, transport, or storage, the sample aliquot must be treated using the procedure in Section 11.2 prior to analysis.

11.2 Aqueous Sample Preparation - Total Recoverable Analytes

11.2.1 For the "direct analysis" of total recoverable analytes in drinking water samples containing turbidity <1 NTU, treat an unfiltered acid preserved sample aliquot using the sample preparation procedure described in Section 11.1.1 while making allowance for sample dilution in the data calculation. For the determination of total recoverable analytes in all other aqueous samples or for preconcentrating drinking water samples prior to analysis follow the procedure given in Sections 11.2.2 through 11.2.8.

11.2.2 For the determination of total recoverable analytes in aqueous samples (other than drinking water with <1 NTU turbidity), transfer a 100 mL (±1 mL) aliquot from a well mixed, acid preserved sample to a 250 mL Griffin beaker (Sections 1.2, 1.3, 1.7, and 1.8). (When necessary, smaller sample aliquot volumes may be used.)

Note: If the sample contains undissolved solids >1%, a well mixed, acid preserved aliquot containing no more than 1 g particulate material should be cautiously evaporated to near 10 mL and extracted using the acid-mixture procedure described in Sections 11.3.3 through 11.3.7.

11.2.3 Add 2 mL (1+1) nitric acid and 1.0 mL of (1+1) hydrochloric acid to the beaker containing the measured volume of sample. Place the beaker on the hot plate for solution evaporation. The hot plate should be located in a fume hood and previously adjusted to provide evaporation at a temperature of approximately but no higher than 85°C. (See the following note.) The beaker should be covered with an elevated watch glass or other necessary steps should be taken to prevent sample contamination from the fume hood environment.

Note: For proper heating adjust the temperature control of the hot plate such that an uncovered Griffin beaker containing 50 mL of water placed in the center of the hot plate can be maintained at a temperature approximately but no higher than 85°C. (Once the beaker is covered with a watch glass the temperature of the water will rise to approximately 95°C.)

11.2.4 Reduce the volume of the sample aliquot to about 20 mL by gentle heating at 85°C. DO NOT BOIL. This step takes about two hours for a 100 mL aliquot with the rate of evaporation rapidly increasing as the sample volume approaches 20 mL. (A spare beaker containing 20 mL of water can be used as a gauge.)

11.2.5 Cover the lip of the beaker with a watch glass to reduce additional evaporation and gently reflux the sample for 30 minutes. (Slight boiling may occur, but vigorous boiling must be avoided to prevent loss of the HCl-H_2O azeotrope.)

11.2.6 Allow the beaker to cool. Quantitatively transfer the sample solution to

a 50 mL volumetric flask or 50 mL class A stoppered graduated cylinder, make to volume with reagent water, stopper and mix.

11.2.7 Allow any undissolved material to settle overnight, or centrifuge a portion of the prepared sample until clear. (If after centrifuging or standing overnight the sample contains suspended solids that would clog the nebulizer, a portion of the sample may be filtered for their removal prior to analysis. However, care should be exercised to avoid potential contamination from filtration.)

11.2.8 Prior to analysis, adjust the chloride concentration by pipetting 20 mL of the prepared solution into a 50 mL volumetric flask, dilute to volume with reagent water and mix. (If the dissolved solids in this solution are >0.2%, additional dilution may be required to prevent clogging of the extraction and/or skimmer cones. If the direct addition procedure (Method A, Section 10.3) is being used, add internal standards and mix. The sample is now ready for analysis. Because the effects of various matrices on the stability of diluted samples cannot be characterized, all analyses should be performed as soon as possible after the completed preparation.

11.3 Solid Sample Preparation - Total Recoverable Analytes

11.3.1 For the determination of total recoverable analytes in solid samples, mix the sample thoroughly and transfer a portion (>20 g) to tared weighing dish, weigh the sample and record the wet weight (WW). (For samples with <35% moisture a 20 g portion is sufficient. For samples with moisture >35% a larger aliquot 50-100 g is required.) Dry the sample to a constant weight at 60°C and record the dry weight (DW) for calculation of percent solids (Section 12.6). (The sample is dried at 60°C to prevent the loss of mercury and other possible volatile metallic compounds, to facilitate sieving, and to ready the sample for grinding.)

11.3.2 To achieve homogeneity, sieve the dried sample using a 5-mesh polypropylene sieve and grind in a mortar and pestle. (The sieve, mortar and pestle should be cleaned between samples.) From the dried, ground material weigh accurately a representative 1.0 ± 0.01 g aliquot (W) of the sample and transfer to a 250 mL Phillips beaker for acid extraction.

11.3.3 To the beaker add 4 mL of (1+1) HNO_3 and 10 mL of (1+4) HCl. Cover the lip of the beaker with a watch glass. Place the beaker on a hot plate for reflux extraction of the analytes. The hot plate should be located in a fume hood and previously adjusted to provide a reflux temperature of approximately 95°C. (See the following note.)

Note: For proper heating adjust the temperature control of the hot plate such that an uncovered Griffin beaker containing 50 mL of water placed in the center of the hot plate can be maintained at a temperature approximately but no higher than 85°C. (Once the beaker is covered with a watch glass the temperature of the water will rise to approximately

95°C.) Also, a block digester capable of maintaining a temperature of 95°C and equipped with 250 mL constricted volumetric digestion tubes may be substituted for the hot plate and conical beakers in the extraction step.

11.3.4 Heat the sample and gently reflux for 30 minutes. Very slight boiling may occur, however vigorous boiling must be avoided to prevent loss of the HCl-H_2O azeotrope. Some solution evaporation will occur (3-4 mL).

11.3.5 Allow the sample to cool and quantitatively transfer the extract to a 100 mL volumetric flask. Dilute to volume with reagent water, stopper and mix.

11.3.6 Allow the sample extract solution to stand overnight to separate insoluble material or centrifuge a portion of the sample solution until clear. (If after centrifuging or standing overnight the extract solution contains suspended solids that would clog the nebulizer, a portion of the extract solution may be filtered for their removal prior to analysis. However, care should be exercised to avoid potential contamination from filtration.)

11.3.7 Prior to analysis, adjust the chloride concentration by pipetting 20 mL of the prepared solution into a 100 mL volumetric flask, dilute to volume with reagent water and mix. (If the dissolved solids in this solution are >0.2%, additional dilution may be required to prevent clogging of the extraction and/or skimmer cones. If the direct addition procedure (Method A, Section 10.3) is being used, add internal standards and mix. The sample extract is now ready for analysis. Because the effects of various matrices on the stability of diluted samples cannot be characterized, all analyses should be performed as soon as possible after the completed preparation.

Note: Determine the percent solids in the sample for use in calculations and for reporting data on a dry weight basis.

11.4 Sample Analysis

11.4.1 For every new or unusual matrix, it is highly recommended that a semi-quantitative analysis be carried out to screen the sample for elements at high concentration. Information gained from this may be used to prevent potential damage to the detector during sample analysis and to identify elements which may be higher than the linear range. Matrix screening may be carried out by using intelligent software, if available, or by diluting the sample by a factor of 500 and analyzing in a semi-quantitative mode. The sample should also be screened for background levels of all elements chosen for use as internal standards in order to prevent bias in the calculation of the analytical data.

11.4.2 Initiate instrument operating configuration. Tune and calibrate the instrument for the analytes of interest (Section 10.0).

11.4.3 Establish instrument software run procedures for quantitative analysis. For all sample analyses, a minimum of three replicate integrations are required for data acquisition. Use the average of the integrations for data reporting.

11.4.4 All masses which might affect data quality must be monitored during the analytical run. As a minimum, those masses prescribed in Table 4 must be monitored in the same scan as is used for the collection of the data. This information should be used to correct the data for identified interferences.

11.4.5 During the analysis of samples, the laboratory must comply with the required quality control described in Sections 9.3 and 9.4. Only for the determination of dissolved analytes or the "direct analysis" of drinking water with turbidity of <1 NTU is the sample digestion step of the LRB, LFB, and LFM not required.

11.4.6 The rinse blank should be used to flush the system between samples. Allow sufficient time to remove traces of the previous sample or a minimum of one minute (Section 4.1.5). Samples should be aspirated for 30 seconds prior to the collection of data.

11.4.7 Samples having concentrations higher than the established linear dynamic range should be diluted into range and reanalyzed. The sample should first be analyzed for the trace elements in the sample, protecting the detector from the high concentration elements, if necessary, by the selection of appropriate scanning windows. The sample should then be diluted for the determination of the remaining elements. Alternatively, the dynamic range may be adjusted by selecting an alternative isotope of lower natural abundance, provided quality control data for that isotope have been established. The dynamic range must not be adjusted by altering instrument conditions to an uncharacterized state.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 Elemental equations recommended for sample data calculations are listed in Table 5. Sample data should be reported in units of µg/L for aqueous samples or mg/kg dry weight for solid samples. Do not report element concentrations below the determined MDL.

12.2 For data values less than 10, two significant figures should be used for reporting element concentrations. For data values greater than or equal to 10, three significant figures should be used.

12.3 For aqueous samples prepared by total recoverable procedure (Section 11.2), multiply solution concentrations by the dilution factor 1.25. If additional dilutions were made to any samples or an aqueous sample was prepared using the acid-mixture procedure described in Section 11.3, the appropriate factor should be applied to the calculated sample concentrations.

12.4 For total recoverable analytes in solid samples (Section 11.3), round the solution analyte concentrations (µg/L in the analysis solution) as instructed in Section 12.2. Multiply the µ/L concentrations in the analysis solution by the factor 0.005 to calculate the mg/L analyte concentration in the 100 mL extract solution. (If additional dilutions were made to any samples, the appropriate factor should be applied to calculate analyte concentrations in the extract solution.) Report the data up to three significant figures as mg/kg dry-weight basis unless specified otherwise by the program or data user. Calculate the concentration using the equation below:

$$\text{Sample Conc. (mg/kg) dry-weight basis} = \frac{C \times V}{W}$$

where:

C = Concentration in the extract (mg/L)
V = Volume of extract (L, 100 mL = 0.1L)
W = Weight of sample aliquot extracted (g x 0.001 = kg)

Do not report analyte data below the estimated solids MDL or an adjusted MDL because of additional dilutions required to complete the analysis.

12.5 To report percent solids in solid samples (Sect. 11.3) calculate as follows:

$$\% \text{ solids (S)} = \frac{DW}{WW} \times 100$$

where:

DW = Sample weight (g) dried at 60°C
WW = Sample weight (g) before drying

Note: If the data user, program or laboratory requires that the reported percent solids be determined by drying at 105°C, repeat the procedure given in Section 11.3 using a separate portion (>20 g) of the sample and dry to constant weight at 103-105°C.

12.6 Data values should be corrected for instrument drift or sample matrix induced interferences by the application of internal standardization. Corrections for characterized spectral interferences should be applied to the data. Chloride interference corrections should be made on all samples, regardless of the addition of hydrochloric acid, as the chloride ion is a common constituent of environmental samples.

12.7 If an element has more than one monitored isotope, examination of the concentration calculated for each isotope, or the isotope ratios, will provide useful information for the analyst in detecting a possible spectral interference.

Consideration should therefore be given to both primary and secondary isotopes in the evaluation of the element concentration. In some cases, secondary isotopes may be less sensitive or more prone to interferences than the primary recommended isotopes, therefore differences between the results do not necessarily indicate a problem with data calculated for the primary isotopes.

12.8 The QC data obtained during the analyses provide an indication of the quality of the sample data and should be provided with the sample results.

13.0 METHOD PERFORMANCE

13.1 Instrument operating conditions used for single laboratory testing of the method are summarized in Table 6. Total recoverable digestion and "direct analysis" MDLs determined using the procedure described in Section 9.2.4, are listed in Table 7.

13.2 Data obtained from single laboratory testing of the method are summarized in Table 9 for five water samples representing drinking water, surface water, ground water and waste effluent. Samples were prepared using the procedure described in Section 11.2. For each matrix, five replicates were analyzed and the average of the replicates used for determining the sample background concentration for each element. Two further pairs of duplicates were fortified at different concentration levels. For each method element, the sample background concentration, mean percent recovery, the standard deviation of the percent recovery and the relative percent difference between the duplicate fortified samples are listed in Table 8.

13.3 Data obtained from single laboratory testing of the method are summarized in Table 10 for three solid samples consisting of SRM 1645 River Sediment, EPA Hazardous Soil and EPA Electroplating Sludge. Samples were prepared using the procedure described in Section 11.3. For each method element, the sample background concentration, mean percent recovery, the standard deviation of the percent recovery and the relative percent difference between the duplicate fortified samples were determined as for Section 13.2.

13.4 Data obtained from single laboratory testing of the method for drinking water analysis using the "direct analysis" procedure (Section 11.2.1) are given in Table 11. Three drinking water samples of varying hardness collected from Regions 4, 6, and 10 were fortified to contain 1 µg/L of all metal primary contaminants, except selenium, which was added to a concentration of 20 µg/L. For each matrix, four replicate aliquots were analyzed to determine the sample background concentration of each analyte and four fortified aliquots were analyzed to determine mean percent recovery in each matrix. Listed in the Table 11 are the average mean percent recovery of each analyte in the three matrices and the standard deviation of the mean percent recoveries.

13.5 Listed in Table 12 are the regression equations for precision and bias developed from the joint USEPA/Association of Official Analytical Chemists (AOAC) multilaboratory validation study conducted on this method. These equations

were developed from data received from 13 laboratories on reagent water, drinking water and ground water. Listed in Tables 13 and 14, respectively, are the precision and recovery data from a wastewater digestate supplied to all laboratories and from a wastewater of the participant's choice. For a complete review of the study see Reference 11, Section 16.0 of this method.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions, consult "Less is Better: Laboratory Chemical Management for Waste Reduction", available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington D.C. 20036, (202)872-4477.

15.0 WASTE MANAGEMENT

15.1 The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult "The Waste Management Manual for Laboratory Personnel", available from the American Chemical Society at the address listed in the Section 14.2.

16.0 REFERENCES

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17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

TABLE 1: ESTIMATED INSTRUMENT DETECTION LIMITS

Element	Recommended Analytical Mass	Scanning Mode[1]	Selection Ion Monitoring Mode[2,3]
Aluminum	27	0.05	0.02
Antimony	123	0.08	0.008
Arsenic(3)	75	0.9	0.02
Barium	137	0.5	0.03
Beryllium	9	0.1	0.02
Cadmium	111	0.1	0.02
Chromium	52	0.07	0.04
Cobalt	59	0.03	0.002
Copper	63	0.03	0.004
Lead	206, 207, 208	0.08	0.015
Manganese	55	0.1	0.007
Mercury	202	n.a	0.2
Molybdenum	98	0.1	0.005
Nickel	60	0.2	0.07
Selenium(3)	82	5	1.3
Silver	107	0.05	0.004
Thallium	205	0.09	0.014
Thorium	232	0.03	0.005
Uranium	238	0.02	0.005
Vanadium	51	0.02	0.006
Zinc	66	0.2	0.07

Instrument detection limits (3σ) estimated from seven replicate integrations of the blank (1% v/v nitric acid) following calibration of the instrument with three replicate integrations of a multi-element standard.

[1]Instrument operating conditions and data acquisition mode are given in Table 6.

[2]IDLs determined using state-of-the-art instrumentation (1994). Data for ^{75}As, ^{77}Se, and ^{82}Se were acquired using a dwell time of 4.096 seconds with 1500 area count per sec ^{83}Kr present in argon supply. All other data were acquired using a dwell time of 1.024 seconds per AMU monitored.

TABLE 2: COMMON MOLECULAR ION INTERFERENCES IN ICP-MS

BACKGROUND MOLECULAR IONS		
Molecular Ion	**Mass**	**Element Interference[a]**
NH^+	15	
OH^+	17	
OH_2^+	18	
C_2^+	24	
CN^+	26	
CO^+	28	
N_2^+	28	
N_2H^+	29	
NO^+	30	
NOH^+	31	
O_2^+	32	
O_2H^+	33	
$^{36}ArH^+$	37	
$^{38}ArH^+$	39	
$^{40}ArH^+$	41	
CO_2^+	44	
CO_2H^+	45	Sc
ArC^+, ArO^+	52	Cr
ArN^+	54	Cr
$ArNH^+$	55	Mn
ArO^+	56	
$ArOH^+$	57	
$^{40}Ar^{36}Ar^+$	76	Se
$^{40}Ar^{38}Ar^+$	78	Se
$^{40}Ar^+$	80	Se

[a]method elements or internal standards affected by the molecular ions.

TABLE 2: COMMON MOLECULAR ION INTERFERENCES IN ICP-MS (Cont'd)

MATRIX MOLECULAR IONS

Molecular Ion		Mass	Element Interference[a]
Bromide[12]			
	$^{81}BrH^+$	82	Se
	$^{79}BrO^+$	95	Mo
	$^{81}BrO^+$	97	Mo
	$^{81}BrOH^+$	98	Mo
	$Ar^{81}Br^+$	121	Sb
Chloride			
	$^{35}ClO^+$	51	V
	$^{35}ClOH^+$	52	Cr
	$^{37}ClO^+$	53	Cr
	$^{37}ClOH^+$	54	Cr
	$Ar^{35}Cl^+$	75	As
	$Ar^{37}Cl^+$	77	Se
Sulphate			
	$^{32}SO^+$	48	
	$^{32}SOH^+$	49	
	$^{34}SO^+$	50	V, Cr
	$^{34}SOH^+$	51	V
	SO_2^+, S_2^+	64	Zn
	$Ar^{32}S^+$	72	
	$Ar^{34}S^+$	74	
Phosphate			
	PO^+	47	
	POH^+	48	
	PO_2^+	63	Cu
	ArP^+	71	
Group I, II Metals			
	$ArNa^+$	63	Cu
	ArK^+	79	
	$ArCa^+$	80	

TABLE 2: COMMON MOLECULAR ION INTERFERENCES IN ICP-MS (Cont'd)

MATRIX MOLECULAR IONS		
Molecular Ion	**Mass**	**Element Interference[a]**
Matrix Oxides[*]		
TiO	62-66	Ni, Cu, Zn
ZrO	106-112	Ag, Cd
MoO	108-116	Cd

[*]Oxide interferences will normally be very small and will only impact the method elements when present at relatively high concentrations. Some examples of matrix oxides are listed of which the analyst should be aware. It is recommended that Ti and Zr isotopes are monitored in solid waste samples, which are likely to contain high levels of these elements. Mo is monitored as a method analyte.

TABLE 3: INTERNAL STANDARDS AND LIMITATIONS OF USE

Internal Standard	Mass	Possible Limitation
^{6}Lithium	6	a
Scandium	45	polyatomic ion interference
Yttrium	89	a,b
Rhodium	103	
Indium	115	isobaric interference by Sn
Terbium	159	
Holmium	165	
Lutetium	175	
Bismuth	209	a

a May be present in environmental samples.

b In some instruments Yttrium may form measurable amounts of YO^{+} (105 amu)and YOH^{+} (106 amu). If this is the case, care should be taken in the use of the cadmium elemental correction equation.

Internal standards recommended for use with this method are shown in bold face. Preparation procedures for these are included in Section 7.3.

TABLE 4: RECOMMENDED ANALYTICAL ISOTOPES AND ADDITIONAL MASSES WHICH MUST BE MONITORED

Isotope	Element of Interest
27	Aluminum
121, 123	Antimony
75	Arsenic
135, 137	Barium
9	Beryllium
106, 108, 111, 114	Cadmium
52, 53	Chromium
59	Cobalt
63, 65	Copper
206, 207, 208	Lead
55	Manganese
95, 97, 98	Molybdenum
60, 62	Nickel
77, 82	Selenium
107, 109	Silver
203, 205	Thallium
232	Thorium
238	Uranium
51	Vanadium
66, 67, 68	Zinc
83	Krypton
99	Ruthenium
105	Palladium
118	Tin

NOTE: Isotopes recommended for analytical determination are underlined.

TABLE 5: RECOMMENDED ELEMENTAL EQUATIONS FOR DATA CALCULATIONS

Element	Elemental Equation	Note
Al	(1.000) (^{27}C)	
Sb	(1.000) (^{123}C)	
As	(1.000) (^{75}C)-(3.127) [(^{77}C)-(0.815) (^{82}C)]	(1)
Ba	(1.000) (^{137}C)	
Be	(1.000) (^{9}C)	
Cd	(1.000) (^{111}C)-(1.073) [(^{108}C)-(0.712) (^{106}C)]	(2)
Cr	(1.000) (^{52}C)	(3)
Co	(1.000) (^{59}C)	
Cu	(1.000) (^{63}C)	
Pb	(1.000) (^{206}C)+(1.000) [(^{207}C)+(1.000) (^{208}C)]	(4)
Mn	(1.000) (^{55}C)	
Mo	(1.000) (^{98}C)-(0.146) (^{99}C)	(5)
Ni	(1.000) (^{60}C)	
Se	(1.000) (^{82}C)	(6)
Ag	(1.000) (^{107}C)	
Tl	(1.000) (^{205}C)	
Th	(1.000) (^{232}C)	
U	(1.000) (^{238}C)	
V	(1.000) (^{51}C)-(3.127) [(^{53}C)-(0.113) (^{52}C)]	(7)
Zn	(1.000) (^{66}C)	

TABLE 5: RECOMMENDED ELEMENTAL EQUATIONS FOR DATA CALCULATIONS

Element	Elemental Equation	Note
Bi	(1.000) (^{209}C)	
In	(1.000) (^{209}C)-(0.016) (^{118}C)	(8)
Sc	(1.000) (^{45}C)	
Tb	(1.000) (^{159}C)	
Y	(1.000) (^{89}C)	

C - Calibration blank subtracted counts at specified mass.

(1) - Correction for chloride interference with adjustment for ^{77}Se. ArCl 75/77 ratio may be determined from the reagent blank. Isobaric mass 82 must be from Se only and not BrH^+.

(2) - Correction for MoO interference. Isobaric mass 106 must be from Cd only not ZrO^+. An additional isobaric elemental correction should be made if palladium is present.

(3) - In 0.4% v/v HCl, the background from ClOH will normally be small. However the contribution may be estimated from the reagent blank. Isobaric mass must be from Cr only not ArC^+.

(4) - Allowance for isotopic variability of lead isotopes.

(5) - Isobaric elemental correction for ruthenium.

(6) - Some argon supplies contain krypton as an impurity. Selenium is corrected for ^{82}Kr by background subtraction.

(7) - Correction for chloride interference with adjustment for ^{53}Cr. ClO 51/53 ratio may be determined from the reagent blank. Isobaric mass 52 must be from Cr only not ArC^+.

(8) - Isobaric elemental correction for tin.

TABLE 6: INSTRUMENT OPERATING CONDITIONS FOR PRECISION AND RECOVERY DATA[1]

Instrument	VG PlasmaQuad Type I
Plasma foward power	1.35 kW
Coolant flow rate	13.5 L/min.
Auxillary flow rate	0.6 L/min.
Nebulizer flow rate	0.78 L/min.
Solution uptake rate	0.6 mL/min.
Spray chamber temperature	15°C
Data Acquistion	
Detector mode	Pulse counting
Replicate integrations	3
Mass range	8-240 amu
Dwell time	320 µs
Number of MCA channels	2048
Number of scan sweeps	85
Total acquisition time	3 minutes per sample

[1]The described instrument and operating conditions were used to determine the scanning mode MDL data listed in Table 7 and the precision and recovery data given in Tables 9 and 10.

TABLE 7: METHOD DETECTION LIMITS

	Scanning Mode[1] Total Recoverable		Selection Ion Monitoring Mode[2] Total Recoverable	Direct Analysis[3]
AMU Element	Aqueous µg/L	Solids mg/kg	Aqueous µg/L	Aqueous µg/L
^{27}Al	1.0	0.4	1.7	0.04
^{123}Sb	0.4	0.2	0.04	0.02
^{75}As	1.4	0.6	0.4	0.1
^{137}Ba	0.8	0.4	0.04	0.04
^{9}Be	0.3	0.1	0.02	0.03
^{111}Cd	0.5	0.2	0.03	0.03
^{52}Cr	0.9	0.4	0.08	0.08
^{59}Co	0.09	0.04	0.004	0.003
^{63}Cu	0.5	0.2	0.02	0.01
^{206,207,208}Pb	0.6	0.3	0.05	0.02
^{55}Mn	0.1	0.05	0.02	0.04
^{202}Hg	n.a.	n.a.	n.a	0.2
^{98}Mo	0.3	0.1	0.01	0.01
^{60}Ni	0.5	0.2	0.06	0.03
^{82}Se	7.9	3.2	2.1	0.5
^{107}Ag	0.1	0.05	0.005	0.005
^{205}Tl	0.3	0.1	0.02	0.01
^{232}Th	0.1	0.05	0.02	0.01
^{238}U	0.1	0.05	0.01	0.01
^{51}V	2.5	1.0	0.9	0.05
^{66}Zn	1.8	0.7	0.1	0.2

[1]Data acquisition mode given in Table 6. Total recoverable MDL concentrations are computed for original matrix with allowance for sample dilution during preparation. Listed MDLs for solids calculated from determined aqueous MDLs.

[2]MDLs determined using state-of-the-art instrumentation (1994). Data for ^{75}As, ^{77}Se, and ^{82}Se were acquired using a dwell time of 4.096 seconds with 1500 area count per seconds ^{83}Kr present in argon supply. All other data were acquired using a dwell time of 1.024 seconds per AMU monitored.

[3]MDLs were determined from analysis of seven undigested aqueous sample aliquots.

n.a. - Not applicable. Total recoverable digestion not suitable for organo-mercury compounds.

TABLE 8: ACCEPTANCE LIMITS FOR QC CHECK SAMPLE

METHOD PERFORMANCE (µg/L)[1]

Element	QC Check Sample Conc.	Average Recovery	Standard Deviation[2] (S_r)	Acceptance Limits[3] µg/L
Aluminum	100	100.4	5.49	84-117
Antimony	100	99.9	2.40	93-107
Arsenic	100	101.6	3.66	91-113
Barium	100	99.7	2.64	92-108
Beryllium	100	105.9	4.13	88-112[4]
Cadmium	100	100.8	2.32	94-108
Chromium	100	102.3	3.91	91-114
Cobalt	100	97.7	2.66	90-106
Copper	100	100.3	2.11	94-107
Lead	100	104.0	3.42	94-114
Manganese	100	98.3	2.71	90-106
Molybdenum	100	101.0	2.21	94-108
Nickel	100	100.1	2.10	94-106
Selenium	100	103.5	5.67	86-121
Silver	100	101.1	3.29	91-111[5]
Thallium	100	98.5	2.79	90-107
Thorium	100	101.4	2.60	94-109
Uranium	100	102.6	2.82	94-111
Vanadium	100	100.3	3.26	90-110
Zinc	100	105.1	4.57	91-119

[1]Method performance characteristics calculated using regression equations from collaborative study, Reference 11.

[2]Single-analyst standard deviation, S_r.

[3]Acceptance limits calculated as average recovery ± three standard deviations.

[4]Acceptance limits centered at 100% recovery.

[5]Statistics estimated from summary statistics at 48 and 64 µg/L.

TABLE 9: PRECISION AND RECOVERY DATA IN AQUEOUS MATRICES

DRINKING WATER

Element	Sample Conc. µg/L	Low Spike µg/L	Average Recovery R (%)	S (R)	RPD	High Spike µg/L	Average Recovery R (%)	S (R)	RPD
Al	175	50	115.8	5.9	0.4	200	102.7	1.6	1.1
Sb	<0.4	10	99.1	0.7	2.0	100	100.8	0.7	2.0
As	<1.4	50	99.7	0.8	2.2	200	102.5	1.1	2.9
Ba	43.8	50	94.8	3.9	5.8	200	95.6	0.8	1.7
Be	<0.3	10	113.5	0.4	0.9	100	111.0	0.7	1.8
Cd	<0.5	10	97.0	2.8	8.3	100	101.5	0.4	1.0
Cr	<0.9	10	111.0	3.5	9.0	100	99.5	0.1	0.2
Co	0.11	10	94.4	0.4	1.1	100	93.6	0.5	1.4
Cu	3.6	10	101.8	8.8	17.4	100	91.6	0.3	0.3
Pb	0.87	10	97.8	2.0	2.8	100	99.0	0.8	2.2
Mn	0.96	10	96.9	1.8	4.7	100	95.8	0.6	1.8
Mo	1.9	10	99.4	1.6	3.4	100	98.6	0.4	1.0
Ni	1.9	10	100.2	5.7	13.5	100	95.2	0.5	1.3
Se	<7.9	50	99.0	1.8	5.3	200	93.5	3.5	10.7
Ag	<0.1	50	100.7	1.5	4.2	200	99.0	0.4	1.0
Tl	<0.3	10	97.5	0.4	1.0	100	98.5	1.7	4.9
Th	<0.1	10	109.0	0.7	1.8	100	106.0	1.4	3.8
U	0.23	10	110.7	1.4	3.5	100	107.8	0.7	1.9
V	<2.5	50	101.4	0.1	0.4	200	97.5	0.7	2.1
Zn	5.2	50	103.4	3.3	7.7	200	96.4	0.5	1.0

S (R) Standard deviation of percent recovery.
RPD Relative percent difference between duplicate spike determinations.
< Sample concentration below established method detection limit.

TABLE 9: PRECISION AND RECOVERY DATA IN AQUEOUS MATRICES (Cont'd)

WELL WATER

Element	Sample Conc. µg/L	Low Spike µg/L	Average Recovery R (%)	S (R)	RPD	High Spike µg/L	Average Recovery R (%)	S (R)	RPD
Al	34.3	50	100.1	3.9	0.8	200	102.6	1.1	1.3
Sb	0.46	10	98.4	0.9	1.9	100	102.5	0.7	1.9
As	<1.4	50	110.0	6.4	16.4	200	101.3	0.2	0.5
Ba	106	50	95.4	3.9	3.3	200	104.9	1.0	1.6
Be	<0.3	10	104.5	0.4	1.0	100	101.4	1.2	3.3
Cd	106	10	88.6	1.7	3.8	100	98.6	0.6	1.6
Cr	<0.9	10	111.0	0.0	0.0	100	103.5	0.4	1.0
Co	2.4	10	100.6	1.0	1.6	100	104.1	0.4	0.9
Cu	37.4	10	104.3	5.1	1.5	100	100.6	0.8	1.5
Pb	3.5	10	95.2	2.5	1.5	100	99.5	1.4	3.9
Mn	2770	10	*	*	1.8	100	*	*	0.7
Mo	2.1	10	103.8	1.1	1.6	100	102.9	0.7	1.9
Ni	11.4	10	116.5	6.3	6.5	100	99.6	0.3	0.0
Se	<7.9	50	127.3	8.4	18.7	200	101.3	0.2	0.5
Ag	<0.1	50	99.2	0.4	1.0	200	101.5	1.4	3.9
Tl	<0.3	10	93.9	0.1	0.0	100	100.4	1.8	5.0
Th	<0.1	10	103.0	0.7	1.9	100	104.5	1.8	4.8
U	1.8	10	106.0	1.1	1.6	100	109.7	2.5	6.3
V	<2.5	50	105.3	0.8	2.1	200	105.8	0.2	0.5
Zn	554	50	*	*	1.2	200	102.1	5.5	3.2

S (R) Standard deviation of percent recovery.
RPD Relative percent difference between duplicate spike determinations.
< Sample concentration below established method detection limit.
* Spike concentration <10% of sample background concentration.

TABLE 9: PRECISION AND RECOVERY DATA IN AQUEOUS MATRICES (Cont'd)

POND WATER

Element	Sample Conc. µg/L	Low Spike µg/L	Average Recovery R (%)	S (R)	RPD	High Spike µg/L	Average Recovery R (%)	S (R)	RPD
Al	610	50	*	*	1.7	200	78.2	9.2	5.5
Sb	<0.4	10	101.1	1.1	2.9	100	101.5	3.0	8.4
As	<1.4	50	100.8	2.0	5.6	200	96.8	0.9	2.6
Ba	28.7	50	102.1	1.8	2.4	200	102.9	3.7	9.0
Be	<0.3	10	109.1	0.4	0.9	100	114.4	3.9	9.6
Cd	<0.5	10	106.6	3.2	8.3	100	105.8	2.8	7.6
Cr	2.0	10	107.0	1.0	1.6	100	100.0	1.4	3.9
Co	0.79	10	101.6	1.1	2.7	100	101.7	1.8	4.9
Cu	5.4	10	107.5	1.4	1.9	100	98.1	2.5	6.8
Pb	1.9	10	108.4	1.5	3.2	100	106.1	0.0	0.0
Mn	617	10	*	*	1.1	100	139.0	11.1	4.0
Mo	0.98	10	104.2	1.4	3.5	100	104.0	2.1	5.7
Ni	2.5	10	102.0	2.3	4.7	100	102.5	2.1	5.7
Se	<7.9	50	102.7	5.6	15.4	200	105.5	1.4	3.8
Ag	0.12	50	102.5	0.8	2.1	200	105.2	2.7	7.1
Tl	<0.3	10	108.5	3.2	8.3	100	105.0	2.8	7.6
Th	0.19	10	93.1	3.5	10.5	100	93.9	1.6	4.8
U	0.30	10	107.0	2.8	7.3	100	107.2	1.8	4.7
V	3.5	50	96.1	5.2	14.2	200	101.5	0.2	0.5
Zn	6.8	50	99.8	1.7	3.7	200	100.1	2.8	7.7

S (R) Standard deviation of percent recovery.
RPD Relative percent difference between duplicate spike determinations.
< Sample concentration below established method detection limit.
* Spike concentration <10% of sample background concentration.

TABLE 9: PRECISION AND RECOVERY DATA IN AQUEOUS MATRICES (Cont'd)

SEWAGE TREATMENT PRIMARY EFFLUENT

Element	Sample Conc. µg/L	Low Spike µg/L	Average Recovery R (%)	S (R)	RPD	High Spike µg/L	Average Recovery R (%)	S (R)	RPD
Al	1150	50	*	*	3.5	200	100.0	13.8	1.5
Sb	1.5	10	95.7	0.4	0.9	100	104.5	0.7	1.9
As	<1.4	50	104.2	4.5	12.3	200	101.5	0.7	2.0
Ba	202	50	79.2	9.9	2.5	200	108.6	4.6	5.5
Be	<0.3	10	110.5	1.8	4.5	100	106.4	0.4	0.9
Cd	9.2	10	101.2	1.3	0.0	100	102.3	0.4	0.9
Cr	128	10	*	*	1.5	100	102.1	1.7	0.4
Co	13.4	10	95.1	2.7	2.2	100	99.1	1.1	2.7
Cu	171	10	*	*	2.4	100	105.2	7.1	0.7
Pb	17.8	10	95.7	3.8	1.1	100	102.7	1.1	2.5
Mn	199	10	*	*	1.5	100	103.4	2.1	0.7
Mo	136	10	*	*	1.4	100	105.7	2.4	2.1
Ni	84.0	10	88.4	16.3	4.1	100	98.0	0.9	0.0
Se	<7.9	50	112.0	10.9	27.5	200	108.8	3.0	7.8
Ag	10.9	50	97.1	0.7	1.5	200	102.6	1.4	3.7
Tl	<0.3	10	97.5	0.4	1.0	100	102.0	0.0	0.0
Th	0.11	10	15.4	1.8	30.3	100	29.3	0.8	8.2
U	0.71	10	109.4	1.8	4.3	100	109.3	0.7	1.8
V	<2.5	50	90.9	0.9	0.6	200	99.4	2.1	6.0
Zn	163	50	85.8	3.3	0.5	200	102.0	1.5	1.9

S (R) Standard deviation of percent recovery.
RPD Relative percent difference between duplicate spike determinations.
< Sample concentration below established method detection limit.
* Spike concentration <10% of sample background concentration.

TABLE 9: PRECISION AND RECOVERY DATA IN AQUEOUS MATRICES (Cont'd)

INDUSTRIAL EFFLUENT

Element	Sample Conc. µg/L	Low Spike µg/L	Average Recovery R (%)	S (R)	RPD	High Spike µg/L	Average Recovery R (%)	S (R)	RPD
Al	44.7	50	98.8	8.7	5.7	200	90.4	2.1	2.2
Sb	2990	10	*	*	0.3	100	*	*	0.0
As	<1.4	50	75.1	1.8	6.7	200	75.0	0.0	0.0
Ba	100	50	96.7	5.5	3.4	200	102.9	1.1	0.7
Be	<0.3	10	103.5	1.8	4.8	100	100.0	0.0	0.0
Cd	10.1	10	106.5	4.4	2.4	100	97.4	1.1	2.8
Cr	171	10	*	*	0.0	100	127.7	2.4	1.7
Co	1.3	10	90.5	3.2	8.7	100	90.5	0.4	1.3
Cu	101	10	*	*	0.9	100	92.5	2.0	1.6
Pb	294	10	*	*	2.6	100	108.4	2.1	0.0
Mn	154	10	*	*	2.8	100	103.6	3.7	1.6
Mo	1370	10	*	*	1.4	100	*	*	0.7
Ni	17.3	10	107.4	7.4	5.0	100	88.2	0.7	1.0
Se	15.0	50	129.5	9.3	15.1	200	118.3	1.9	3.6
Ag	<0.1	50	91.8	0.6	1.7	200	87.0	4.9	16.1
Tl	<0.3	10	90.5	1.8	5.5	100	98.3	1.0	2.8
Th	0.29	10	109.6	1.2	2.7	100	108.7	0.0	0.0
U	0.17	10	104.8	2.5	6.6	100	109.3	0.4	0.9
V	<2.5	50	74.9	0.1	0.3	200	72.0	0.0	0.0
Zn	43.4	50	85.0	4.0	0.6	200	97.6	1.0	0.4

S (R) Standard deviation of percent recovery.
RPD Relative percent difference between duplicate spike determinations.
< Sample concentration below established method detection limit.
* Spike concentration <10% of sample background concentration.

TABLE 10: PRECISION AND RECOVERY DATA IN SOLID MATRICES

EPA HAZARDOUS SOIL #884

Element	Sample Conc. (mg/kg)	Low+ Spike (mg/kg)	Average Recovery R (%)	S (R)	RPD	High+ Spike (mg/kg)	Average Recovery R (%)	S (R)	RPD
Al	5170	20	*	*	–	100	*	*	–
Sb	5.4	20	69.8	2.5	4.7	100	70.4	1.8	6.5
As	8.8	20	104.7	5.4	9.1	100	102.2	2.2	5.4
Ba	113	20	54.9	63.6	18.6	100	91.0	9.8	0.5
Be	0.6	20	100.1	0.6	1.5	100	102.9	0.4	1.0
Cd	1.8	20	97.3	1.0	1.4	100	101.7	0.4	1.0
Cr	83.5	20	86.7	16.1	8.3	100	105.5	1.3	0.0
Co	7.1	20	98.8	1.2	1.9	100	102.9	0.7	1.8
Cu	115	20	86.3	13.8	3.4	100	151.7	4.2	4.6
Pb	152	20	85.0	45.0	13.9	100	85.2	25.7	23.7
Mn	370	20	*	*	12.7	100	95.2	10.4	2.2
Mo	4.8	20	95.4	1.5	2.9	100	102.3	0.7	2.0
Ni	19.2	20	101.7	3.8	1.0	100	100.7	0.8	0.8
Se	<3.2	20	79.5	7.4	26.4	100	94.8	9.4	26.5
Ag	1.1	20	96.1	0.6	0.5	100	97.9	0.8	2.3
Tl	0.24	20	94.3	1.1	3.1	100	76.0	1.0	2.9
Th	1.0	20	69.8	0.6	1.3	100	102.9	2.2	7.9
U	1.1	20	100.1	0.2	0.0	100	106.7	0.0	0.0
V	17.8	20	109.2	4.2	2.3	100	113.4	1.3	2.4
Zn	128	20	87.0	27.7	5.5	100		12.9	14.1

S (R) Standard deviation of percent recovery.
RPD Relative percent difference between duplicate spike determinations.
< Sample concentration below established method detection limit.
* Spike concentration <10% of sample background concentration.
– Not determined.
+ Equivalent.

TABLE 10: PRECISION AND RECOVERY DATA IN SOLID MATRICES

NBS 1645 RIVER SEDIMENT

Element	Sample Conc. (mg/kg)	Low+ Spike (mg/kg)	Average Recovery R (%)	S (R)	RPD	High+ Spike (mg/kg)	Average Recovery R (%)	S (R)	RPD
Al	5060	20	*	*	–	100	*	*	–
Sb	21.8	20	73.9	6.5	9.3	100	81.2	1.5	3.9
As	67.2	20	104.3	13.0	7.6	100	107.3	2.1	2.9
Ba	54.4	20	105.6	4.9	2.8	100	98.6	2.2	3.9
Be	0.59	20	88.8	0.2	0.5	100	87.9	0.1	0.2
Cd	8.3	20	92.9	0.4	0.0	100	95.7	1.4	3.9
Cr	29100	20	*	*	–	100	*	*	–
Co	7.9	20	97.6	1.3	2.6	100	103.1	0.0	0.0
Cu	112	20	121.0	9.1	1.5	100	105.2	2.2	1.8
Pb	742	20	*	*	–	100	–	–	–
Mn	717	20	*	*	–	100	–	–	–
Mo	17.1	20	89.8	8.1	12.0	100	98.4	0.7	0.9
Ni	41.8	20	103.7	6.5	4.8	100	102.2	0.8	0.0
Se	<3.2	20	108.3	14.3	37.4	100	93.9	5.0	15.1
Ag	1.8	20	94.8	1.6	4.3	100	96.2	0.7	1.9
Tl	1.2	20	91.2	1.3	3.6	100	94.4	0.4	1.3
Th	0.90	20	91.3	0.9	2.6	100	92.3	0.9	2.8
U	0.79	20	95.6	1.8	5.0	100	98.5	1.2	3.5
V	21.8	20	91.8	4.6	5.7	100	100.7	0.6	0.8
Zn	1780	20	*	*	–	100	*	*	–

S (R) Standard deviation of percent recovery.
RPD Relative percent difference between duplicate spike determinations.
< Sample concentration below established method detection limit.
* Spike concentration <10% of sample background concentration.
– Not determined.
+ Equivalent.

TABLE 10: PRECISION AND RECOVERY DATA IN SOLID MATRICES

EPA ELECTROPLATING SLUDGE #286

Element	Sample Conc. (mg/kg)	Low+ Spike (mg/kg)	Average Recovery R (%)	S (R)	RPD	High+ Spike (mg/kg)	Average Recovery R (%)	S (R)	RPD
Al	5110	20	*	*	–	100	*	*	–
Sb	8.4	20	55.4	1.5	4.1	100	61.0	0.2	0.9
As	41.8	20	91.0	2.3	1.7	100	94.2	0.8	1.5
Ba	27.3	20	1.8	7.1	8.3	100	0	1.5	10.0
Be	0.25	20	92.0	0.9	2.7	100	93.4	0.3	0.9
Cd	112	20	85.0	5.2	1.6	100	88.5	0.8	0.5
Cr	7980	20	*	*	–	100	*	*	–
Co	4.1	20	89.2	1.8	4.6	100	88.7	1.5	4.6
Cu	740	20	*	*	6.0	100	61.7	20.4	5.4
Pb	1480	20	*	*	–	100	*	*	–
Mn	295	20	*	*	–	100	–	–	–
Mo	13.3	20	82.9	1.2	1.3	100	89.2	0.4	1.0
Ni	450	20	*	*	6.8	100	83.0	10.0	4.5
Se	3.5	20	89.7	3.7	4.2	100	91.0	6.0	18.0
Ag	5.9	20	89.8	2.1	4.6	100	85.1	0.4	1.1
Tl	1.9	20	96.9	0.9	2.4	100	98.9	0.9	2.4
Th	3.6	20	91.5	1.3	3.2	100	97.4	0.7	2.0
U	2.4	20	107.7	2.0	4.6	100	109.6	0.7	1.8
V	21.1	20	105.6	1.8	2.1	100	97.4	1.1	2.5
Zn	13300	20	*	*	–	100	*	*	–

S (R) Standard deviation of percent recovery.
RPD Relative percent difference between duplicate spike determinations.
< Sample concentration below established method detection limit.
* Spike concentration <10% of sample background concentration.
– Not determined.
+ Equivalent.

TABLE 11: PRIMARY DRINKING WATER CONTAMINANTS
PRECISION AND RECOVERY DATA

Analyte	Regional Sample Background Concentration, µg/L (IV)	(VI)	(X)	Average Mean[1] % Recovery	S (R)
Antimony	0.16	0.07	0.03	114%	1.9
Arsenic	< MDL	2.4	1.0	93	8.5
Barium	4.6	280	14.3	(*)	–
Beryllium	< MDL	< MDL	< MDL	100%	8.2
Cadmium	0.05	0.05	0.03	81	4.0
Chromium	0.71	5.1	0.10	94	2.5
Copper	208	130	14.3	(*)	–
Lead	1.2	1.2	2.5	91	2.6
Mercury	< MDL	0.23	< MDL	86	11.4
Nickel	1.7	3.6	0.52	101%	11.5
Selenium	< MDL	4.3	< MDL	98	8.4
Thallium	< MDL	0.01	< MDL	100	1.4

[1]The three regional waters were fortified with 1.0 µg/L of all analytes listed, except selenium, which was fortified to 20 µg/L.

(*) Recovery of barium and copper was not calculated because the analyte addition was <20% the sample background concentration in all waters. (Recovery calculations are not required if the concentration of the analyte added is less than 30% of the sample background concentration. Section 9.4.3).

S (R) Standard deviation of the mean percent recoveries.

TABLE 12: SUMMARY STATISTICS AND DESCRIPTIVE EQUATIONS FOR THE 20 ANALYTES TESTED IN THE COLLABORATIVE STUDY

		Reagent Water				Finished Drinking Water				Ground Water			
Analyte	C[a]	$\bar{X}$[b]	S_R	S_r	Regr. Equations	$\bar{X}$	S_R	S_r	Regr. Equations	$\bar{X}$	S_R	S_r	Regr. Equations
Aluminum	8.00	10.01	2.33	1.74	$\bar{X} = 0.992C + 1.19$	11.18	9.02	6.34	$\bar{X} = 0.954C + 2.38$	9.86	7.10	2.70	$\bar{X} = 0.946C + 2.20$
	12.00	10.98	5.16		$S_R = 0.056\bar{X} + 2.59$[c]	11.02	3.02		$S_R = 7.70$[d]	13.40	10.27		$S_R = 0.169\bar{X} + 6.22$[c]
	56.00	59.13	5.55	4.19	$S_r = 0.042\bar{X} + 1.27$	56.97	7.14	6.18	$S_r = 0.013\bar{X} + 6.17$	51.75	10.78	16.92	$S_r = 0.172\bar{X} + 0.75$[c]
	80.00	82.59	4.92			82.73	8.01			82.83	33.37		
	160.00	158.95	11.82	8.90		159.89	11.94	10.59		155.40	15.39	19.27	
	200.00	200.89	8.61			189.98	12.97			189.64	31.46		
Antimony	2.80	2.75	0.27	0.27	$\bar{X} = 0.999C + 0.04$	2.73	0.29	0.17	$\bar{X} = 0.983C + 0.03$	2.82	0.19	0.22	$\bar{X} = 1.003C + 0.01$
	4.00	4.22	0.46		$S_R = 0.013\bar{X} + 0.61$[e]	4.10	0.47		$S_R = 0.049\bar{X} + 0.19$	4.02	0.35		$S_R = 0.059\bar{X} + 0.04$
	20.00	19.76	1.09	0.85	$S_r = 0.022\bar{X} + 0.20$	19.17	1.37	0.66	$S_r = 0.026\bar{X} + 0.08$	20.12	0.82	0.97	$S_r = 0.058\bar{X} + 0.02$
	28.00	27.48	1.38			26.48	1.72			27.77	1.38		
	80.00	82.52	2.24	1.76		83.43	2.05	2.46		80.34	9.14	6.80	
	100.00	98.06	1.34			97.19	5.31			101.09	2.89		
Arsenic	8.00	8.64	3.01	3.02	$\bar{X} = 1.013C + 0.50$	9.00	3.13	1.96	$\bar{X} = 0.993C + 0.57$	10.40	5.17	4.90	$\bar{X} = 0.949C + 0.91$
	12.00	12.58	3.18		$S_R = 0.031\bar{X} + 2.74$	11.37	1.77		$S_R = 0.018\bar{X} + 2.55$	7.85	4.62		$S_R = 0.048\bar{X} + 4.52$
	56.00	55.44	4.64	3.51	$S_r = 0.007\bar{X} + 2.95$	53.77	4.12	4.07	$S_r = 0.031\bar{X} + 1.65$	53.25	3.49	7.88	$S_r = 0.059\bar{X} + 4.29$
	80.00	85.15	2.54			87.72	4.14			83.60	12.46		
	160.00	161.80	11.15	3.96		157.56	4.83	6.30		159.86	11.67	14.94	
	200.00	201.52	10.81			197.99	10.66			194.41	18.24		
Barium	8.01	7.58	0.50	0.48	$\bar{X} = 1.001C - 0.36$	8.21	1.21	1.11	$\bar{X} = 0.995C + 0.37$	8.04	2.60	2.24	$\bar{X} = 1.055C - 0.21$
	12.00	11.81	1.05		$S_R = 0.039\bar{X} + 0.31$	12.56	1.79		$S_R = 0.045\bar{X} + 0.97$[c]	12.85	1.45		$S_R = 0.020\bar{X} + 2.05$
	48.00	47.32	1.60	1.82	$S_r = 0.024\bar{X} + 0.25$	49.13	3.72	3.77	$S_r = 0.040\bar{X} + 0.72$[c]	50.12	2.98	2.19	$S_r = 0.014\bar{X} + 2.08$
	64.00	65.52	2.90			65.30	4.16			69.53	2.66		
	160.00	157.09	6.53	4.07		155.25	7.82	5.67		164.44	8.81	6.61	
	200.00	198.53	8.28			196.52	5.70			208.32	9.22		
Beryllium	2.80	3.31	0.81	0.26	$\bar{X} = 1.056C + 0.32$	3.15	0.47	0.31	$\bar{X} = 1.055C + 0.20$	3.02	0.46	0.22	$\bar{X} = 1.049C + 0.08$
	4.00	4.45	0.73		$S_R = 0.067\bar{X} + 0.55$	4.45	0.51		$S_R = 0.057\bar{X} + 0.28$	4.27	0.44		$S_R = 0.084\bar{X} + 0.16$
	20.00	22.38	2.76	1.00	$S_r = 0.038\bar{X} + 0.11$	21.27	1.23	0.63	$S_r = 0.016\bar{X} + 0.25$	21.55	1.72	1.10	$S_r = 0.043\bar{X} + 0.06$
	28.00	30.02	2.86			29.57	1.67			29.24	2.09		
	80.00	84.18	4.79	4.02		87.59	6.89	1.88		84.23	9.05	4.32	
	100.00	102.88	5.90			102.64	6.27			103.39	10.17		
Cadmium	4.00	4.01	0.34	0.20	$\bar{X} = 1.007C + 0.07$	4.11	0.88	0.71	$\bar{X} = 0.985C + 0.10$	3.98	0.48	0.14	$\bar{X} = 0.944C + 0.11$
	6.00	6.32	0.49		$S_R = 0.041\bar{X} + 0.19$	5.87	0.58		$S_R = 0.031\bar{X} + 0.65$	5.62	0.73		$S_R = 0.017\bar{X} + 1.09$[e]
	20.00	19.81	1.12	0.86	$S_r = 0.022\bar{X} + 0.10$[c]	19.57	1.45	1.26	$S_r = 0.021\bar{X} + 0.61$	18.15	1.73	0.88	$S_r = 0.029\bar{X} + 0.01$
	28.00	28.33	0.94			27.68	1.27			26.86	2.59		
	80.00	81.28	4.91	1.33		80.62	4.45	2.02		77.83	3.05	1.88	
	100.00	100.11	3.24			98.15	3.60			95.31	2.04		

TABLE 12: SUMMARY STATISTICS AND DESCRIPTIVE EQUATIONS FOR THE 20 ANALYTES TESTED IN THE COLLABORATIVE STUDY

		Reagent Water				Finished Drinking Water				Ground Water			
Analyte	C[a]	$\bar{X}$[b]	S_R	S_r	Regr. Equations	$\bar{X}$	S_R	S_r	Regr. Equations	$\bar{X}$	S_R	S_r	Regr. Equations
Chromium	8.00	8.27	0.32	1.54	$\bar{X} = 1.017\bar{C} + 0.62$	9.46	2.34	2.08	$\bar{X} = 0.990\bar{C} + 1.45$	8.98	1.47	0.37	$\bar{X} = 1.026\bar{C} + 0.89$
	12.00	13.88	3.10		$S_R = 0.066\bar{X} + 0.48$	13.10	2.39		$S_R = 0.015\bar{X} + 2.19$	13.42	1.13		$S_R = 0.067\bar{X}$ 0.68
	56.00	57.86	4.03	2.68	$S_r = 0.026\bar{X} + 1.25$	56.04	2.24	1.29	$S_r = 2.18$[d]	59.35	5.99	5.42	$S_r = 0.068\bar{X} - 0.37$
	80.00	84.73	2.65			84.38	3.18			83.90	5.70		
	160.00	157.66	13.62	6.97		158.24	5.12	3.16		164.58	14.11	9.80	
	200.00	197.43	9.47			196.72	7.47			199.88	11.19		
Cobalt	0.80	0.88	0.10	0.05	$\bar{X} = 0.977\bar{C} + 0.01$	0.92	0.45	0.31	$\bar{X} = 0.964\bar{C} + 0.06$	0.85	0.13	0.09	$\bar{X} = 0.989\bar{C} - 0.01$
	1.21	0.98	0.04		$S_R = 0.028\bar{X} + 0.06$	1.02	0.10		$S_R = 0.019\bar{X} + 0.32$	1.04	0.18		$S_R = 0.057\bar{X} + 0.09$
	20.10	20.77	0.74	0.67	$S_r = 0.027\bar{X} + 0.02$	20.45	0.91	0.53	$S_r = 0.014\bar{X} + 0.30$	20.81	1.11	1.12	$S_r = 0.012\bar{X} + 0.40$[e]
	28.20	27.75	0.96			27.29	1.22			28.07	2.16		
	80.50	78.59	2.29	2.31		78.04	3.72	1.84		79.26	4.66	1.34	
	101.00	98.79	2.94			97.62	4.62			99.41	4.22		
Copper	4.00	3.88	0.73	0.59	$\bar{X} = 1.003\bar{C} - 0.05$	3.33	0.85	0.99	$\bar{X} = 0.976\bar{C} - 0.38$	3.86	1.40	0.71	$\bar{X} = 0.977\bar{C} - 0.01$
	6.00	6.14	1.00		$S_R = 0.037\bar{X} + 0.64$	5.95	1.78		$S_R = 0.063\bar{X} + 0.86$	5.96	0.95		$S_R = 0.073\bar{X} + 0.92$
	20.00	20.07	1.08	0.92	$S_r = 0.016\bar{X} + 0.51$	18.90	1.64	1.51	$S_r = 0.029\bar{X} + 0.86$	18.97	1.68	2.32	$S_r = 0.077\bar{X} + 0.35$
	28.00	27.97	1.94			27.21	2.76			27.44	2.58		
	80.00	79.80	3.22	1.91		76.64	5.30	3.42		79.30	9.05	6.54	
	100.00	99.57	4.42			96.17	5.64			97.54	11.16		
Lead	4.00	4.00	1.57	1.62	$\bar{X} = 1.043\bar{C} - 0.31$	3.44	1.15	1.18	$\bar{X} = 1.032\bar{C} - 0.30$	4.20	1.13	1.76	$\bar{X} = 1.012\bar{C} + 0.15$
	6.00	5.56	2.00		$S_R = 0.064\bar{X} + 1.43$[c]	6.84	1.10		$S_R = 0.015\bar{X} + 1.06$	6.27	2.38		$S_R = 0.048\bar{X} + 1.27$
	20.00	20.54	2.91	4.36	$S_r = 3.42$[d]	20.18	1.20	1.44	$S_r = 0.011\bar{X} + 1.13$	19.57	2.72	0.88	$S_r = 1.78$[d]
	28.00	30.90	4.58			28.08	1.57			28.55	1.73		
	80.00	80.57	3.13	4.29		80.92	2.30	2.07		82.47	4.38	2.69	
	100.00	102.93	6.62			101.60	3.23			102.47	3.58		
Manganese	0.80	0.86	0.15	0.09	$\bar{X} = 0.983\bar{C} + 0.02$	0.96	0.32	0.42	$\bar{X} = 0.989\bar{C} + 0.10$	0.64	0.22	0.17	$\bar{X} = 0.954\bar{C} - 0.16$
	1.20	1.09	0.12		$S_R = 0.026\bar{X} + 0.11$	1.13	0.38		$S_R = 0.047\bar{X} + 0.29$	0.90	0.21		$S_R = 0.103\bar{X} + 0.14$
	20.00	20.43	0.89	0.72	$S_r = 0.027\bar{X} + 0.06$	21.06	1.32	0.96	$S_r = 0.021\bar{X} + 0.40$	19.61	2.60	2.62	$S_r = 0.025\bar{X} + 0.09$[e]
	28.00	27.53	0.41			27.60	1.47			25.65	4.10		
	80.00	79.00	3.16	2.38		79.57	4.18	2.01		77.38	6.13	2.90	
	100.00	97.60	2.51			97.97	4.10			95.86	6.74		

TABLE 12: SUMMARY STATISTICS AND DESCRIPTIVE EQUATIONS FOR THE 20 ANALYTES TESTED IN THE COLLABORATIVE STUDY

		Reagent Water				Finished Drinking Water				Ground Water			
Analyte	C[a]	$\bar{X}$[b]	S_R	S_r	Regr. Equations	$\bar{X}$	S_R	S_r	Regr. Equations	$\bar{X}$	S_R	S_r	Regr. Equations
Molybdenum	2.80	2.63	0.32	0.16	$\bar{X} = 1.012C - 0.20$	2.80	0.20	0.32	$\bar{X} = 1.013C - 0.07$	3.00	0.47	0.42	$\bar{X} = 1.032C - 0.09$
	4.00	3.85	0.31		$S_R = 0.032\bar{X} + 0.22$	3.95	0.47		$S_R = 0.037\bar{X} + 0.17$	3.60	0.90		$S_R = 0.55\bar{X} + 0.43$
	20.00	19.75	0.64	0.64	$S_r = 0.021X + 0.09$	19.78	0.60	1.16	$S_r = 0.035X + 0.20$	20.69	1.37	1.11	$S_r = 0.042X + 0.27$
	28.00	27.87	1.07			27.87	1.51			28.80	2.01		
	80.00	83.07	3.07	1.78		85.65	3.50	3.07		84.26	4.13	4.81	
	100.00	100.08	4.32			99.06	2.89			103.57	6.10		
Nickel	4.00	4.02	0.41	0.50	$\bar{X} = 1.000C + 0.12$	3.66	0.53	1.03	$\bar{X} = 0.953C - 0.19$	4.81	2.06	2.82	$\bar{X} = 1.022C + 0.66$
	6.00	6.36	0.91		$S_R = 0.051\bar{X} + 0.31$	5.44	1.32		$S_R = 0.046\bar{X} + 0.56$	6.67	3.66		$S_R = 0.091\bar{X} + 2.03$
	20.00	19.93	1.30	0.63	$S_r = 0.017X + 0.40$	18.42	0.87	1.11	$S_r = 0.023X + 0.91$	20.58	3.71	2.37	$S_r = 0.008X + 2.75$[c]
	28.00	28.02	1.25			27.09	1.68			30.73	3.75		
	80.00	79.29	2.95	2.55		75.84	4.40	3.94		82.71	9.49	5.42	
	100.00	100.87	7.20			95.83	4.41			101.00	9.89		
Selenium	32.00	33.54	4.63	1.57	$\bar{X} = 1.036C - 0.06$	32.57	4.37	3.65	$\bar{X} = 1.022C + 0.14$	32.46	4.95	3.24	$\bar{X} = 1.045C - 0.83$
	40.00	41.03	6.04		$S_R = 0.051\bar{X} + 3.24$	42.18	3.71		$S_R = 0.056\bar{X} + 2.10$	41.46	3.30		$S_R = 0.037\bar{X} + 2.97$
	80.00	81.40	5.86	5.44	$S_r = 0.061X - 0.64$	79.97	6.66	5.28	$S_r = 0.040X + 2.15$	81.63	6.94	5.65	$S_r = 0.058X + 1.02$
	96.10	98.34	8.57			94.94	7.90			98.92	4.39		
	160.00	163.58	15.69	9.86		163.48	9.17	10.06		167.54	8.69	12.98	
	200.00	214.30	10.57			212.19	16.49			209.21	14.65		
Silver	0.80	0.93	0.09	0.14	$\bar{X} = 0.917C + 0.26$	0.70	0.34	0.34	$\bar{X} = 0.888C + 0.09$	0.70	0.26	0.10	$\bar{X} = 0.858C - 0.00$
	1.20	1.51	0.23		$S_R = 0.196\bar{X} - 0.09$	1.37	0.33		$S_R = 0.186\bar{X} + 0.17$	0.98	0.28		$S_R = 0.169\bar{X} + 0.14$
	48.00	49.39	3.25	1.81	$S_r = 0.053X + 0.08$	45.43	6.78	5.15	$S_r = 0.164X + 0.18$	45.59	4.27	2.70	$S_r = 0.120X - 0.01$
	64.00	63.54	2.75			60.35	2.22			59.71	6.58		
	160.00	136.42	48.31	12.19		119.06	55.28	36.34		121.43	42.55	28.19	
	200.00	153.74	57.34			172.15	31.92			160.69	27.15		
Thallium	2.80	2.89	0.23	0.22	$\bar{X} = 0.984\bar{X} + 0.08$	2.88	0.40	0.16	$\bar{X} = 1.010C + 0.01$	2.88	0.14	0.12	$\bar{X} = 1.023C - 0.06$
	4.00	3.92	0.15		$S_R = 0.035\bar{X} + 0.09$	3.96	0.21		$S_R = 0.040\bar{X} + 0.21$	3.88	0.37		$S_R = 0.056\bar{X} + 0.04$
	20.00	19.27	0.99	0.67	$S_r = 0.027X + 0.13$	19.77	1.13	0.83	$S_r = 0.039X + 0.02$	20.22	1.05	0.65	$S_r = 0.049X - 0.06$
	28.00	28.08	0.83			27.61	1.24			28.65	1.50		
	80.00	81.29	3.65	2.86		85.32	4.08	4.05		83.97	6.10	6.05	
	100.00	96.69	2.86			100.07	4.33			101.09	4.15		
Thorium	0.80	0.93	0.16	0.09	$\bar{X} = 1.013C + 0.08$	0.78	0.13	0.07	$\bar{X} = 1.019C - 0.06$	0.87	0.17	0.07	$\bar{X} = 1.069C - 0.03$
	1.20	1.22	0.19		$S_R = 0.036\bar{X} + 0.13$	1.09	0.19		$S_R = 0.035\bar{X} + 0.12$	1.15	0.17		$S_R = 0.041\bar{X} + 0.13$
	20.00	20.88	0.90	0.71	$S_r = 0.025X + 0.07$	21.66	0.94	0.54	$S_r = 0.024X + 0.05$	21.78	0.90	0.94	$S_r = 0.027X + 0.04$
	28.00	27.97	1.11			28.09	0.83			29.86	1.65		
	80.10	81.14	2.99	2.14		79.99	2.03	2.60		86.00	3.43	1.95	
	100.00	102.64	3.39			100.50	4.56			107.35	4.72		

TABLE 12: SUMMARY STATISTICS AND DESCRIPTIVE EQUATIONS FOR THE 20 ANALYTES TESTED IN THE COLLABORATIVE STUDY

		Reagent Water				Finished Drinking Water				Ground Water			
Analyte	C[a]	$\bar{X}$[b]	S_R	S_r	Regr. Equations	$\bar{X}$	S_R	S_r	Regr. Equations	$\bar{X}$	S_R	S_r	Regr. Equations
Uranium	0.80	0.86	0.05	0.08	$\bar{X} = 1.026\underline{C} - 0.02$	0.85	0.15	0.09	$\bar{X} = 1.026\underline{C} - 0.04$	0.84	0.23	0.19	$\bar{X} = 1.058\underline{C} - 0.06$
	1.20	1.10	0.11		$S_R = 0.048\bar{X} + 0.02$	1.05	0.13		$S_R = 0.044\bar{X} + 0.11$	1.10	0.14		$S_R = 0.039\bar{X} + 0.17$
	20.10	21.38	0.99	0.82	$S_r = 0.027\bar{X} + 0.05$	22.30	1.40	0.46	$S_r = 0.022\bar{X} + 0.07$	21.56	1.11	1.08	$S_r = 0.028\bar{X} + 0.16$
	28.10	28.36	1.10			28.89	1.47			29.86	1.83		
	80.30	82.47	4.03	2.16		80.31	2.00	2.71		85.01	3.76	2.00	
	100.00	103.49	5.24			100.70	5.30			106.47	3.74		
Vanadium	32.00	31.02	2.68	2.19	$\bar{X} = 1.025C - 2.21$	33.15	2.51	2.28	$\bar{X} = 1.022\underline{C} - 0.30$	33.25	3.83	1.87	$\bar{X} = 1.076\underline{C} - 1.87$
	40.00	38.54	2.94		$S_R = 3.79$[d]	40.20	1.88		$S_R = 0.023\bar{X} + 1.45$	40.34	3.08		$S_R = 0.033\bar{X} + 2.25$
	80.00	79.14	4.94	4.29	$S_r = 3.26$[d]	77.83	4.18	2.75	$S_r = 0.023\bar{X} + 1.38$	84.42	3.97	2.93	$S_r = 0.049\bar{X} - 0.09$
	96.00	93.47	3.85			96.32	1.34			98.70	5.03		
	160.00	162.43	5.67	3.30		161.89	7.63	6.56		170.94	9.09	11.55	
	200.00	208.20	2.65			214.91	5.89			217.90	11.36		
Zinc	8.00	8.33	2.56	1.78	$\bar{X} = 1.042\underline{C} + 0.87$	11.60	6.18	5.72	$\bar{X} = 0.943\underline{C} + 2.54$	7.29	1.12	2.20	$\bar{X} = 0.962\underline{C} + 0.07$
	12.00	15.49	4.18		$S_R = 0.041\bar{X} + 2.60$	10.21	4.96		$S_R = 0.048\bar{X} + 5.27$	12.66	3.24		$S_R = 0.093\bar{X} + 0.92$
	56.00	56.07	2.91	2.47	$S_r = 0.030\bar{X} + 1.42$	56.83	7.66	4.56	$S_r = 0.004\bar{X} + 5.66$[c]	54.86	5.12	7.24	$S_r = 0.069\bar{X} + 1.55$
	80.00	85.53	5.81			82.88	8.34			78.62	8.56		
	160.00	165.17	7.78	9.87		156.69	17.01	9.48		150.12	12.52	10.84	
	200.00	207.27	14.61			191.59	17.21			184.37	16.59		

[a] True Value for the concentration added ($\mu g/L$)
[b] Mean Recovery ($\mu g/L$)
[c] $COD_w < 0.5$ - Use of regression equation outside study concentration range not recommended.
[d] $COD_w < 0$ - Mean precision is reported.
[e] $COD_w < 0$ - Unweighted linear regression equation presented.

TABLE 13: BACKGROUND AND SPIKE MEASUREMENTS IN WASTEWATER DIGESTATE[a]

	Background		Concentrate 1					Concentrate 2					
	Conc. µg/L	Std Dev µg/L	Spike µg/L	Found µg/L	Std Dev µg/L	% Rec %	RSD %	Spike µg/L	Found µg/L	Std Dev µg/L	% Rec %	RSD %	RSD_r %
Be	0.0	0.0	100	94.5	11.8	94.5	12.5	125	118.1	14.7	94.5	12.4	3.5
Al	78.2	12.4	200	260.9	41.2	91.4	15.8	250	309.1	48.5	92.4	15.7	2.7
Cr	19.5	8.1	200	222.2	23.3	101.4	10.5	250	274.3	26.6	101.9	9.7	2.0
V	1.9	2.8	250	271.8	36.5	108.0	13.4	200	219.3	30.1	108.7	13.7	2.6
Mn	296.6	24.7	125	419.0	35.7	97.9	8.5	100	397.4	34.8	100.8	8.8	1.0
Co	2.5	0.4	125	124.7	12.3	97.8	9.9	101	100.7	9.4	97.2	9.3	2.8
Ni	47.3	5.0	125	161.7	4.9	91.5	3.0	100	142.7	5.6	95.4	3.9	2.1
cu	77.4	13.2	125	194.5	29.5	93.7	15.2	100	172.3	26.6	94.9	15.4	2.2
Zn	77.4	4.9	200	257.4	16.3	90.0	6.3	250	302.5	21.1	90.0	7.0	1.8
As	0.8	1.1	200	194.9	8.0	97.1	4.1	250	244.7	12.8	97.6	5.2	3.4
Se	4.5	6.2	250	236.8	14.2	92.9	6.0	200	194.3	9.3	94.9	4.8	3.8
Mo	166.1	9.4	100	269.8	19.0	103.7	7.0	125	302.0	18.0	108.7	6.0	1.5
Ag	0.6	0.7	200	176.0	14.6	87.7	8.3	250	214.6	17.8	85.6	8.3	2.3
Cd	2.7	1.1	125	117.0	4.8	91.4	4.1	100	96.6	3.2	93.9	3.3	2.9
Sb	3.3	0.2	100	100.2	4.8	96.9	4.8	125	125.9	4.3	98.1	3.4	1.8
Ba	68.6	3.3	250	321.0	19.4	101.0	6.0	200	279.3	17.2	105.4	6.2	2.5
Tl	0.1	0.1	100	103.3	8.0	103.2	7.7	125	129.2	8.9	103.3	6.9	2.1
Pb	6.9	0.5	125	135.1	7.8	102.6	5.8	100	110.3	6.3	103.4	5.7	1.8
Th	0.1	0.1	125	140.2	19.5	112.1	13.9	100	113.3	15.4	113.2	13.6	2.7
U	0.4	0.2	125	141.2	19.3	112.6	13.7	100	113.6	16.0	113.2	14.1	2.5

[a]Results from 10 participating laboratories. Wastewater digestate supplied with the study materials. Mean background concentrations determined by the participants.

TABLE 14: SPIKE MEASUREMENTS IN PARTICIPANTS WASTEWATER[a]

	Concentrate 1					Concentrate 2					
	Spike µg/L	Found µg/L	Std Dev µg/L	% Rec %	RSD %	Spike µg/L	Found µg/L	Std Dev µg/L	% Rec %	RSD %	RSD_r %
Be	101	103.4	12.0	103.4	11.6	125	128.2	13.6	102.6	10.6	2.4
Al	200	198.7	23.9	99.4	12.0	250	252.4	15.5	101.0	6.1	2.9
Cr	200	205.4	12.3	102.7	6.0	250	253.4	15.4	101.4	6.1	1.1
V	250	246.5	4.4	98.6	1.8	200	196.8	2.8	98.4	1.4	2.0
Mn	125	119.0	5.4	95.2	4.5	100	95.5	4.3	95.5	4.5	0.8
Co	125	125.8	7.0	100.6	5.6	101	99.5	5.3	98.5	5.3	1.8
Ni	125	127.4	9.7	101.9	7.6	100	101.0	7.5	101.0	7.4	1.7
cu	125	126.8	5.3	101.4	4.2	100	105.3	3.6	105.3	3.4	2.8
Zn	200	201.4	36.7	100.7	18.2	250	246.4	29.7	98.6	12.1	2.6
As	200	207.3	11.9	103.7	5.7	250	263.0	2.6	105.2	1.0	3.2
Se	250	256.8	26.4	102.7	10.3	200	214.0	18.7	107.3	8.7	3.6
Mo	100	98.6	4.6	98.6	4.7	125	123.2	6.7	98.6	5.4	2.2
Ag	200	200.7	48.9	100.4	24.4	250	231.2	63.5	92.5	27.5	8.2
Cd	125	123.2	11.5	98.6	9.3	100	95.8	2.9	95.8	3.0	5.8
Sb	100	92.2	4.4	92.2	4.8	125	119.0	1.0	95.2	0.8	2.8
Ba	250	245.2	12.8	98.1	5.2	200	204.7	12.1	102.4	5.9	2.1
Tl	100	100.0	0.9	100.0	0.9	125	128.0	6.0	102.4	4.7	3.5
Pb	125	125.8	5.1	100.6	4.1	100	100.8	2.7	100.8	2.7	2.2
Th	125	124.2	7.6	99.4	6.1	100	99.8	5.7	99.8	5.7	3.2
U	125	130.4	10.3	104.3	7.9	100	106.4	6.8	106.4	6.4	2.3

[a]Results from five participating laboratories. Mean concentrations before spiking are not listed because they varied considerably among the different wastewaters.

METHOD 245.1

DETERMINATION OF MERCURY IN WATER BY COLD VAPOR ATOMIC ABSORPTION SPECTROMETRY

Revision 3.0
EMMC Version

J.F. Kopp, M.C. Longbottom, and L.B. Lobring - Mercury in Water (Cold Vapor Technique), Revision 1.0, (1972)

J.F. Kopp and L.B. Lobring - Method 245.1, Revision 2.0 (1979)

L.B. Lobring and B.B. Potter - Method 245.1, Revision 2.3 (1991)

J.W. O'Dell, B.B. Potter, L.B. Lobring, and T.D. Martin - Method 245.1, Revision 3.0 (1994)

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
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METHOD 245.1

DETERMINATION OF MERCURY IN WATER
BY COLD VAPOR ATOMIC ABSORPTION SPECTROMETRY

1.0 SCOPE AND APPLICATION

1.1 This procedure[1] measures total mercury (organic + inorganic) in drinking, surface, ground, sea, brackish waters, industrial and domestic wastewater.

Analyte	Chemical Abstracts Service Registry Number (CASRN)
Mercury	7439-97-6

1.2 The range of the method is 0.2-10 µg Hg/L. The range may be extended above or below the normal range by increasing or decreasing sample size. However, the actual method detection limit and linear working range will be dependent on the sample matrix, type of instrumentation configuration, and selected operating conditions.

1.3 Reduced volume or semi-automated versions of this method, that use the same reagents and molar ratios, are acceptable provided they meet the quality control and performance requirements stated in the method (Section 9.0).

1.4 For reference where this method is approved for use in compliance monitoring programs [e.g., Clean Water Act (NPDES) or Safe Drinking Water Act (SDWA)] consult both the appropriate sections of the Code of Federal Regulation (40 CFR Part 136 Table 1B for NPDES, and Part 141 § 141.23 for drinking water), and the latest Federal Register announcements.

2.0 SUMMARY OF METHOD

2.1 A known portion of a water sample is transferred to a BOD bottle, equivalent ground glass stoppered flask or other suitable closed container. It is digested in diluted potassium permanganate-potassium persulfate solutions and oxidized for two hours at 95°C. Mercury in the digested water sample is reduced with stannous chloride to elemental mercury and measured by the conventional cold vapor atomic absorption technique.

3.0 DEFINITIONS

3.1 **Calibration Blank** - A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to auto-zero the instrument.

3.2 **Calibration Standard (CAL)** - A solution prepared from the dilution of stock standard solutions. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

3.3 **Field Reagent Blank (FRB)** - An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to the sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FRB is to determine if method analytes or other interferences are present in the field environment.

3.4 **Instrument Performance Check (IPC) Solution** - A solution of the method analyte, used to evaluate the performance of the instrument system with respect to a defined set of method criteria.

3.5 **Laboratory Duplicates (LD1 and LD2)** - Two aliquots of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of LD1 and LD2 indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

3.6 **Laboratory Fortified Blank (LFB)** - An aliquot of LRB to which a known quantity of the method analyte is added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

3.7 **Laboratory Fortified Sample Matrix (LFM)** - An aliquot of an environmental sample to which a known quantity of the method analyte is added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations.

3.8 **Laboratory Reagent Blank (LRB)** - An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples. The LRB is used to determine if the method analyte or other interferences are present in the laboratory environment, reagents, or apparatus.

3.9 **Linear Dynamic Range (LDR)** - The concentration range over which the instrument response to an analyte is linear.

3.10 **Method Detection Limit (MDL)** - The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero.

3.11 **Quality Control Sample (QCS)** - A solution of the method analyte of known concentration which is used to fortify an aliquot of LRB or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check either laboratory or instrument performance.

3.12 **Standard Addition** - The addition of a known amount of analyte to the sample in order to determine the relative response of the detector to an analyte within the sample matrix. The relative response is then used to assess either an operative matrix effect or the sample analyte concentration.

3.13 **Stock Standard Solution** - A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

4.0 INTERFERENCES

4.1 Interferences have been reported for waters containing sulfide, chloride, copper and tellurium. Organic compounds which have broad band UV absorbance (around 253.7 nm) are confirmed interferences. The concentration levels for interferants are difficult to define. This suggests that quality control procedures (Section 9.0) must be strictly followed.

4.2 Volatile materials (e.g., chlorine) which absorb at 253.7 nm will cause a positive interference. In order to remove any interfering volatile materials, the dead air space in the digestion vessel (BOD bottle) should be purged before addition of stannous chloride solution.

4.3 Low level mercury sample preparation, digestion, and analysis may be subject to environmental contamination if preformed in areas with high ambient backgrounds where mercury was previously employed as an analytical reagent in analyses such as total Kjeldahl nitrogen (TKN) or chemical oxygen demand (COD).

5.0 SAFETY

5.l The toxicity and carcinogenicity of each reagent used in this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be minimized by good laboratory practices[1]. Normal accepted laboratory safety practices should be followed during reagent preparation and instrument operation. Always wear safety glasses or full-face shield for eye protection when working with these reagents. Each laboratory is responsible for maintaining a current safety plan, a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method.[3,4]

5.2 Mercury compounds are highly toxic if swallowed, inhaled, or absorbed through the skin. Analyses should be conducted in a laboratory exhaust hood. The analyst should use chemical resistant gloves when handling concentrated mercury standards.

5.3 The acidification of samples containing reactive materials may result in the release of toxic gases, such as cyanides or sulfides. Acidification of samples should be done in a fume hood.

5.4 All personnel handling environmental samples known to contain or to have been in contact with human waste should be immunized against known disease causative agents.

6.0 EQUIPMENT AND SUPPLIES

6.1 Atomic Absorption Cold Vapor System

6.1.1 Atomic Absorption Spectrophotometer - Any atomic absorption unit having an open sample presentation area in which to mount the absorption cell is suitable. Instrument settings recommended by the particular manufacturer should be followed. The use of background correction is recommended, but is not mandatory.

6.1.2 Mercury Hollow Cathode Lamp - Single element hollow cathode lamp or electrodeless discharge lamp and associated power supply.

6.1.3 Absorption Cell - Standard spectrophotometer cells 10-cm long, having quartz windows may be used. Suitable cells may be constructed from plexiglass tubing, 1 in. O.D. by 4 ½ in. long. The ends are ground perpendicular to the longitudinal axis and quartz windows (1 in. diameter by 1/16 in. thickness) are cemented in place. Gas inlet and outlet ports (also of plexiglass but ¼ in. O.D.) are attached approximately ½ in. from each end. The cell is strapped to a burner for support and aligned in the light beam to give the maximum transmittance.

6.1.4 Aeration Tubing - Inert mercury-free tubing is used for passage of mercury vapor from the sample bottle to the absorption cell. In some systems, mercury vapor is recycled. Straight glass tubing terminating in a coarse porous glass aspirator is used for purging mercury released from the water sample in the BOD bottle.

6.1.5 Air Pump - Any pump (pressure or vacuum system) capable of passing air 1 L/min. is used. Regulated compressed air can be used in an open one-pass system.

6.1.6 Drying Tube - Tube (6 in. x ¾ in. O.D.) containing 20 g of magnesium perchlorate. The filled tube is inserted (in-line) between the BOD bottle and the absorption tube. In place of the magnesium perchlorate drying tube, a small reading lamp is positioned to radiate heat (about 10°C above ambient) on the absorption cell. Heat from the lamp prevents water condensation in the cell.

6.1.7 Recorder - Any multi-range variable speed recorder or data system that is compatible with the UV detection system is suitable.

Note: Instruments designed specifically for mercury measurement using the cold vapor technique are commercially available and may be substituted for the atomic absorption cold vapor system described above.

6.2 Flowmeter, capable of measuring an air flow of 1 L/min.

6.3 A water bath with a covered top and capacity to maintain a water depth of 2-3 in. at 95°C.

6.4 Analytical balance, with capability to measure to 0.1 mg, for use in weighing reagents and preparing standards.

6.5 Labware - All reusable labware should be sufficiently clean for the task objectives. Particular attention should be given to all ground glass surfaces during cleaning. Routinely all items should be soaked in 30% HNO_3 and rinsed three times in reagent water. Digestion containers used in sample preparation that do not rinse clean of the previous sample should be washed with a detergent solution prior to acid cleaning.

6.5.1 Glassware - Volumetric flasks and graduated cylinders.

6.5.2 BOD bottles (or other equivalent suitable closed containers).

6.5.3 Assorted calibrated pipettes.

7.0 REAGENTS AND STANDARDS

7.1 Reagents may contain elemental impurities which bias analytical results. All reagents should be assayed by the chemical manufacturer for mercury and meet ACS specifications. The assayed mercury level of all solid reagents used in this method should not exceed 0.05 ppm. It is recommended that the laboratory analyst assay all reagents for mercury.

7.2 Reagent Water, ASTM Type II[5].

7.3 Nitric Acid (HNO_3), concentrated (sp.gr. 1.41), assayed mercury level is not to exceed 1 µg/L.

7.3.1 Nitric acid (1+1) - Add 500 mL concentrated HNO_3 to 400 mL reagent water and dilute to 1 L.

7.4 Sulfuric Acid (H_2SO_4), concentrated (sp.gr. 1.84), assayed mercury level is not to exceed 1 µg/L.

7.4.1 Sulfuric acid, 0.5 N - Slowly add 14.0 mL of conc. H_2SO_4 to 500 mL of reagent water and dilute to 1 L with reagent water.

7.5 Mercury standard, stock, 1 mL = 100 µg Hg: DO NOT DRY. **CAUTION:** highly toxic element. Dissolve 0.1354 g $HgCl_2$ in 75 mL reagent water. Add 50.0 mL concentrated HNO_3 (Section 7.3) and dilute to volume in 1 L volumetric flask with reagent water.

7.6 Mercury calibration standard (CAL) - To each volumetric flask used for serial dilutions, acidify with (0.1-0.2% by volume) HNO_3 (Section 7.3). Using mercury stock standard (Section 7.5), make serial dilutions to obtain a concentration of 0.1 µg Hg/mL.

7.7 Potassium permanganate solution - Dissolve 5 g of $KMnO_4$ in 100 mL of reagent water.

7.8 Potassium persulfate solution - Dissolve 5 g of $K_2S_2O_8$ in 100 mL of reagent water.

7.9 Sodium chloride-hydroxylammonium chloride solution - Dissolve 12 g of NaCl and 12 g of hydroxylamine hydrochloride ($NH_2OH \cdot HCl$) in 100 mL reagent water. (Hydroxylamine sulfate $(NH_2OH)_2 \cdot H_2SO_4$ may be used in place of hydroxylamine hydrochloride.)

7.10 Stannous chloride solution - Add 25 g of $SnCl_2 \cdot 2H_2O$ to 250 mL of 0.5 N H_2SO_4 (Section 7.4.1). This mixture is a suspension and should be stirred continuously during use.

7.11 Blanks - Three types of blanks are required for the analysis. The calibration blank is used in establishing the analytical curve, the laboratory reagent blank is used to assess possible contamination from the sample preparation procedure, and the laboratory fortified blank is used to assess routine laboratory performance.

7.11.1 The calibration blank must contain all reagents in the same concentrations and in the same volume as used in preparing the calibration solutions.

7.11.2 The laboratory reagent blank (LRB) is prepared in the manner as the calibration blank except the LRB must be carried through the entire sample preparation scheme.

7.11.3 The laboratory fortified blank (LFB) is prepared by fortifying a sample size volume of laboratory reagent blank solution with mercury to a suitable

concentration of >10X the MDL, but less than the midpoint concentration of the calibration curve. The LFB must be carried through the entire sample preparation scheme.

7.12 Instrument Performance Check (IPC) Solution - The IPC solution is used to periodically verify instrument performance during analysis. It must contain all reagents in the same concentration as the calibration solutions and mercury at an appropriate concentration to approximate the midpoint of the calibration curve. The IPC solution should be prepared from the same CAL standard (Section 7.6) as used to prepare the calibration solutions. Agency programs may specify or request that additional instrument performance check solutions be prepared at specified concentrations in order to meet particular program needs.

7.13 Quality Control Sample (QCS) - For initial and periodic verification of calibration standards and instrument performance, analysis of a QCS is required. The QCS must be obtained from an outside source different from the standard stock solution, but prepared in the same manner as the calibration solutions. The concentration of the mercury in the QCS solution should be such that the resulting solution will provide an absorbance reading near the midpoint of the calibration curve. The QCS should be analyzed quarterly or more frequently as needed to meet data-quality needs.

8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

8.1 Because of the extreme sensitivity of the analytical procedure and the presence of mercury in a laboratory environment, care must be taken to avoid extraneous contamination. Sampling devices, sample containers and plastic items should be determined to be free of mercury; the sample should not be exposed to any condition in the laboratory that may result in contamination from airborne mercury vapor.

8.2 For the determination of total mercury (inorganic + organic) in aqueous samples, samples are **not** filtered, but acidified with (1+1) nitric acid (Section 7.3.1) to pH <2 (normally, 3 mL of (1+1) acid per liter of sample is sufficient for most ambient and drinking water samples). Preservation may be done at the time of collection, however, to avoid the hazards of strong acids in the field, transport restrictions, and possible contamination it is recommended that the samples be returned to the laboratory as soon as possible after collection and acid preserved upon receipt in the laboratory. Following acidification, the sample should be mixed, held for 16 hours, and then verified to be pH <2 just prior withdrawing an aliquot for processing. If for some reason such as high alkalinity the sample pH is verified to be >2, more acid must be added and the sample held for additional 16 hours until verified to be pH <2. The preserved sample should be analyzed within 28 days of collection.

Note: When the nature of the sample is either unknown or is known to be hazardous, acidification should be done in a fume hood. See Section 5.2.

8.3 A field blank should be prepared and analyzed as required by the data user. Use the same container and acid as used in sample collection.

9.0 QUALITY CONTROL

9.1 Each laboratory using this method is required to operate a formal quality control (QC) program. The minimum requirements of this program consist of an initial demonstration of laboratory capability by analysis of laboratory reagent blanks, fortified blanks and samples used for continuing check on method performance. Commercially available water quality control samples are acceptable for routine laboratory use. The laboratory is required to maintain performance records that define the quality of the data generated.

9.2 Initial Demonstration of Performance (mandatory).

9.2.1 The initial demonstration of performance is used to characterize instrument performance (determination of linear dynamic ranges and analysis of quality control samples) and laboratory performance (determination of method detection limits) prior to analyses conducted by this method.

9.2.2 Linear dynamic range (LDR) - The upper limit of the LDR must be established. It must be determined from a linear calibration prepared from a minimum of three different concentration standards, one of which is close to the upper limit of the linear range. The LDR should be determined by analyzing succeedingly higher standard concentrations of mercury until the observed analyte concentration is no more than 10% below the stated concentration of the standard. The determined LDR must be documented and kept on file. The LDR which may be used for the analysis of samples should be judged by the analyst from the resulting data. Determined sample analyte concentrations that are greater than 90% of the determined upper LDR limit must be diluted and reanalyzed. The LDR should be verified annually or whenever, in the judgement of the analyst, a change in analytical performance caused by either a change in instrument hardware or operating conditions would dictate they be redetermined.

9.2.3 Quality control sample (QCS) - When beginning the use of this method, on a quarterly basis, after the preparation of stock or calibration standard solutions or as required to meet data-quality needs, verify the calibration standards and acceptable instrument performance with the preparation and analyses of a QCS (Section 7.13). To verify the calibration standards, the determined concentration of the QCS must be within ±10% of the stated value. If the calibration standard cannot be verified, performance of the determinative step of the method is unacceptable. The source of the problem must be identified and corrected before either proceeding on with the initial determination of method detection limits or continuing with on-going analyses.

9.2.4 Method detection limit (MDL) - A mercury MDL must be established using an LRB solution fortified at a concentration of two to three times the estimated detection limit.[5] To determine MDL values, take seven replicate aliquots of the fortified LRB and process through the entire analytical method. Perform all calculations defined in the method and report the concentration values in the appropriate units. Calculate the MDL as follows:

$$MDL = (t) \times (S)$$

where:

t = Student's t value for n-1 degrees of freedom at the 99% confidence level; t = 3.143 for six degrees of freedom

S = standard deviation of the replicate analyses

Note: If the relative standard deviation (RSD) from the analyses of the seven aliquots is <10%, the concentration used to determine the mercury MDL may have been inappropriately high for the determination. If so, this could result in the calculation of an unrealistically low MDL. Concurrently, determination of MDL in an LRB solution represents a best case situation and does not reflect possible matrix effects of real world samples. However, successful analyses of LFMs (Section 9.4) can give confidence to the MDL value determined in LRB solution.

The MDL must be sufficient to detect mercury at the required level according to compliance monitoring regulation (Section 1.2). The mercury MDL should be determined annually, when a new operator begins work or whenever, in the judgement of the analyst, a change in analytical performance caused by either a change in instrument hardware or operating conditions would dictate they be redetermined.

9.3 Assessing Laboratory Performance (mandatory)

9.3.1 Laboratory reagent blank (LRB) - The laboratory must analyze at least one LRB (Section 7.11.2) with each batch of 20 or fewer samples of the same matrix. LRB data are used to assess contamination from the laboratory environment. LRB values that exceed the MDL indicate laboratory or reagent contamination should be suspected. When LRB values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable LRB values have been obtained.

9.3.2 Laboratory fortified blank (LFB) - The laboratory must analyze at least one LFB (Section 7.11.3) with each batch of samples. Calculate accuracy as percent recovery using the following equation:

$$R = \frac{LFB - LRB}{s} \times 100$$

where:

R = percent recovery
LFB = laboratory fortified blank
LRB = laboratory reagent blank
s = concentration equivalent of mercury added to fortify the LRB solution.

If the recovery of mercury falls outside the required control limits of 85-115%, the analysis is judged out of control, and the source of the problem should be identified and resolved before continuing analyses.

9.3.3 The laboratory must use LFB analyses data to assess laboratory performance against the required control limits of 85-115% (Section 9.3.2). When sufficient internal performance data become available (usually a minimum of 20-30 analyses), optional control limits can be developed from the mean percent recovery (x) and the standard deviation (S) of the mean percent recovery. These data can be used to establish the upper and lower control limits as follows:

UPPER CONTROL LIMIT = x + 3S
LOWER CONTROL LIMIT = x - 3S

The optional control limits must be equal to or better than the required control limits of 85-115%. After each five to ten new recovery measurements, new control limits can be calculated using only the most recent 20-30 data points. Also, the standard deviation (S) data should be used to establish an on-going precision statement for the level of concentrations included in the LFB. These data must be kept on file and be available for review.

9.3.4 Instrument performance check (IPC) solution - For all determinations the laboratory must analyze the IPC solution (Section 7.12) and a calibration blank immediately following each calibration, after every 10th sample (or more frequently, if required) and at the end of the sample run. Analysis of the calibration blank should always be less than the MDL. Analysis of the IPC solution immediately following calibration must verify that the instrument is within ±5% of calibration. Subsequent analyses of the IPC solution must be within ±10 % of calibration. If the calibration cannot be

verified within the specified limits, analysis must be discontinued, the cause determined and/or in the case of drift the instrument recalibrated. All samples following the last acceptable IPC solution must be reanalyzed. The analysis data of the calibration blank and IPC solution must be kept on file with the sample analyses data.

9.4 Assessing Analyte Recovery and Data Quality

9.4.1 Sample homogeneity and the chemical nature of the sample matrix can affect mercury recovery and the quality of the data. Taking separate aliquots from the sample for replicate and fortified analyses can in some cases assess the effect. Unless otherwise specified by the data user, laboratory or program, the following laboratory fortified matrix (LFM) procedure (Section 9.4.2) is required.

9.4.2 The laboratory must add a known amount of mercury to a minimum of 10% of samples or one sample per sample set, whichever is greater. In each case the LFM aliquot must be a duplicate of the aliquot used for sample analysis. Select a sample with a low mercury background that is representative of the type of water samples being analyzed. It is recommended that this sample be analyzed prior to fortification. The concentration of mercury added may vary based on the nature of samples being analyzed. When possible, the concentration should be the same as that added to the LRB, but should not exceed the midpoint concentration of the calibration curve. Over time, samples from all routine sample sources should be fortified.

9.4.3 Calculate the percent recovery, corrected for background concentration measured in the unfortified sample aliquot, and compare these values to the control limits to the designated LFM recovery range of 70-130%. Percent recovery may be calculated using the following equation:

$$R = \frac{C_s - C}{s} \times 100$$

where:

R = percent recovery
C_s = fortified sample concentration
C = sample background concentration
s = concentration equivalent of mercury added to water sample

9.4.4 If mercury recovery falls outside the designated range, and the laboratory performance is shown to be in control (Section 9.3), the recovery problem encountered with the fortified water sample is judged to be matrix related, not system related. The result for mercury in the unfortified sample must

be labelled to inform the data user that the results are suspect due to matrix effects.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Conveniently arrange and connect the various components of the instrument system using one of the options shown in Figure 1. If adjustable, the monochromator should be set to 253.65 nm. Prior to the use of this method the air flow should be optimized. (The recommended air flow rate through the system is 1 L/min.) For all determinations allow an instrument and hollow cathode lamp warm up period of not less than 15 minutes. When an instrument designed specifically for the determination of mercury by the cold vapor technique is being utilized, the analyst should follow the instructions provided by the manufacturer.

10.2 Before using the procedure (Section 11.0) to analyze samples, there must be data available documenting initial demonstration of performance. The required data and procedure is described in Section 9.2. This data must be generated using the same instrument operating conditions and calibration routine used for sample analysis. These documented data must be kept on file and be available for review by the data user.

10.3 The recommended calibration routine is given in Section 11.2.

11.0 PROCEDURE

11.1 Sample Preparation

11.1.1 Transfer 100 mL of the water sample [or an aliquot diluted with reagent water (Section 7.2) to 100 mL] into a sample container.

Note: For reduced volume analysis, adjust sample and reagent volumes to maintain the required sample to reagent ratios.

11.1.2 Add 5 mL of H_2SO_4 (Section 7.4) and 2.5 mL of HNO_3 (Section 7.3) to the container.

11.1.3 To each container add 15 mL $KMnO_4$ solution (Section 7.7). For sewage or industry wastewaters, additional $KMnO_4$ may be required. Shake and add additional portions of $KMnO_4$ solution, if necessary, until the purple color persists for at least 15 minutes. Add 8 mL of $K_2S_2O_8$ solution (Section 7.8) to each container. Mix thoroughly, cap and cover the top of the sample container (if required) with aluminum foil or other appropriate cover. Heat for two hours in a water bath at 95°C.

11.1.4 Remove the sample containers from the water bath and cool to room temperature. (During the cool down period proceed with instrument warm up and calibration.)

11.1.5 When the samples are at room temperature, to each container, add 6 mL of NaCl-$(NH_2OH)_2H_2SO_4$ solution (Section 7.9) to reduce the excess permanganate.

11.2 Sample Analysis

11.2.1 Before beginning daily calibration the instrument should be reconfigured to the optimized conditions. Turn on the instrument and circulating pump. Adjust pump rate to 1 L/min. or as required. Allow system to stabilize.

11.2.2 Prepare calibration standards by transferring 0.5, 1.0, 2.0, 5.0, and 10 mL aliquots of the 0.1 µg/mL CAL (Section 7.6) to a series of sample containers (Section 6.5.2). Dilute the standard aliquots to 100 mL with reagent water (Section 7.2) and process as described in Sections 11.1.2, 11.1.3 (without heating), and 11.1.5. These solutions contain 0.05-1.0 µg of Hg. (Other appropriate calibration standards, volumes, and ranges may also be used.)

11.2.3 Treating each standard solution container individually, add 5 mL of $SnCl_2$ solution (Section 7.10) and immediately attach the container to the aeration apparatus. The absorbance, as exhibited either on the instrument or recording device, will increase and reach maximum within 30 sec. As soon as the maximum response is obtained, approximately one minute, open the bypass value (or optionally remove aspirator from the sample container if it is vented under the hood) and continue aeration until the absorbance returns to its minimum value.

11.2.4 Close the by-pass value, remove the aspirator from the standard solution container and continue aeration. Repeat (Section 11.2.3) until data from all standards have been collected.

11.2.5 Construct a standard curve by plotting peak height, area or maximum response obtained from each standard solution, versus micrograms of mercury in the container. The standard curve must comply with Section 9.2.2. Calibration using computer or calculator based regression curve fitting techniques on concentration/response data is acceptable.

11.2.6 Following calibration the digested samples are analyzed in the same manner as the standard solutions described in Section 11.2.3. However, prior to the addition of the $SnCl_2$ solution, place the aspirator inside the container above the liquid, and purge the head space (20-30 seconds) to remove possible gaseous interference.

11.2.7 During the analysis of samples, the laboratory must comply with the required quality control described in Sections 9.3 and 9.4.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 From the prepared calibration curve (Section 11.2.4) compute sample values by comparing response with the standard curve.

12.2 Calculate the mercury concentration in the sample by the formula:

$$\mu g\ Hg/L = \left(\begin{array}{c}\mu g\ Hg\ in \\ aliquot\end{array}\right)\left(\frac{1{,}000}{mL\ of\ aliquot}\right)$$

12.3 Report mercury concentrations to the proper significant figures in mg/L, µg/L or ng/L as required.

13.0 METHOD PERFORMANCE

13.1 In a single laboratory (EMSL), using an Ohio River composite sample with a background mercury concentration of 0.35 µg/L Hg and fortified with concentration of 1.0, 3.0, and 4.0 µg/L Hg, the standard deviations were ±0.14, ±0.10, and ±0.08 µg/L Hg, respectively. Standard deviation at the 0.35 µg/L Hg level was ±0.16 µg/L Hg. Percent recoveries at the three levels were 89%, 87%, and 87%, respectively.

13.2 In a joint EPA/ASTM interlaboratory study of the cold vapor technique for total mercury in water, increments of organic and inorganic mercury were added to natural waters. Recoveries were determined by difference. A statistical summary of this study is found in Table 1.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions, consult “Less is Better: Laboratory Chemical Management for Waste Reduction, available from the American Chemical Society's Department of Government Relations and Science Policy”, 1155 16th Street N.W., Washington D.C. 20036, (202)872-4477.

15.0 WASTE MANAGEMENT

15.1 The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rule and regulations. The Agency urges laboratories to protect the air, water, and land by minimizing and

controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult "The Waste Management Manual for Laboratory Personnel", available from the American Chemical Society at the address listed in the Section 14.2.

16.0 REFERENCES

1. Kopp, J.F., Longbottom, M.C., and Lobring, L.B., "'Cold Vapor' Method for Determining Mercury"; J. Am. Water Works Assoc., Vol. 64, No. 1, January 1972.

2. "Safety in Academic Chemistry Laboratories", American Chemical Society Publication, Committee on Chemical Safety, 3rd Edition, 1979.

3. "OSHA Safety and Health Standards, General Industry", (29CFR 1910), Occupational Safety and Health Administration, OSHA 2206, revised January 1976.

4. "Proposed OSHA Safety and Health Standards, Laboratories", Occupational Safety and Health Administration, Federal Register, July 24, 1986.

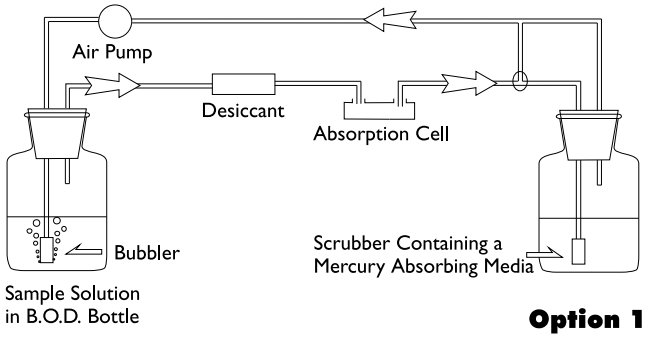
5. "Specification for Reagent Water", D1193, Annual Book of ASTM Standards, Vol. 11.01, 1990.

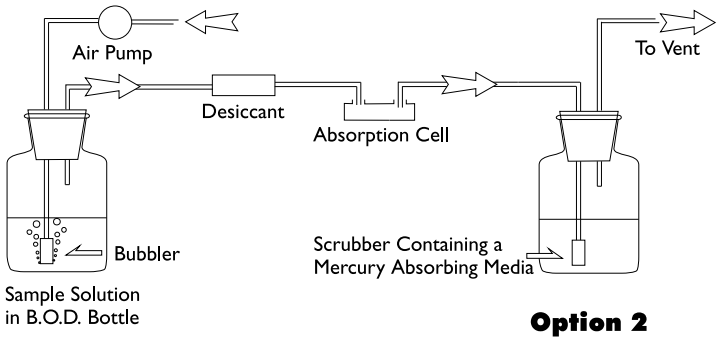
6. Code of Federal Regulations 40, Ch. 1, Pt. 136 Appendix B.

17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

TABLE 1. INTERLABORATORY PRECISION AND ACCURACY DATA FOR FLAMELESS ATOMIC ABSORPTION

Number of Labs	True Values µg/L	Mean Value µg/L	Standard Deviation µg/L	RSD %	Mean Accuracy as % Bias
76	0.21	0.349	0.276	89	66
80	0.27	0.414	0.279	67	53
82	0.51	0.674	0.541	80	32
77	0.60	0.709	0.390	55	18
82	3.4	3.41	1.49	44	0.34
79	4.1	3.81	1.12	29	-7.1
79	8.8	8.77	3.69	42	-0.4
78	9.6	9.10	3.57	39	-5.2





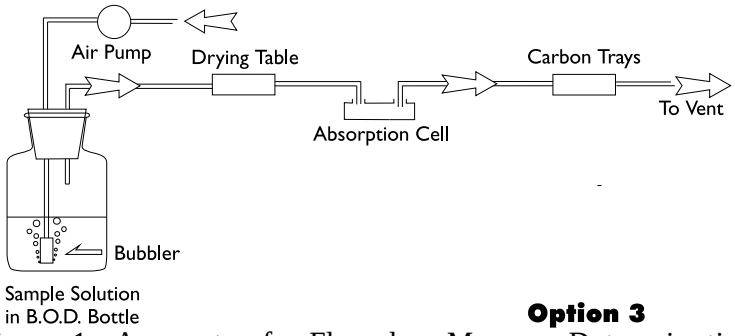


Figure 1. Apparatus for Flameless Mercury Determination

Because of the toxic nature of mercury vapor, inhalation must be avoided. Therefore, a bypass has been included in the system to either vent the mercury vapor into an exhaust hood or pass the vapor through some absorbing media, such as:

a) equal volumes of 0.1 N $KMnO_4$ and 10% H_2SO_4
b) 0.25% iodine in a 3% KI solution.

A specially treated charcoal that will absorb mercury vapor is also available from Barnebey and Cheney, P.O. Box 2526, Columbus, OH 43216, Catalog No. 580-13 or 580-22.

METHOD 524.2. MEASUREMENT OF PURGEABLE ORGANIC COMPOUNDS IN WATER BY CAPILLARY COLUMN GAS CHROMATOGRAPHY/MASS SPECTROMETRY

Revision 4.1

Edited by J.W. Munch (1995)

A. Alford-Stevens, J.W. Eichelberger, W.L. Budde - Method 524, Rev. 1.0 (1983)

R.W. Slater, Jr. - Revision 2.0 (1986)

J.W. Eichelberger, and W.L. Budde - Revision 3.0 (1989)

J.W. Eichelberger, J.W. Munch, and T.A. Bellar - Revision 4.0 (1992)

NATIONAL EXPOSURE RESEARCH LABORATORY
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METHOD 524.2

MEASUREMENT OF PURGEABLE ORGANIC COMPOUNDS IN WATER BY CAPILLARY COLUMN GAS CHROMATOGRAPHY/MASS SPECTROMETRY

1. SCOPE AND APPLICATION

1.1 This is a general purpose method for the identification and simultaneous measurement of purgeable volatile organic compounds in surface water, ground water, and drinking water in any stage of treatment (1,2). The method is applicable to a wide range of organic compounds, including the four trihalomethane disinfection by-products, that have sufficiently high volatility and low water solubility to be removed from water samples with purge and trap procedures. The following compounds can be determined by this method.

Analyte	Chemical Abstract Service Registry Number
Acetone*	67-64-1
Acrylonitrile*	107-13-1
Allyl chloride*	107-05-1
Benzene	71-43-2
Bromobenzene	108-86-1
Bromochloromethane	74-97-5
Bromodichloromethane	75-27-4
Bromoform	75-25-2
Bromomethane	74-83-9
2-Butanone*	78-93-3
n-Butylbenzene	104-51-8
sec-Butylbenzene	135-98-8
tert-Butylbenzene	98-06-6
Carbon disulfide*	75-15-0
Carbon tetrachloride	56-23-5
Chloroacetonitrile*	107-14-2
Chlorobenzene	108-90-7
1-Chlorobutane*	109-69-3
Chloroethane	75-00-3
Chloroform	67-66-3
Chloromethane	74-87-3
2-Chlorotoluene	95-49-8
4-Chlorotoluene	106-43-4
Dibromochloromethane	124-48-1
1,2-Dibromo-3-chloropropane	96-12-8
1,2-Dibromoethane	106-93-4
Dibromomethane	74-95-3
1,2-Dichlorobenzene	95-50-1
1,3-Dichlorobenzene	541-73-1
1,4-Dichlorobenzene	106-46-7
trans-1,4-Dichloro-2-butene*	110-57-6
Dichlorodifluoromethane	75-71-8

1,1-Dichloroethane	75-34-3
1,2-Dichloroethane	107-06-2
1,1-Dichloroethene	75-35-4
cis-1,2-Dichloroethene	156-59-2
trans-1,2-Dichloroethene	156-60-5
1,2-Dichloropropane	78-87-5
1,3-Dichloropropane	142-28-9
2,2-Dichloropropane	590-20-7
1,1-Dichloropropene	563-58-6
1,1-Dichloropropanone*	513-88-2
cis-1,3-Dichloropropene	10061-01-5
trans-1,3-Dichloropropene	10061-02-6
Diethyl ether*	60-29-7
Ethylbenzene	100-41-4
Ethyl methacrylate*	97-63-2
Hexachlorobutadiene	87-68-3
Hexachloroethane*	67-72-1
2-Hexanone*	591-78-6
Isopropylbenzene	98-82-8
4-Isopropyltoluene	99-87-6
Methacrylonitrile*	126-98-7
Methylacrylate*	96-33-3
Methylene chloride	75-09-2
Methyl iodide*	74-88-4
Methylmethacrylate*	80-62-6
4-Methyl-2-pentanone*	108-10-1
Methyl-t-butyl ether*	1634-04-4
Naphthalene	91-20-3
Nitrobenzene*	98-95-3
2-Nitropropane*	79-46-9
Pentachloroethane*	76-01-7
Propionitrile*	107-12-0
n-Propylbenzene	103-65-1
Styrene	100-42-5
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethene	127-18-4
Tetrahydrofuran*	109-99-9
Toluene	108-88-3
1,2,3-Trichlorobenzene	87-61-6
1,2,4-Trichlorobenzene	120-82-1
1,1,1-Trichloroethane	71-55-6
1,1,2-Trichloroethane	79-00-5
Trichloroethene	79-01-6
Trichlorofluoromethane	75-69-4
1,2,3-Trichloropropane	96-18-4
1,2,4-Trimethylbenzene	95-63-6
1,3,5-Trimethylbenzene	108-67-8
Vinyl chloride	75-01-4
o-Xylene	95-47-6

m-Xylene	108-38-3
p-Xylene	106-42-3

* New Compound in Revision 4.0

1.2 Method detection limits (MDLs) (3) are compound, instrument and especially matrix dependent and vary from approximately 0.02 to 1.6 µg/L. The applicable concentration range of this method is primarily column and matrix dependent, and is approximately 0.02 to 200 µg/L when a wide-bore thick-film capillary column is used. Narrow-bore thin-film columns may have a capacity which limits the range to about 0.02 to 20 µg/L. Volatile water soluble, polar compounds which have relatively low purging efficiencies can be determined using this method. Such compounds may be more susceptible to matrix effects, and the quality of the data may be adversely influenced.

1.3 Analytes that are not separated chromatographically, but which have different mass spectra and noninterfering quantitation ions (Table 1), can be identified and measured in the same calibration mixture or water sample as long as their concentrations are somewhat similar (Sect. 11.6.2). Analytes that have very similar mass spectra cannot be individually identified and measured in the same calibration mixture or water sample unless they have different retention times (Sect. 11.6.3). Coeluting compounds with very similar mass spectra, typically many structural isomers, must be reported as an isomeric group or pair. Two of the three isomeric xylenes and two of the three dichlorobenzenes are examples of structural isomers that may not be resolved on the capillary column, and if not, must be reported as isomeric pairs. The more water soluble compounds (> 2% solubility) and compounds with boiling points above 200°C are purged from the water matrix with lower efficiencies. These analytes may be more susceptible to matrix effects.

2. SUMMARY OF METHOD

2.1 Volatile organic compounds and surrogates with low water solubility are extracted (purged) from the sample matrix by bubbling an inert gas through the aqueous sample. Purged sample components are trapped in a tube containing suitable sorbent materials. When purging is complete, the sorbent tube is heated and backflushed with helium to desorb the trapped sample components into a capillary gas chromatography (GC) column interfaced to a mass spectrometer (MS). The column is temperature programmed to facilitate the separation of the method analytes which are then detected with the MS. Compounds eluting from the GC column are identified by comparing their measured mass spectra and retention times to reference spectra and retention times in a data base. Reference spectra and retention times for analytes are obtained by the measurement of calibration standards under the same conditions used for samples. Analytes are quantitated using procedural standard calibration (Sect. 3.14). The concentration of each identified component is measured by relating the MS response of the quantitation ion produced by that compound to the MS response of the quantitation ion produced by a compound that is used as an internal standard. Surrogate analytes, whose concentrations are known in every sample, are measured with the same internal standard calibration procedure.

3. DEFINITIONS

3.1 INTERNAL STANDARD (IS) -- A pure analyte(s) added to a sample, extract, or standard solution in known amount(s) and used to measure the relative responses of other method analytes and surrogates that are components of the same sample or solution. The internal standard must be an analyte that is not a sample component.

3.2 SURROGATE ANALYTE (SA) -- A pure analyte(s), which is extremely unlikely to be found in any sample, and which is added to a sample aliquot in known amount(s) before extraction or other processing and is measured with the same procedures used to measure other sample components. The purpose of the SA is to monitor method performance with each sample.

3.3 LABORATORY DUPLICATES (LD1 and LD2) -- Two aliquots of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of LD1 and LD2 indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

3.4 FIELD DUPLICATES (FD1 and FD2) -- Two separate samples collected at the same time and place under identical circumstances and treated exactly the same throughout field and laboratory procedures. Analyses of FD1 and FD2 give a measure of the precision associated with sample collection, preservation and storage, as well as with laboratory procedures.

3.5 LABORATORY REAGENT BLANK (LRB) -- An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. The LRB is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

3.6 FIELD REAGENT BLANK (FRB) -- An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FRB is to determine if method analytes or other interferences are present in the field environment.

3.7 LABORATORY PERFORMANCE CHECK SOLUTION (LPC) -- A solution of one or more compounds (analytes, surrogates, internal standard, or other test compounds) used to evaluate the performance of the instrument system with respect to a defined set of method criteria.

3.8 LABORATORY FORTIFIED BLANK (LFB) -- An aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

3.9 LABORATORY FORTIFIED SAMPLE MATRIX (LFM) -- An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory.

The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations.

3.10 STOCK STANDARD SOLUTION (SSS) -- A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

3.11 PRIMARY DILUTION STANDARD SOLUTION (PDS) -- A solution of several analytes prepared in the laboratory from stock standard solutions and diluted as needed to prepare calibration solutions and other needed analyte solutions.

3.12 CALIBRATION STANDARD (CAL) -- A solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards and surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

3.13 QUALITY CONTROL SAMPLE (QCS) -- A solution of method analytes of known concentrations which is used to fortify an aliquot of LRB or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

3.14 PROCEDURAL STANDARD CALIBRATION -- A calibration method where aqueous calibration standards are prepared and processed (e.g. purged,extracted, and/or derivatized) in exactly the same manner as a sample. All steps in the process from addition of sampling preservatives through instrumental analyses are included in the calibration. Using procedural standard calibration compensates for any inefficiencies in the processing procedure.

4. INTERFERENCES

4.1 During analysis, major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap. The use of Teflon tubing, Teflon thread sealants, or flow controllers with rubber components in the purging device should be avoided since such materials out-gas organic compounds which will be concentrated in the trap during the purge operation. Analyses of laboratory reagent blanks provide information about the presence of contaminants. When potential interfering peaks are noted in laboratory reagent blanks, the analyst should change the purge gas source and regenerate the molecular sieve purge gas filter. Subtracting blank values from sample results is not permitted.

4.2 Interfering contamination may occur when a sample containing low concentrations of volatile organic compounds is analyzed immediately after a sample containing relatively high concentrations of volatile organic compounds. A preventive technique is between-sample rinsing of the purging apparatus and sample syringes with two portions of reagent water. After analysis of a sample containing high concentrations of volatile organic compounds, one or more laboratory reagent blanks should be analyzed to check for cross-contamination.

4.3 Special precautions must be taken to determine methylene chloride. The analytical and sample storage area should be isolated from all atmospheric sources of methylene chloride, otherwise random background levels will result. Since methylene chloride will permeate Teflon tubing, all GC carrier gas lines and purge gas plumbing should be constructed of stainless steel or copper tubing. Laboratory worker's clothing should be cleaned frequently since clothing previously exposed to methylene chloride fumes during common liquid/liquid extraction procedures can contribute to sample contamination.

4.4 Traces of ketones, methylene chloride, and some other organic solvents can be present even in the highest purity methanol. This is another potential source of contamination, and should be assessed before standards are prepared in the methanol.

5. SAFETY

5.1 The toxicity or carcinogenicity of chemicals used in this method has not been precisely defined; each chemical should be treated as a potential health hazard, and exposure to these chemicals should be minimized. Each laboratory is responsible for maintaining awareness of OSHA regulations regarding safe handling of chemicals used in this method. Additional references to laboratory safety are available (4-6) for the information of the analyst.

5.2 The following method analytes have been tentatively classified as known or suspected human or mammalian carcinogens: benzene, carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichlorethane, hexachlorobutadiene, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, chloroform, 1,2-dibromoethane,tetrachloroethene, trichloroethene, and vinyl chloride. Pure standard materials and stock standard solutions of these compounds should be handled in a hood. A NIOSH/MESA approved toxic gas respirator should be worn when the analyst handles high concentrations of these toxic compounds.

6. EQUIPMENT AND SUPPLIES (All specifications are suggested. Catalog numbers are included for illustration only.)

6.1 SAMPLE CONTAINERS -- 40-mL to 120-mL screw cap vials each equipped with a Teflon faced silicone septum. Prior to use, wash vials and septa with detergent and rinse with tap and distilled water. Allow the vials and septa to air dry at room temperature, place in a 105°C oven for 1 hr, then remove and allow to cool in an area known to be free of organics.

6.2 PURGE AND TRAP SYSTEM -- The purge and trap system consists of three separate pieces of equipment: purging device, trap, and desorber. Systems are commercially available from several sources that meet all of the following specifications.

6.2.1 The all glass purging device (Figure 1) should be designed to accept 25-mL samples with a water column at least 5 cm deep. A smaller (5-mL) purging device is recommended if the GC/MS system has adequate sensitivity to obtain the method detection limits required. Gaseous volumes above the sample must be kept to a minimum (< 15 mL) to eliminate dead volume effects. A glass frit should be installed at the base of the sample chamber so

the purge gas passes through the water column as finely divided bubbles with a diameter of < 3 mm at the origin. Needle spargers may be used, however, the purge gas must be introduced at a point about 5 mm from the base of the water column. The use of a moisture control device is recommended to prohibit much of the trapped water vapor from entering the GC/MS and eventually causing instrumental problems.

6.2.2 The trap (Figure 2) must be at least 25 cm long and have an inside diameter of at least 0.105 in. Starting from the inlet, the trap should contain 1.0 cm of methyl silicone coated packing and the following amounts of adsorbents: 1/3 of 2,6-diphenylene oxide polymer, 1/3 of silica gel, and 1/3 of coconut charcoal. If it is not necessary to determine dichlorodifluoromethane, the charcoal can be eliminated and the polymer increased to fill 2/3 of the trap. Before initial use, the trap should be conditioned overnight at 180°C by backflushing with an inert gas flow of at least 20 mL/min. Vent the trap effluent to the room, not to the analytical column. Prior to daily use, the trap should be conditioned for 10 min at 180°C with backflushing. The trap may be vented to the analytical column during daily conditioning; however, the column must be run through the temperature program prior to analysis of samples. The use of alternative sorbents is acceptable provided the data acquired meets all quality control criteria described in Section 9, and <u>provided the purge and desorption procedures specified in Section 11 of the method are not changed</u>. Specifically, the purging time, the purge gas flow rate, and the desorption time may not be changed. Since many of the potential alternate sorbents may be thermally stable above 180°C, alternate traps may be desorbed and baked out at higher temperatures than those described in Section 11. If higher temperatures are used, the analyst should monitor the data for possible analyte and/or trap decomposition.

6.2.3 The use of the methyl silicone coated packing is recommended, but not mandatory. The packing serves a dual purpose of protecting the Tenax adsorbant from aerosols, and also of insuring that the Tenax is fully enclosed within the heated zone of the trap thus eliminating potential cold spots. Alternatively, silanized glass wool may be used as a spacer at the trap inlet.

6.2.4 The desorber (Figure 2) must be capable of rapidly heating the trap to 180°C either prior to or at the beginning of the flow of desorption gas. The polymer section of the trap should not be heated higher than 200°C or the life expectancy of the trap will decrease. Trap failure is characterized by a pressure drop in excess of 3 lb/in^2 across the trap during purging or by poor bromoform sensitivities. The desorber design illustrated in Fig. 2 meets these criteria.

6.3 GAS CHROMATOGRAPHY/MASS SPECTROMETER/DATA SYSTEM (GC/MS/DS)

6.3.1 The GC must be capable of temperature programming and should be equipped with variable-constant differential flow controllers so that the column flow rate will remain constant throughout desorption and temperature program operation. If the column oven is to be cooled to 10°C or lower, a subambient oven controller will likely be required. If syringe injections of 4-

bromofluorobenzene (BFB) will be used, a split/splitless injection port is required.

6.3.2 Capillary GC Columns. Any gas chromatography column that meets the performance specifications of this method may be used (Sect. 10.2.4.1). Separations of the calibration mixture must be equivalent or better than those described in this method. Four useful columns have been evaluated, and observed compound retention times for these columns are listed in Table 2.

6.3.2.1 Column 1 -- 60 m x 0.75 mm ID VOCOL (Supelco, Inc.) glass wide-bore capillary with a 1.5 µm film thickness.

Column 2 -- 30 m x 0.53 mm ID DB-624 (J&W Scien-tific, Inc.) fused silica capillary with a 3 µm film thickness.

Column 3 -- 30 m x 0.32 mm ID DB-5 (J&W Scientific, Inc.) fused silica capillary with a 1 µm film thickness.

Column 4 -- 75 m x 0.53 mm id DB-624 (J&W Scien-tific, Inc.) fused silica capillary with a 3 µm film thickness.

6.3.3 Interfaces between the GC and MS. The interface used depends on the column selected and the gas flow rate.

6.3.3.1 The wide-bore columns 1, 2, and 4 have the capacity to accept the standard gas flows from the trap during thermal desorption, and chromatography can begin with the onset of thermal desorption. Depending on the pumping capacity of the MS, an additional interface between the end of the column and the MS may be required. An open split interface (7) or an all-glass jet separator is an acceptable interface. Any interface can be used if the performance specifications described in this method (Sect. 9 and 10) can be achieved. The end of the transfer line after the interface, or the end of the analytical column if no interface is used, should be placed within a few mm of the MS ion source.

6.3.3.2 When narrow bore column 3 is used, a cryogenic interface placed just in front of the column inlet is suggested. This interface condenses the desorbed sample components in a narrow band on an uncoated fused silica precolumn using liquid nitrogen cooling. When all analytes have been desorbed from the trap, the interface is rapidly heated to transfer them to the analytical column. The end of the analytical column should be placed within a few mm of the MS ion source. A potential problem with this interface is blockage of the interface by frozen water from the trap. This condition will result in a major loss in sensitivity and chromatographic resolution.

6.3.4 The mass spectrometer must be capable of electron ionization at a nominal electron energy of 70 eV. The spectrometer must be capable of scanning from

35 to 260 amu with a complete scan cycle time (including scan overhead) of 2 sec or less. (Scan cycle time = Total MS data acquisition time in seconds divided by number of scans in the chromatogram.) The spectrometer must produce a mass spectrum that meets all criteria in Table 3 when 25 ng or less of 4-bromofluorobenzene (BFB) is introduced into the GC. An average spectrum across the BFB GC peak may be used to test instrument performance.

6.3.5 An interfaced data system is required to acquire, store, reduce, and output mass spectral data. The computer software should have the capability of processing stored GC/MS data by recognizing a GC peak within any given retention time window, comparing the mass spectra from the GC peak with spectral data in a user-created data base, and generating a list of tentatively identified compounds with their retention times and scan numbers. The software must allow integration of the ion abundance of any specific ion between specified time or scan number limits. The software should also allow calculation of response factors as defined in Sect. 10.2.6 (or construction of a linear or second order regression calibration curve), calculation of response factor statistics (mean and standard deviation), and calculation of concentrations of analytes using either the calibration curve or the equation in Sect. 12.

6.4 SYRINGE AND SYRINGE VALVES

6.4.1 Two 5-mL or 25-mL glass hypodermic syringes with Luer-Lok tip (depending on sample volume used).

6.4.2 Three 2-way syringe valves with Luer ends.

6.4.3 Micro syringes - 10, 100 µL.

6.4.4 Syringes - 0.5, 1.0, and 5-mL, gas tight with shut-off valve.

6.5 MISCELLANEOUS

6.5.1 Standard solution storage containers -- 15-mL bottles with Teflon lined screw caps.

7. REAGENTS AND STANDARDS

7.1 TRAP PACKING MATERIALS

7.1.1 2,6-Diphenylene oxide polymer, 60/80 mesh, chromatographic grade (Tenax GC or equivalent).

7.1.2 Methyl silicone packing (optional) -- OV-1 (3%) on Chromosorb W, 60/80 mesh, or equivalent.

7.1.3 Silica gel -- 35/60 mesh, Davison, grade 15 or equivalent.

7.1.4 Coconut charcoal -- Prepare from Barnebey Cheney, CA-580-26 lot #M-2649 (or equivalent) by crushing through 26 mesh screen.

7.2 REAGENTS

7.2.1 Methanol -- Demonstrated to be free of analytes.

7.2.2 Reagent water -- Prepare reagent water by passing tap water through a filter bed containing about 0.5 kg of activated carbon, by using a water purification system, or by boiling distilled water for 15 min followed by a 1-h purge with inert gas while the water temperature is held at 90°C. Store in clean, narrow-mouth bottles with Teflon lined septa and screw caps.

7.2.3 Hydrochloric acid (1+1) -- Carefully add measured volume of conc. HCl to equal volume of reagent water.

7.2.4 Vinyl chloride -- Certified mixtures of vinyl chloride in nitrogen and pure vinyl chloride are available from several sources (for example, Matheson, Ideal Gas Products, and Scott Gases).

7.2.5 Ascorbic acid -- ACS reagent grade, granular.

7.2.6 Sodium thiosulfate -- ACS reagent grade, granular.

7.3 STOCK STANDARD SOLUTIONS -- These solutions may be purchased as certified solutions or prepared from pure standard materials using the following procedures. One of these solutions is required for every analyte of concern, every surrogate, and the internal standard. A useful working concentration is about 1-5 mg/mL.

7.3.1 Place about 9.8 mL of methanol into a 10-mL ground-glass stoppered volumetric flask. Allow the flask to stand, unstoppered, for about 10 min or until all alcohol-wetted surfaces have dried and weigh to the nearest 0.1 mg.

7.3.2 If the analyte is a liquid at room temperature, use a 100-µL syringe and immediately add two or more drops of reference standard to the flask. Be sure that the reference standard falls directly into the alcohol without contacting the neck of the flask. If the analyte is a gas at room temperature, fill a 5-mL valved gas-tight syringe with the standard to the 5.0-mL mark, lower the needle to 5 mm above the methanol meniscus, and slowly inject the standard into the neck area of the flask. The gas will rapidly dissolve in the methanol.

7.3.3 Reweigh, dilute to volume, stopper, then mix by inverting the flask several times. Calculate the concentration in µg/µL from the net gain in weight. When compound purity is certified at 96% or greater, the weight can be used without correction to calculate the concentration of the stock standard.

7.3.4 Store stock standard solutions in 15-mL bottles equipped with Teflon lined screw caps. Methanol solutions of acrylonitrile, methyl iodide, and methyl acrylate are stable for only one week at 4°C. Methanol solutions prepared from other liquid analytes are stable for at least 4 weeks when stored at 4°C.

Methanol solutions prepared from gaseous analytes are not stable for more than 1 week when stored at < 0°C; at room temperature, they must be discarded after 1 day.

7.4 PRIMARY DILUTION STANDARDS -- Use stock standard solutions to prepare primary dilution standard solutions that contain all the analytes of concern in methanol or other suitable solvent. The primary dilution standards should be prepared at concentrations that can be easily diluted to prepare aqueous calibration solutions that will bracket the working concentration range. Store the primary dilution standard solutions with minimal headspace and check frequently for signs of deterioration or evaporation, especially just before preparing calibration solutions. Storage times described for stock standard solutions in Sect. 7.3.4 also apply to primary dilution standard solutions.

7.5 FORTIFICATION SOLUTIONS FOR INTERNAL STANDARD AND SURROGATES

7.5.1 A solution containing the internal standard and the surrogate compounds is required to prepare laboratory reagent blanks (also used as a laboratory performance check solution), and to fortify each sample. Prepare a fortification solution containing fluorobenzene (internal standard), 1,2- dichlorobenzene-d_4 (surrogate), and BFB (surrogate) in methanol at concentrations of 5 µg/mL of each (any appropriate concentration is acceptable). A 5-µL aliquot of this solution added to a 25-mL water sample volume gives concentrations of 1 µg/L of each. A 5-µL aliquot of this solution added to a 5-mL water sample volume gives a concentration of 5 µg/L of each. Additional internal standards and surrogate analytes are optional. Additional surrogate compounds should be similar in physical and chemical characteristics to the analytes of concern.

7.6 PREPARATION OF LABORATORY REAGENT BLANK (LRB) -- Fill a 25-mL (or 5-mL) syringe with reagent water and adjust to the mark (no air bubbles). Inject an appropriate volume of the fortification solution containing the internal standard and surrogates through the Luer Lok valve into the reagent water. Transfer the LRB to the purging device. See Sect. 11.1.2.

7.7 PREPARATION OF LABORATORY FORTIFIED BLANK -- Prepare this exactly like a calibration standard (Sect. 7.8). This is a calibration standard that is treated as a sample.

7.8 PREPARATION OF CALIBRATION STANDARDS

7.8.1 The number of calibration solutions (CALs) needed depends on the calibration range desired. A minimum of three CAL solutions is required to calibrate a range of a factor of 20 in concentration. For a factor of 50, use at least four standards, and for a factor of 100 at least five standards. One calibration standard should contain each analyte of concern at a concentration of 2-10 times the method detection limit (Tables 4, 5, and 7) for that compound. The other CAL standards should contain each analyte of concern at concentrations that define the range of the method. Every CAL solution contains the internal

standard and the surrogate compounds at the same concentration (5 µg/L suggested for a 5-mL sample; 1 µg/L for a 25-mL sample).

7.8.2 To prepare a calibration standard, add an appropriate volume of a primary dilution standard containing all analytes of concern to an aliquot of acidified (pH 2) reagent water in a volumetric flask. Also add an appropriate volume of internal standard and surrogate compound solution from Sect. 7.5.1. Use a microsyringe and rapidly inject the methanol solutions into the expanded area of the filled volumetric flask. Remove the needle as quickly as possible after injection. Mix by inverting the flask three times only. Discard the contents contained in the neck of the flask. Aqueous standards are not stable in a volumetric flask and should be discarded after 1 hr unless transferred to a sample bottle and sealed immediately. Alternately, aqueous calibration standards may be prepared in a gas tight, 5 mL or 25 mL syringe. **NOTE:** If unacidified samples are being analyzed for THMs only, calibration standards should be prepared without acid.

8. SAMPLE COLLECTION, PRESERVATION, AND STORAGE

8.1 SAMPLE COLLECTION AND DECHLORINATION

8.1.1 Collect all samples in duplicate. If samples, such as finished drinking water, are suspected to contain residual chlorine, add about 25 mg of ascorbic acid per 40 mL of sample to the sample bottle before filling. If analytes that are gases at room temperature (such as vinyl chloride), or analytes in Table 7 are not to be determined, sodium thiosulfate is recommended to reduce the residual chlorine. Three milligrams of sodium thiosulfate should be added for each 40 mL of water sample.
NOTE: If the residual chlorine is likely to be present > 5 mg/L, a determination of the amount of the chlorine may be necessary. Diethyl-p-phenylenediamine (DPD) test kits are commercially available to determine residual chlorine in the field. Add an additional 25 mg of ascorbic acid or 3 mg of sodium thiosulfate per each 5 mg/L of residual chlorine.

8.1.2 When sampling from a water tap, open the tap and allow the system to flush until the water temperature has stabilized (usually about 10 min). Adjust the flow to about 500 mL/min and collect duplicate samples containing the desired dechlorinating agent from the flowing stream.

8.1.3 When sampling from an open body of water, partially fill a 1-quart wide-mouth bottle or 1-L beaker with sample from a representative area. Fill duplicate sample bottles containing the desired dechlorinating agent with sample from the larger container.

8.1.4 Fill sample bottles to overflowing, but take care not to flush out the rapidly dissolving dechlorinating agent. No air bubbles should pass through the sample as the bottle is filled, or be trapped in the sample when the bottle is sealed.

8.2 SAMPLE PRESERVATION

8.2.1 Adjust the pH of all samples to < 2 at the time of collection, but after dechlorination, by carefully adding two drops of 1:1 HCl for each 40 mL of sample. Seal the sample bottles, Teflon face down, and mix for 1 min. Exceptions to the acidification requirement are detailed in Sections 8.2.2 and 8.2.3. **NOTE:** Do not mix the ascorbic acid or sodium thiosulfate with the HCl in the sample bottle prior to sampling.

8.2.2 **When sampling for THM analysis only**, acidification may be omitted if sodium thiosulfate is used to dechlorinate the sample. This exception to acidification does not apply if ascorbic acid is used for dechlorination.

8.2.3 If a sample foams vigorously when HCl is added, discard that sample. Collect a set of duplicate samples but do not acidify them. These samples must be flagged as "not acidified" and must be stored at 4°C or below. These samples must be analyzed within 24 hr of collection time if they are to be analyzed for any compounds other than THMs.

8.2.4 The samples must be chilled to about 4°C when collected and maintained at that temperature until analysis. Field samples that will not be received at the laboratory on the day of collection must be packaged for shipment with sufficient ice to ensure that they will arrive at the laboratory with a substantial amount of ice remaining in the cooler.

8.2 SAMPLE STORAGE

8.2.1 Store samples at ≤ 4°C until analysis. The sample storage area must be free of organic solvent vapors and direct or intense light.

8.2.2 Analyze all samples within 14 days of collection. Samples not analyzed within this period must be discarded and replaced.

8.3 FIELD REAGENT BLANKS (FRB)

8.3.1 Duplicate FRBs must be handled along with each sample set, which is composed of the samples collected from the same general sample site at approximately the same time. At the laboratory, fill field blank sample bottles with reagent water and sample preservatives, seal, and ship to the sampling site along with empty sample bottles and back to the laboratory with filled sample bottles. Wherever a set of samples is shipped and stored, it is accompanied by appropriate blanks. FRBs must remain hermetically sealed until analysis.

8.3.2 Use the same procedures used for samples to add ascorbic acid and HCl to blanks (Sect. 8.1.1). The same batch of ascorbic acid and HCl should be used for the field reagent blanks as for the field samples.

9. QUALITY CONTROL

9.1 Quality control (QC) requirements are the initial demonstration of laboratory capability followed by regular analyses of laboratory reagent blanks, field reagent blanks, and laboratory fortified blanks. A MDL for each analyte must also be determined. Each laboratory must maintain records to document the quality of the data generated. Additional quality control practices are recommended.

9.2 Initial demonstration of low system background. Before any samples are analyzed, it must be demonstrated that a laboratory reagent blank (LRB) is reasonably free of contamination that would prevent the determination of any analyte of concern. Sources of background contamination are glassware, purge gas, sorbents, reagent water, and equipment. Background contamination must be reduced to an acceptable level before proceeding with the next section. In general, background from method analytes should be below the method detection limit.

9.3 Initial demonstration of laboratory accuracy and precision. Analyze four to seven replicates of a laboratory fortified blank containing each analyte of concern at a concentration in the range of 2-5 µg/L depending upon the calibration range of the instrumentation.

9.3.1 Prepare each replicate by adding an appropriate aliquot of a quality control sample to reagent water. It is recommended that a QCS from a source different than the calibration standards be used for this set of LFBs, since it will serve as a check to verify the accuracy of the standards used to generate the calibration curve. This is particularly useful if the laboratory is using the method for the first time, and has no historical data base for standards. Prepare each replicate by adding an appropriate aliquot of a quality control sample to reagent water. Also add the appropriate amounts of internal standard and surrogates. If it is expected that field samples will contain a dechlorinating agent and HCl, then add these to the LFBs in the same amounts proscribed in Sect. 8.1.1. If only THMs are to be determined and field samples do not contain HCl, then do not acidify LFBs. Analyze each replicate according to the procedures described in Section 11.

9.3.2 Calculate the measured concentration of each analyte in each replicate, the mean concentration of each analyte in all replicates, and mean accuracy (as mean percentage of true value) for each analyte, and the precision (as relative standard deviation, RSD) of the measurements for each analyte.

9.3.3 Some analytes, particularly early eluting gases and late eluting higher molecular weight compounds, will be measured with less accuracy and precision than other analytes. However, the accuracy and precision for all analytes must fall within the limits expressed below. If these criteria are not met for an analyte of interest, take remedial action and repeat the measurements for that analyte until satisfactory performance is achieved. For each analyte, the mean accuracy must be 80-120% (i.e. an accuracy of ± 20%). The preci-

sion of the recovery (accuracy) for each analyte must be less than twenty percent (<20%). These criteria are different than the ± 30% response factor criteria specified in Sect. 10.3.5. The criteria differ, because the measurements in Sect. 9.3.3 as part of the initial demonstration of capability are meant to be more stringent than the continuing calibration measurements in Sect. 10.3.5.

9.3.4 To determine the MDL, analyze a minimum of 7 LFBs prepared at a low concentration. MDLs in Table 5 were calculated from samples fortified from 0.1-0.5 µg/L, which can be used as a guide, or use calibration data to estimate a concentration for each analyte that will yield a peak with a 3-5 signal to noise response. Analyze the 7 replicates as described in Sect.11, and on a schedule that results in the analyses being conducted over several days. Calculate the mean accuracy and standard deviation for each analyte. Calculate the MDL using the equation in Sect. 13.

9.3.5 Develop and maintain a system of control charts to plot the precision and accuracy of analyte and surrogate measurements as a function of time. Charting surrogate recoveries is an especially valuable activity because surrogates are present in every sample and the analytical results will form a significant record of data quality.

9.4 Monitor the integrated areas of the quantitation ions of the internal standards and surrogates (Table 1) in all samples, continuing calibration checks, and blanks. These should remain reasonably constant over time. An abrupt change may indicate a matrix effect or an instrument problem. If a cryogenic interface is utilized, it may indicate an inefficient transfer from the trap to the column. These samples must be reanalyzed or a laboratory fortified duplicate sample analyzed to test for matrix effect. A more gradual drift of more than 50% in any area is indicative of a loss in sensitivity, and the problem must be found and corrected.

9.5 LABORATORY REAGENT BLANKS (LRB) -- With each batch of samples processed as a group within a work shift, analyze a LRB to determine the background system contamination.

9.6 Assessing Laboratory Performance. Use the procedures and criteria in Sects. 10.3.4 and 10.3.5 to evaluate the accuracy of the measurement of the laboratory fortified blank (LFB), which must be analyzed with each batch of samples that is processed as a group within a work shift. If more than 20 samples are in a work shift batch, analyze one LFB per 20 samples. Prepare the LFB with the concentration of each analyte that was used in the Sect. 9.3.3 analysis. If the acceptable accuracy for this measurement (±30%) is not achieved, the problem must be solved before additional samples may be reliably analyzed. Acceptance criteria for the IS and surrogate given in Sect.10.3.4 also applies to this LFB.

Since the calibration check sample in Sect. 10.3.5 and the LFB are made the same way and since procedural standards are used, the sample analyzed here may also be

used as a calibration check in Sect. 10.3.5. Add the results of the LFB analysis to the control charts to document data quality.

9.7 If a water sample is contaminated with an analyte, verify that it is not a sampling error by analyzing a field reagent blank. The results of these analyses will help define contamination resulting from field sampling, storage and transportation activities. If the field reagent blank shows unacceptable contamination, the analyst should identify and eliminate the contamination.

9.8 At least quarterly, replicate LFB data should be evaluated to determine the precision of the laboratory measurements. Add these results to the ongoing control charts to document data quality.

9.9 At least quarterly, analyze a quality control sample (QCS) from an external source. If measured analyte concentrations are not of acceptable accuracy, check the entire analytical procedure to locate and correct the problem source.

9.10 Sample matrix effects have not been observed when this method is used with distilled water, reagent water, drinking water, or ground water. Therefore, analysis of a laboratory fortified sample matrix (LFM) is not required unless the criteria in Section 9.4 are not met. If matrix effects are observed or suspected to be causing low recoveries, analyze a laboratory fortified matrix sample for that matrix. The sample results should be flagged and the LFM results should be reported with them.

9.11 Numerous other quality control measures are incorporated into other parts of this procedure, and serve to alert the analyst to potential problems.

10. CALIBRATION AND STANDARDIZATION

10.1 Demonstration and documentation of acceptable initial calibration is required before any samples are analyzed. In addition, acceptable performance must be confirmed intermittently throughout analysis of samples by performing continuing calibration checks. These checks are required at the beginning of each work shift, but no less than every 12 hours. Additional periodic calibration checks are good laboratory practice. It is highly recommended that an additional calibration check be performed at the end of any cycle of continuous instrument operation, so that each set of field samples is bracketed by calibration check standards. **NOTE:** Since this method uses procedural standards, the analysis of the laboratory fortified blank, which is required in Sect. 9.6, may be used here as a calibration check sample.

10.2 INITIAL CALIBRATION

10.2.1 Calibrate the mass and abundance scales of the MS with calibration compounds and procedures prescribed by the manufacturer with any modifications necessary to meet the requirements in Sect. 10.2.2.

10.2.2 Introduce into the GC (either by purging a laboratory reagent blank or making a syringe injection) 25 ng or less of BFB and acquire mass spectra for m/z 35-260 at 70 eV (nominal). Use the purging procedure and/or GC conditions given in Sect. 11. If the spectrum does not meet all criteria in Table 3, the MS must be returned and adjusted to meet all criteria before proceeding with calibration. An average spectrum across the GC peak may be used to evaluate the performance of the system.

10.2.3 Purge a medium CAL solution, (e.g., 10-20 µg/L) using the procedure given in Sect. 11.

10.2.4 Performance criteria for calibration standards. Examine the stored GC/MS data with the data system software. Figures 3 and 4 shown acceptable total ion chromatograms.

10.2.4.1 GC performance. Good column performance will produce symmetrical peaks with minimum tailing for most compounds. If peaks are unusually broad, or if there is poor resolution between peaks, the wrong column has been selected or remedial action is probably necessary (Sect.10.3.6).

10.2.4.2 MS sensitivity. The GC/MS/DS peak identification software should be able to recognize a GC peak in the appropriate retention time window for each of the compounds in calibration solution, and make correct tentative identifications. If fewer than 99% of the compounds are recognized, system maintenance is required. See Sect. 10.3.6.

10.2.5 If all performance criteria are met, purge an aliquot of each of the other CAL solutions using the same GC/MS conditions.

10.2.6 Calculate a response factor (RF) for each analyte and isomer pair for each CAL solution using the internal standard fluorobenzene. Table 1 contains suggested quantitation ions for all compounds. This calculation is supported in acceptable GC/MS data system software (Sect. 6.3.5), and many other software programs. RF is a unitless number, but units used to express quantities of analyte and internal standard must be equivalent.

$$RF = \frac{(A_x)(Q_{is})}{(A_{is})(Q_x)}$$

where: A_x = integrated abundance of the quantitation ion of the analyte.
A_{is} = integrated abundance of the quantitation ion of the internal standard.

Q_x = quantity of analyte purged in nanograms or concentration units.
Q_{is} = quantity of internal standard purged in ng or concentration units.

10.2.6.1 For each analyte and surrogate, calculate the mean RF from analyses of CAL solutions. Calculate the standard deviation (SD) and the relative standard deviation (RSD) from each mean: RSD = 100 (SD/M). If the RSD of any analyte or surrogate mean RF exceeds 20%, either analyze additional aliquots of appropriate CAL solutions to obtain an acceptable RSD of RFs over the entire concentration range, or take action to improve GC/MS performance Sect. 10.3.6). Surrogate compounds are present at the same concentration on every sample, calibration standard, and all types of blanks.

10.2.7 As an alternative to calculating mean response factors and applying the RSD test, use the GC/MS data system software or other available software to generate a linear or second order regression calibration curve, by plotting A/A_{is} vs. Q_x.

10.3 CONTINUING CALIBRATION CHECK -- Verify the MS tune and initial calibration at the beginning of each 12-hr work shift during which analyses are performed using the following procedure. Additional periodic calibration checks are good laboratory practice. It is highly recommended that an additional calibration check be performed at the end of any cycle of continuous instrument operation, so that each set of field samples is bracketed by calibration check standards.

10.3.1 Introduce into the GC (either by purging a laboratory reagent blank or making a syringe injection) 25 ng or less of BFB and acquire a mass spectrum that includes data for m/z 35-260. If the spectrum does not meet all criteria (Table 3), the MS must be returned and adjusted to meet all criteria before proceeding with the continuing calibration check.

10.3.2 Purge a CAL solution and analyze with the same conditions used during the initial calibration. Selection of the concentration level of the calibration check standard should be varied so that the calibration is verified at more than one point over the course of several days.

10.3.3 Demonstrate acceptable performance for the criteria shown in Sect. 10.2.4.

10.3.4 Determine that the absolute areas of the quantitation ions of the internal standard and surrogates have not decreased by more than 30% from the areas measured in the most recent continuing calibration check, or by more than 50% from the areas measured during initial calibration. If these areas have decreased by more than these amounts, adjustments must be made to restore system sensitivity. These adjustments may require cleaning of the MS

ion source, or other maintenance as indicated in Sect. 10.3.6, and recalibration. Control charts are useful aids in documenting system sensitivity changes.

10.3.5 Calculate the RF for each analyte of concern and surrogate compound from the data measured in the continuing calibration check. The RF for each analyte and surrogate must be within 30% of the mean value measured in the initial calibration. Alternatively, if a linear or second order regression is used, the concentration measured using the calibration curve must be within 30% of the true value of the concentration in the calibration solution. If these conditions do not exist, remedial action must be taken which may require recalibration. All data from field samples obtained after the last successful calibration check standard, should be considered suspect. After remedial action has been taken, duplicate samples should be analyzed if they are available.

10.3.6 Some possible remedial actions. Major maintenance such as cleaning an ion source, cleaning quadrupole rods, etc. require returning to the initial calibration step.

10.3.6.1 Check and adjust GC and/or MS operating conditions; check the MS resolution, and calibrate the mass scale.

10.3.6.2 Clean or replace the splitless injection liner; silanize a new injection liner. This applies only if the injection liner is an integral part of the system.

10.3.6.3 Flush the GC column with solvent according to manufacturer's instructions.

10.3.6.4 Break off a short portion (about 1 meter) of the column from the end near the injector; or replace GC column. This action will cause a slight change in retention times. Analyst may need to redefine retention windows.

10.3.6.5 Prepare fresh CAL solutions, and repeat the initial calibration step.

10.3.6.6 Clean the MS ion source and rods (if a quadrupole).

10.3.6.7 Replace any components that allow analytes to come into contact with hot metal surfaces.

10.3.6.8 Replace the MS electron multiplier, or any other faulty components.

10.3.6.9 Replace the trap, especially when only a few compounds fail the criteria in Sect. 10.3.5 while the majority are determined success-

fully. Also check for gas leaks in the purge and trap unit as well as the rest of the analytical system.

10.4 Optional calibration for vinyl chloride using a certified gaseous mixture of vinyl chloride in nitrogen can be accomplished by the following steps.

10.4.1 Fill the purging device with 25.0 mL (or 5-mL) of reagent water or aqueous calibration standard.

10.4.2 Start to purge the aqueous mixture. Inject a known volume (between 100 and 2000 µL) of the calibration gas (at room temperature) directly into the purging device with a gas tight syringe. Slowly inject the gaseous sample through a septum seal at the top of the purging device at 2000 µL/min. If the injection of the standard is made through the aqueous sample inlet port, flush the dead volume with several mL of room air or carrier gas. Inject the gaseous standard before 5 min of the 11-min purge time have elapsed.

10.4.3 Determine the aqueous equivalent concentration of vinyl chloride standard, in µg/L, injected with one of the following equations:

$$\text{5 mL samples, } S = 0.51\,(C)(V)$$
$$\text{25 mL samples, } S = 0.102\,(C)(V)$$

where S = Aqueous equivalent concentration of vinyl chloride standard in µg/L;
C = Concentration of gaseous standard in mg/L (v/v);
V = Volume of standard injected in mL.

11. PROCEDURE

11.1 SAMPLE INTRODUCTION AND PURGING

11.1.1 This method is designed for a 25-mL or 5-mL sample volume, but a smaller (5 mL) sample volume is recommended if the GC/MS system has adequate sensitivity to achieve the required method detection limits. Adjust the helium purge gas flow rate to 40 mL/min. Attach the trap inlet to the purging device and open the syringe valve on the purging device.

11.1.2 Remove the plungers from two 25-mL (or 5-mL depending on sample size) syringes and attach a closed syringe valve to each. Warm the sample to room temperature, open the sample bottle, and carefully pour the sample into one of the syringe barrels to just short of overflowing. Replace the syringe plunger, invert the syringe, and compress the sample. Open the syringe valve and vent any residual air while adjusting the sample volume to 25.0-mL (or 5-mL). To all samples, blanks, and calibration standards, add 5-µL (or an appropriate volume) of the fortification solution containing the internal standard and the surrogates to the sample through the syringe valve. Close the valve. Fill the

second syringe in an identical manner from the same sample bottle. Reserve this second syringe for a reanalysis if necessary.

11.1.3 Attach the sample syringe valve to the syringe valve on the purging device. Be sure that the trap is cooler than 25°C, then open the sample syringe valve and inject the sample into the purging chamber. Close both valves and initiate purging. Purge the sample for 11.0 min at ambient temperature.

11.1.4 Standards and samples must be analyzed in exactly the same manner. Room temperature must be reasonably constant, and changes in excess of 10°F will adversely affect the accuracy and precision of the method.

11.2 SAMPLE DESORPTION

11.2.1 Non-cryogenic interface -- After the 11-min purge, place the purge and trap system in the desorb mode and preheat the trap to 180°C without a flow of desorption gas. Then simultaneously start the flow of desorption gas at a flow rate suitable for the column being used (optimum desorb flow rate is 15 mL/min) for about 4 min, begin the GC temperature program, and start data acquisition.

11.2.2 Cryogenic interface -- After the 11-min purge, place the purge and trap system in the desorb mode, make sure the cryogenic interface is a -150°C or lower, and rapidly heat the trap to 180°C while backflushing with an inert gas at 4 mL/min for about 5 min. At the end of the 5 min desorption cycle, rapidly heat the cryogenic trap to 250°C, and simultaneously begin the temperature program of the gas chromatograph, and start data acquisition.

11.2.3 While the trapped components are being introduced into the gas chromatograph (or cryogenic interface), empty the purging device using the sample syringe and wash the chamber with two 25-mL flushes of reagent water. After the purging device has been emptied, leave syringe valve open to allow the purge gas to vent through the sample introduction needle.

11.3 GAS CHROMATOGRAPHY/MASS SPECTROMETRY -- Acquire and store data over the nominal mass range 35-260 with a total cycle time (including scan overhead time) of 2 sec or less. If water, methanol, or carbon dioxide cause a background problem, start at 47 or 48 m/z. If ketones are to be determined, data must be acquired starting at m/z 43. Cycle time must be adjusted to measure five or more spectra during the elution of each GC peak. Suggested temperature programs are provided below. Alternative temperature programs can be used.

11.3.1 Single ramp linear temperature program for wide bore column 1 and 2 with a jet separator. Adjust the helium carrier gas flow rate to within the capacity of the separator, or about 15 mL/min. The column temperature is reduced 10°C and held for 5 min from the beginning of desorption, then programmed to 160°C at 6°C/min, and held until all components have eluted.

11.3.2 Multi-ramp temperature program for wide bore column 2 with the open split interface. Adjust the helium carrier gas flow rate to about 4.6 mL/min. The column temperature is reduced to 10°C and held for 6 min from the beginning of desorption, then heated to 70°C at 10°/min, heated to 120°C at 5°/min, heated to 180° at 8°/min, and held at 180° until all compounds have eluted.

11.3.3 Single ramp linear temperature program for narrow bore column 3 with a cryogenic interface. Adjust the helium carrier gas flow rate to about 4 mL/min. The column temperature is reduced to 10°C and held for 5 min from the beginning of vaporization from the cryogenic trap, programmed at 6°/min for 10 min, then 15°/min for 5 min to 145°C, and held until all components have eluted.

11.3.4 Multi-ramp temperature program for wide bore column 4 with the open split interface. Adjust the helium carrier gas flow rate to about 7.0 mL/min. The column temperature is - 10°C and held for 6 min. from beginning of desorption, then heated to 100°C at 10°C/min, heated to 200°C at 5°C/min and held at 200°C for 8 min or until all compounds of interest had eluted.

11.4 TRAP RECONDITIONING -- After desorbing the sample for 4 min, recon-dition the trap by returning the purge and trap system to the purge mode. Wait 15 sec, then close the syringe valve on the purging device to begin gas flow through the trap. Maintain the trap temperature at 180°C. Maintain the moisture control module, if utilized, at 90°C to remove residual water. After approximately 7 min, turn off the trap heater and open the syringe valve to stop the gas flow through the trap. When the trap is cool, the next sample can be analyzed.

11.5 TERMINATION OF DATA ACQUISITION -- When all the sample components have eluted from the GC, terminate MS data acquisition. Use appropriate data output software to display full range mass spectra and appropriate plots of ion abundance as a function of time. If any ion abundance exceeds the system working range, dilute the sample aliquot in the second syringe with reagent water and analyze the diluted aliquot.

11.6 IDENTIFICATION OF ANALYTES -- Identify a sample component by comparison of its mass spectrum (after background subtraction) to a reference spectrum in the user-created data base. The GC retention time of the sample component should be within three standard deviations of the mean retention time of the compound in the calibration mixture.

11.6.1 In general, all ions that are present above 10% relative abundance in the mass spectrum of the standard should be present in the mass spectrum of the sample component and should agree within absolute 20%. For example, if an ion has a relative abundance of 30% in the standard spectrum, its abundance in the sample spectrum should be in the range of 10 to 50%. Some ions, particularly the molecular ion, are of special importance, and should be evaluated even if they are below 10% relative abundance.

11.6.2 Identification requires expert judgment when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When GC peaks obviously represent more than one sample component (i.e., broadened peak with shoulder(s) or valley between two or more maxima), appropriate analyte spectra and background spectra can be selected by examining plots of characteristic ions for tentatively identified components. When analytes coelute (i.e., only one GC peak is apparent), the identification criteria can be met but each analyte spectrum will contain extraneous ions contributed by the coeluting compound. Because purgeable organic compounds are relatively small molecules and produce comparatively simple mass spectra, this is not a significant problem for most method analytes.

11.6.3 Structural isomers that produce very similar mass spectra can be explicitly identified only if they have sufficiently different GC retention times. Acceptable resolution is achieved if the height of the valley between two peaks is less than 25% of the average height of the two peaks. Otherwise, structural isomers are identified as isomeric pairs. Two of the three isomeric xylenes and two of the three dichlorobenzenes are examples of structural isomers that may not be resolved on the capillary columns. If unresolved, these groups of isomers must be reported as isomeric pairs.

11.6.4 Methylene chloride, acetone, carbon disulfide, and other background components appear in variable quantities in laboratory and field reagent blanks, and generally cannot be accurately measured. Subtraction of the concentration in the blank from the concentration in the sample is not acceptable because the concentration of the background in the blank is highly variable.

12. DATA ANALYSIS AND CALCULATIONS

12.1 Complete chromatographic resolution is not necessary for accurate and precise measurements of analyte concentrations if unique ions with adequate intensities are available for quantitation. If the response for any analyte exceeds the linear range of the calibration established in Section 10, obtain and dilute a duplicate a duplicate sample. Do not extrapolate beyond the calibration range.

12.1.1 Calculate analyte and surrogate concentrations, using the multi-point calibration established in Section 10. Do not use the daily calibration verification data to quantitate analytes in samples.

$$C_x = \frac{(A_x)(Q_{is})\ 1000}{(A_{is})\ RF\ V}$$

where: C_x = concentration of analyte or surrogate in µg/L in the water sample.
A_x = integrated abundance of the quantitation ion of the analyte in the sample.
A_{is} = integrated abundance of the quantitation ion

of the internal standard in the sample.
Q_{is} = total quantity (in micrograms) of internal standard added to the water sample.
V = original water sample volume in mL.
RF = mean response factor of analyte from the initial calibration.

12.1.2 Alternatively, use the GC/MS system software or other available proven software to compute the concentrations of the analytes and surrogates from the linear or second order regression curve established in Section 10. Do not use the daily calibration verification data to quantitate analytes in samples.

12.1.3 Calculations should utilize all available digits of precision, but final reported concentrations should be rounded to an appropriate number of significant figures (one digit of uncertainty). Experience indicates that three significant figures may be used for concentrations above 99 µg/L, two significant figures for concentrations between 1- 99 µg/L, and one significant figure for lower concentrations.

12.1.4 Calculate the total trihalomethane concentration by summing the four individual trihalomethane concentrations.

13. METHOD PERFORMANCE

13.1 Single laboratory accuracy and precision data were obtained for the method analytes using laboratory fortified blanks with analytes at concentrations between 0.1 and 5 µg/L. Results were obtained using the four columns specified (Sect. 6.3.2.1) and the open split or jet separator (Sect. 6.3.3.1), or the cryogenic interface (Sect. 6.3.3.2). These data are shown in Tables 4-8.

13.2 With these data, method detection limits were calculated using the formula (3):

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

where:

$t_{(n-1,1\text{-alpha} = 0.99)}$ = Student's t value for the 99% confidence level with n-1 degrees of freedom,

n = number of replicates

S = the standard deviation of the replicate analyses.

14. POLLUTION PREVENTION

14.1 No solvents are utilized in this method except the extremely small volumes of methanol needed to make calibration standards. The only other chemicals used in this method

are the neat materials in preparing standards and sample preservatives. All are used in extremely small amounts and pose no threat to the environment.

15. WASTE MANAGEMENT

15.1 There are no waste management issues involved with this method. Due to the nature of this method, the discarded samples are chemically less contaminated than when they were collected.

16. REFERENCES

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7. R.F. Arrendale, R.F. Severson, and O.T. Chortyk, "Open Split Interface for Capillary Gas Chromatography/Mass Spectrometry," Anal. Chem. 1984, 56, 1533.

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17. TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

TABLE 1. MOLECULAR WEIGHTS AND QUANTITATION IONS FOR METHOD ANALYTES

Compound	MW[a]	Primary Quantitation Ion	Secondary Quantitation Ions
Internal standard			
Fluorobenzene	96	96	77
Surrogates			
4-Bromofluorobenzene	174	95	174,176
1,2-Dichlorobenzene-d4	150	152	115,150
Target Analytes			
Acetone	58	43	58
Acrylonitrile	53	52	53
Allyl chloride	76	76	49
Benzene	78	78	77
Bromobenzene	156	156	77,158
Bromochloromethane	128	128	49,130
Bromodichloromethane	162	83	85,127
Bromoform	250	173	175,252
Bromomethane	94	94	96
2-Butanone	72	43	57,72
n-Butylbenzene	134	91	134
sec-Butylbenzene	134	105	134
tert-Butylbenzene	134	119	91
Carbon disulfide	76	76	--
Carbon tetrachloride	152	117	119
Chloroacetonitrile	75	48	75
Chlorobenzene	112	112	77,114
1-Chlorobutane	92	56	49
Chloroethane	64	64	66
Chloroform	118	83	85
Chloromethane	50	50	52
2-Chlorotoluene	126	91	126
4-Chlorotoluene	126	91	126
Dibromochloromethane	206	129	127
1,2-Dibromo-3-Chloropropane	234	75	155,157
1,2-Dibromoethane	186	107	109,188
Dibromomethane	172	93	95,174
1,2-Dichlorobenzene	146	146	111,148
1,3-Dichlorobenzene	146	146	111,148
1,4-Dichlorobenzene	146	146	111,148

TABLE 1. (continued)

Compound	MW[a]	Primary Quantitation Ion	Secondary Quantitation Ions
trans-1,4-Dichloro-2-butene	124	53	88,75
Dichlorodifluoromethane	120	85	87
1,1-Dichloroethane	98	63	65,83
1,2-Dichloroethane	98	62	98
1,1-Dichloroethene	96	96	61,63
cis-1,2-Dichloroethene	96	96	61,98
trans-1,2-Dichloroethene	96	96	61,98
1,2-Dichloropropane	112	63	112
1,3-Dichloropropane	112	76	78
2,2-Dichloropropane	112	77	97
1,1-Dichloropropene	110	75	110,77
1,1-Dichloropropanone	126	43	83
cis-1,3-dichloropropene	110	75	110
trans-1,3-dichloropropene	110	75	110
Diethyl ether	74	59	45,73
Ethylbenzene	106	91	106
Ethyl methacrylate	114	69	99
Hexachlorobutadiene	258	225	260
Hexachloroethane	234	117	119,201
2-Hexanone	100	43	58
Isopropylbenzene	120	105	120
4-Isopropyltoluene	134	119	134,91
Methacrylonitrile	67	67	52
Methyl acrylate	86	55	85
Methylene chloride	84	84	86,49
Methyl iodide	142	142	127
Methylmethacrylate	100	69	99
4-Methyl-2-pentanone	100	43	58,85
Methyl-t-butyl ether	88	73	57
Naphthalene	128	128	--
Nitrobenzene	123	51	77
2-Nitropropane	89	46	--
Pentachloroethane	200	117	119,167
Propionitrile	55	54	--
n-Propylbenzene	120	91	120
Styrene	104	104	78
1,1,1,2-Tetrachloroethane	166	131	133,119
1,1,2,2-Tetrachloroethane	166	83	131,85
Tetrachloroethene	164	166	168,129
Tetrahydrofuran	72	71	72,42
Toluene	92	92	91
1,2,3-Trichlorobenzene	180	180	182
1,2,4-Trichlorobenzene	180	180	182
1,1,1-Trichloroethane	132	97	99,61
1,1,2-Trichloroethane	132	83	97,85

TABLE 1. (continued)

Compound	MW[a]	Primary Quantitation Ion	Secondary Quantitation Ions
Trichloroethene	130	95	130,l32
Trichlorofluoromethane	136	101	103
1,2,3-Trichloropropane	146	75	77
1,2,4-Trimethylbenzene	120	105	120
1,3,5-Trimethylbenzene	120	105	120
Vinyl Chloride	62	62	64
o-Xylene	106	106	91
m-Xylene	106	106	91
p-Xylene	106	106	91

[a]Monoisotopic molecular weight calculated from the atomic masses of the isotopes with the smallest masses.

TABLE 2. CHROMATOGRAPHIC RETENTION TIMES FOR METHOD ANALYTES ON THREE COLUMNS WITH FOUR SETS OF CONDITIONS[a]

Compound	Retention Time (min:sec) Col. 1[b]	Col. 2[b]	Col. 2[c]	Col. 3[d]	Col. 4[e]
Internal standard					
Fluorobenzene	8:49	6:27	14:06	8:03	22:00
Surrogates					
4-Bromofluorobenzene	18:38	15:43	23:38		31:21
1,2-Dichlorobenzene-d4	22:16	19:08	27:25		35:51
Target Analytes					
Acetone					16:14
Acrylonitrile					17:49
Allyl chloride					16:58
Benzene	8:14	5:40	13:30	7:25	21:32
Bromobenzene	18:57	15:52	24:00	16:25	31:52
Bromochloromethane	6:44	4:23	12:22	5:38	20:20
Bromodichloromethane	10:35	8:29	15:48	9:20	23:36
Bromoform	17:56	14:53	22:46	15:42	30:32
Bromomethane	2:01	0:58	4:48	1:17	12:26
2-Butanone					19:41
n-Butylbenzene	22:13	19:29	27:32	17:57	35:41
sec-Butylbenzene	20:47	18:05	26:08	17:28	34:04
tert-Butylbenzene	20:17	17:34	25:36	17:19	33:26
Carbon Disulfide					16:30
Carbon Tetrachloride	7:37	5:16	13:10	7:25	21:11
Chloroacetonitrile					23:51
Chlorobenzene	15:46	13:01	20:40	14:20	28:26
1-Chlorobutane					21:00
Chloroethane	2:05	1:01		1:27	
Chloroform	6:24	4:48	12:36	5:33	20:27
Chloromethane	1:38	0:44	3:24	0:58	9:11
2-Chlorotoluene	19:20	16:25	24:32	16:44	32:21
4-Chlorotoluene	19:30	16:43	24:46	16:49	32:38
Cyanogen chloride (8)				1:03	
Dibromochloromethane	14:23	11:51	19:12	12:48	26:57
1,2-Dibromo-3-Chloropropane	24:32	21:05		18:02	38:20
1,2-Dibromoethane	14:44	11:50	19:24	13:36	27:19
Dibromomethane	10:39	7:56	15:26	9:05	23:22
1,2-Dichlorobenzene	22:31	19:10	27:26	17:47	35:55
1,3-Dichlorobenzene	21:13	18:08	26:22	17:28	34:31
1,4-Dichlorobenzene	21:33	18:23	26:36	17:38	34:45
t-1,4-Dichloro-2-butene					31:44
Dichlorodifluoromethane	1:33	0:42	3:08	0:53	7:16
1,1-Dichloroethane	4:51	2:56	10:48	4:02	18:46

TABLE 2. (continued)

Compound	Retention Time (min:sec) Col. 1[b]	Col. 2[b]	Col. 2[c]	Col. 3[d]	Col. 4[e]
1,2-Dichloroethane	8:24	5:50	13:38	7:00	21:31
1,1-Dichloroethene	2:53	1:34	7:50	2:20	16:01
cis-1,2-Dichloroethene	6:11	3:54	11:56	5:04	19:53
trans-1,2-Dichloroethene	3:59	2:22	9:54	3:32	17:54
1,2-Dichloropropane	10:05	7:40	15:12	8:56	23:08
1,3-Dichloropropane	14:02	11:19	18:42	12:29	26:23
2,2-Dichloropropane	6:01	3:48	11:52	5:19	19:54
1,1-Dichloropropanone					24:52
1,1-Dichloropropene	7:49	5:17	13:06	7:10	21:08
cis-1,3-dichloropropene	11.58		16:42		24:24
trans-1,3-dichloropropene	13.46		17:54		25:33
Diethyl ether					15:31
Ethylbenzene	15:59	13:23	21:00	14:44	28:37
Ethyl Methacrylate					25:35
Hexachlorobutadiene	26:59	23:41	32:04	19:14	42:03
Hexachloroethane					36:45
Hexanone					26:23
Isopropylbenzene	18:04	15:28	23:18	16:25	30:52
4-Isopropyltoluene	21:12	18:31	26:30	17:38	34:27
Methacrylonitrile					20:15
Methylacrylate					20:02
Methylene Chloride	3:36	2:04	9:16	2:40	17:18
Methyl Iodide					16:21
Methylmethacrylate					23:08
4-Methyl-2-pentanone					24:38
Methyl-t-butyl ether					17:56
Naphthalene	27:10	23:31	32:12	19:04	42:29
Nitrobenzene					39:02
2-Nitropropane					23:58
Pentachloroethane					33:33
Propionitrile					19:58
n-Propylbenzene	19:04	16:25	24:20	16:49	32:00
Styrene	17:19	14:36	22:24	15:47	29:57
1,1,1,2-Tetrachloroethane	15:56	13:20	20:52	14:44	28:35
1,1,2,2-Tetrachloroethane	18:43	16:21	24:04	15:47	31:35
Tetrachloroethene	13:44	11:09	18:36	13:12	26:27
Tetrahydrofuran					20:26
Toluene	12:26	10:00	17:24	11:31	25:13
1,2,3-Trichlorobenzene	27:47	24:11	32:58	19:14	43:31
1,2,4-Trichlorobenzene	26:33	23:05	31:30	18:50	41:26
1,1,1-Trichloroethane	7:16	4:50	12:50	6:46	20:51
1,1,2-Trichloroethane	13:25	11:03	18:18	11:59	25:59
Trichloroethene	9:35	7:16	14:48	9:01	22:42
Trichlorofluoromethane	2:16	1:11	6:12	1:46	14:18
1,2,3-Trichloropropane	19:01	16:14	24:08	16:16	31:47
1,2,4-Trimethylbenzene	20:20	17:42	31:30	17:19	33:33

TABLE 2. (continued)

Compound	Retention Time (min:sec) Col. 1[b]	Col. 2[b]	Col. 2[c]	Col. 3[d]	Col. 4[e]
1,3,5-Trimethylbenzene	19:28	16:54	24:50	16:59	32:26
Vinyl chloride	1:43	0:47	3:56	1:02	10:22
o-Xylene	17:07	14:31	22:16	15:47	29:56
m-Xylene	16:10	13:41	21:22	15:18	28:53
p-Xylene	16:07	13:41	21:18	15:18	28:53

[a]Columns 1-4 are those given in Sect. 6.3.2.1; retention times were measured from the beginning of thermal desorption from the trap (columns 1-2, and 4) or from the beginning of thermal release from the cryogenic interface (column 3).

[b]GC conditions given in Sect. 11.3.1.

[c]GC conditions given in Sect. 11.3.2.

[d]GC conditions given in Sect. 11.3.3.

[e]GC conditions given in Sect. 11.3.4.

TABLE 3. ION ABUNDANCE CRITERIA FOR 4-BROMOFLUOROBENZENE (BFB)

Mass (M/z)	Relative Abundance Criteria
50	15 to 40% of mass 95
75	30 to 80% of mass 95
95	Base Peak, 100% Relative Abundance
96	5 to 9% of mass 95
173	< 2% of mass 174
174	> 50% of mass 95
175	5 to 9% of mass 174
176	> 95% but < 101% of mass 174
177	5 to 9% of mass 176

TABLE 4. ACCURACY AND PRECISION DATA FROM 16-31 DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING WIDE-BORE CAPILLARY COLUMN 1[a]

Compound	True Conc. Range (µg/L)	Mean Accuracy (% of True Value)	Rel. Std. Dev. (%)	Method Det. Limit[b] (µg/L)
Benzene	0.1-10	97	5.7	0.04
Bromobenzene	0.1-10	100	5.5	0.03
Bromochloromethane	0.5-10	90	6.4	0.04
Bromodichloromethane	0.1-10	95	6.1	0.08
Bromoform	0.5-10	101	6.3	0.12
Bromomethane	0.5-10	95	8.2	0.11
n-Butylbenzene	0.5-10	100	7.6	0.11
sec-Butylbenzene	0.5-10	100	7.6	0.13
tert-Butylbenzene	0.5-10	102	7.3	0.14
Carbon Tetrachloride	0.5-10	84	8.8	0.21
Chlorobenzene	0.1-10	98	5.9	0.04
Chloroethane	0.5-10	89	9.0	0.10
Chloroform	0.5-10	90	6.1	0.03
Chloromethane	0.5-10	93	8.9	0.13
2-Chlorotoluene	0.1-10	90	6.2	0.04
4-Chlorotoluene	0.1-10	99	8.3	0.06
Dibromochloromethane	0.1-10	92	7.0	0.05
1,2-Dibromo-3-Chloropropane	0.5-10	83	19.9	0.26
1,2-Dibromoethane	0.5-10	102	3.9	0.06
Dibromomethane	0.5-10	100	5.6	0.24
1,2-Dichlorobenzene	0.1-10	93	6.2	0.03
1,3-Dichlorobenzene	0.5-10	99	6.9	0.12
1,4-Dichlorobenzene	0.2-20	103	6.4	0.03
Dichlorodifluoromethane	0.5-10	90	7.7	0.10
1,1-Dichloroethane	0.5-10	96	5.3	0.04
1,2-Dichloroethane	0.1-10	95	5.4	0.06
1,1-Dichloroethene	0.1-10	94	6.7	0.12
cis-1,2-Dichloroethene	0.5-10	101	6.7	0.12
trans-1,2-Dichloroethene	0.1-10	93	5.6	0.06
1,2-Dichloropropane	0.1-10	97	6.1	0.04
1,3-Dichloropropane	0.1-10	96	6.0	0.04
2,2-Dichloropropane	0.5-10	86	16.9	0.35
1,1-Dichloropropene	0.5-10	98	8.9	0.10
cis-1,2-Dichloropropene				
trans-1,2-Dichloropropene				
Ethylbenzene	0.1-10	99	8.6	0.06
Hexachlorobutadiene	0.5-10	100	6.8	0.11
Isopropylbenzene	0.5-10	101	7.6	0.15
4-Isopropyltoluene	0.1-10	99	6.7	0.12

TABLE 4. ACCURACY AND PRECISION DATA FROM 16-31 DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING WIDE-BORE CAPILLARY COLUMN 1[a]

Compound	True Conc. Range (µg/L)	Mean Accuracy (% of True Value)	Rel. Std. Dev. (%)	Method Det. Limit[b] (µg/L)
Methylene Chloride	0.1-10	95	5.3	0.03
Naphthalene	0.1-100	104	8.2	0.04
n-Propylbenzene	0.1-10	100	5.8	0.04
Styrene	0.1-100	102	7.2	0.04
1,1,1,2-Tetrachloroethane	0.5-10	90	6.8	0.05
1,1,2,2-Tetrachloroethane	0.1-10	91	6.3	0.04
Tetrachloroethene	0.5-10	89	6.8	0.14
Toluene	0.5-10	102	8.0	0.11
1,2,3-Trichlorobenzene	0.5-10	109	8.6	0.03
1,2,4-Trichlorobenzene	0.5-10	108	8.3	0.04
1,1,1-Trichloroethane	0.5-10	98	8.1	0.08
1,1,2-Trichloroethane	0.5-10	104	7.3	0.10
Trichloroethene	0.5-10	90	7.3	0.19
Trichlorofluoromethane	0.5-10	89	8.1	0.08
1,2,3-Trichloropropane	0.5-10	108	14.4	0.32
1,2,4-Trimethylbenzene	0.5-10	99	8.1	0.13
1,3,5-Trimethylbenzene	0.5-10	92	7.4	0.05
Vinyl Chloride	0.5-10	98	6.7	0.17
o-Xylene	0.1-31	103	7.2	0.11
m-Xylene	0.1-10	97	6.5	0.05
p-Xylene	0.5-10	104	7.7	0.13

[a]Data obtained by using Column 1 with a jet separator interface and a quadrupole mass spectrometer (Section 11.3.1) with analytes divided among three solutions.

[b]Replicate samples at the lowest concentration listed in Column 2 of this table were analyzed. These results were used to calculate MDLs.

TABLE 5. ACCURACY AND PRECISION DATA FROM SEVEN DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING THE CRYOGENIC TRAPPING OPTION AND A NARROW-BORE CAPILLARY COLUMN 3[a]

Compound	True Conc. (µg/L)	Mean Accuracy (% of True Value)	Rel. Std. Dev. (%)	Method Det. Limit (µg/L)
Benzene	0.1	99	6.2	0.03
Bromobenzene	0.5	97	7.4	0.11
Bromochloromethane	0.5	97	5.8	0.07
Bromodichloromethane	0.1	100	4.6	0.03
Bromoform	0.1	99	5.4	0.20
Bromomethane	0.1	99	7.1	0.06
n-Butylbenzene	0.5	94	6.0	0.03
sec-Butylbenzene	0.5	90	7.1	0.12
tert-Butylbenzene	0.5	90	2.5	0.33
Carbon Tetrachloride	0.1	92	6.8	0.08
Chlorobenzene	0.1	91	5.8	0.03
Chloroethane	0.1	100	5.8	0.02
Chloroform	0.1	95	3.2	0.02
Chloromethane	0.1	99	4.7	0.05
2-Chlorotoluene	0.1	99	4.6	0.05
4-Chlorotoluene	0.1	96	7.0	0.05
Cyanogen Chloride[b]		92	10.6	0.30
Dibromochloromethane	0.1	99	5.6	0.07
1,2-Dibromo-3-Chloropropane	0.1	92	10.0	0.05
1,2-Dibromoethane	0.1	97	5.6	0.02
Dibromomethane	0.1	93	6.9	0.03
1,2-Dichlorobenzene	0.1	97	3.5	0.05
1,3-Dichlorobenzene	0.1	99	6.0	0.05
1,4-Dichlorobenzene	0.1	93	5.7	0.04
Dichlorodifluoromethane	0.1	99	8.8	0.11
1,1-Dichloroethane	0.1	98	6.2	0.03
1,2-Dichloroethane	0.1	100	6.3	0.02
1,1-Dichloroethene	0.1	95	9.0	0.05
cis-1,2-Dichloroethene	0.1	100	3.7	0.06
trans-1,2-Dichloroethene	0.1	98	7.2	0.03
1,2-Dichloropropane	0.1	96	6.0	0.02
1,3-Dichloropropane	0.1	99	5.8	0.04
2,2-Dichloropropane	0.1	99	4.9	0.05
1,1-Dichloropropene	0.1	98	7.4	0.02
cis-1,2-Dichloropropene				
trans-1,2-Dichloropropene				
Ethylbenzene	0.1	99	5.2	0.03
Hexachlorobutadiene	0.1	100	6.7	0.04

TABLE 5. ACCURACY AND PRECISION DATA FROM SEVEN DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING THE CRYOGENIC TRAPPING OPTION AND A NARROW-BORE CAPILLARY COLUMN 3[a]

Compound	True Conc. (µg/L)	Mean Accuracy (% of True Value)	Rel. Std. Dev. (%)	Method Det. Limit (µg/L)
Isopropylbenzene	0.5	98	6.4	0.10
4-Isopropyltoluene	0.5	87	13.0	0.26
Methylene Chloride	0.5	97	13.0	0.09
Naphthalene	0.1	98	7.2	0.04
n-Propylbenzene	0.1	99	6.6	0.06
Styrene	0.1	96	19.0	0.06
1,1,1,2-Tetrachloroethane	0.1	100	4.7	0.04
1,1,2,2-Tetrachloroethane	0.1	100	12.0	0.20
Tetrachloroethene	0.1	96	5.0	0.05
Toluene	0.1	100	5.9	0.08
1,2,3-Trichlorobenzene	0.1	98	8.9	0.04
1,2,4-Trichlorobenzene	0.1	91	16.0	0.20
1,1,1-Trichloroethane	0.1	100	4.0	0.04
1,1,2-Trichloroethane	0.1	98	4.9	0.03
Trichloroethene	0.1	96	2.0	0.02
Trichlorofluoromethane	0.1	97	4.6	0.07
1,2,3-Trichloropropane	0.1	96	6.5	0.03
1,2,4-Trimethylbenzene	0.1	96	6.5	0.04
1,3,5-Trimethylbenzene	0.1	99	4.2	0.02
Vinyl Chloride	0.1	96	0.2	0.04
o-Xylene	0.1	94	7.5	0.06
m-Xylene	0.1	94	4.6	0.03
p-Xylene	0.1	97	6.1	0.06

[a]Data obtained by using Column 3 with a cryogenic interface and a quadrupole mass spectrometer (Section 11.3.3).

[b]Reference 8.

TABLE 6. ACCURACY AND PRECISION DATA FROM SEVEN DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING WIDE-BORE CAPILLARY COLUMN 2[a]

Compound	No.[b]	Mean Accuracy (% of True Value, 2 µg/L Conc.)	RSD (%)	Mean Accuracy (% of True Value, 0.2 µg/L Conc.)	RSD (%)
Internal Standard					
Fluorobenzene	1	–	–	–	–
Surrogates					
4-Bromofluorobenze	2	98	1.8	96	1.3
1,2-Dichlorobenzene-d_4	3	97	3.2	95	1.7
Target Analytes					
Benzene	37	97	4.4	113	1.8
Bromobenzene	38	102	3.0	101	1.9
Bromochloromethane	4	99	5.2	102	2.9
Bromodichloromethane	5	96	1.8	100	1.8
Bromoform	6	89	2.4	90	2.2
Bromomethane	7	55	27.	52	6.7
n-Butylbenzene	39	89	4.8	87	2.3
sec-Butylbenzene	40	102	3.5	100	2.8
tert-Butylbenzene	41	101	4.5	100	2.9
Carbon Tetrachloride	8	84	3.2	92	2.6
Chlorobenzene	42	104	3.1	103	1.6
Chloroethane[c]					
Chloroform	9	97	2.0	95	2.1
Chloromethane	10	110	5.0	[d]	
2-Chlorotoluene	43	91	2.4	108	3.1
4-Chlorotoluene	44	89	2.0	108	4.4
Dibromochloromethane	11	95	2.7	100	3.0
1,2-Dibromo-3-Chloropropane[c]					
1,2-Dibromoethane[c]					
Dibromomethane	13	99	2.1	95	2.2
1,2-Dichlorobenzene	45	93	2.7	94	5.1
1,3-Dichlorobenzene	46	100	4.0	87	2.3
1,4-Dichlorobenzene	47	98	4.1	94	2.8
Dichlorodifluoromethane	14	38	25.	[d]	
1,1-Dichloroethane	15	97	2.3	85	3.6
1,2-Dichloroethane	16	102	3.8	100	2.1

TABLE 6. ACCURACY AND PRECISION DATA FROM SEVEN DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING WIDE-BORE CAPILLARY COLUMN 2[a]

Compound	No.[b]	Mean Accuracy (% of True Value, 2 µg/L Conc.)	RSD (%)	Mean Accuracy (% of True Value, 0.2 µg/L Conc.)	RSD (%)
1,1-Dichloroethene	17	90	2.2	87	3.8
cis-1,2-Dichloroethene	18	100	3.4	89	2.9
trans-1,2-Dichloroethene	19	92	2.1	85	2.3
1,2-Dichloropropane	20	102	2.2	103	2.9
1,3-Dichloropropane	21	92	3.7	93	3.2
2,2-Dichloropropane[c]					
1,1-Dichloropropene[c]					
cis-1,2-Dichloropropene[c]					
trans-1,2-Dichloropropene	25	96	1.7	99	2.1
Ethylbenzene	48	96	9.1	100	4.0
Hexachlorobutadiene	26	91	5.3	88	2.4
Isopropylbenzene	49	103	3.2	101	2.1
4-Isopropyltoluene	50	95	3.6	95	3.1
Methylene Chloride	27	[e]		[e]	
Naphthalene	51	93	7.6	78	8.3
n-Propylbenzene	52	102	4.9	97	2.1
Styrene	53	95	4.4	104	3.1
1,1,1,2-Tetrachloroethane	28	99	2.7	95	3.8
1,1,2,2-Tetrachloroethane	29	101	4.6	84	3.6
Tetrachloroethene	30	97	4.5	92	3.3
Toluene	54	105	2.8	126	1.7
1,2,3-Trichlorobenzene	55	90	5.7	78	2.9
1,2,4-Trichlorobenzene	56	92	5.2	83	5.9
1,1,1-Trichloroethane	31	94	3.9	94	2.5
1,1,2-Trichloroethane	32	107	3.4	109	2.8
Trichloroethene	33	99	2.9	106	2.5
Trichlorofluoromethane	34	81	4.6	48	13.
1,2,3-Trichloropropane	35	97	3.9	91	2.8
1,2,4-Trimethylbenzene	57	93	3.1	106	2.2
1,3,5-Trimethylbenzene	58	88	2.4	97	3.2
Vinyl Chloride	36	104	3.5	115	14.

TABLE 6. ACCURACY AND PRECISION DATA FROM SEVEN DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING WIDE-BORE CAPILLARY COLUMN 2[a]

Compound	No.[b]	Mean Accuracy (% of True Value, 2 µg/L Conc.)	RSD (%)	Mean Accuracy (% of True Value, 0.2 µg/L Conc.)	RSD (%)
o-Xylene	59	97	1.8	98	1.7
m-Xylene	60	[f]		[f]	
p-Xylene	61	98	2.3	103	1.4

[a]Data obtained using Column 2 with the open split interface and an ion trap mass spectrometer (Section 11.3.2) with all method analytes in the same reagent water solution.
[b]Designation in Figures 1 and 2.
[c]Not measured; authentic standards were not available.
[d]Not found at 0.2 µg/L.
[e]Not measured; methylene chloride was in the laboratory reagent blank.
[f]m-xylene coelutes with and cannot be distinguished from its isomer p-xylene, No 61.

TABLE 7. ACCURACY AND PRECISION DATA FROM SEVEN DETERMINATIONS OF METHOD ANALYTES IN REAGENT WATER USING WIDE-BORE CAPILLARY COLUMN 4[a]

Compound	True Conc. (µg/L)	Mean Conc. Detected (µg/L)	Rel. Std. Dev. (%)	Method Detect. Limit (µg/L)
Acetone	1.0	1.6	5.7	0.28
Acrylonitrile	1.0	0.81	8.7	0.22
Allyl Chloride	1.0	0.90	4.7	0.13
2-Butanone	2.0	2.7	5.6	0.48
Carbon Disulfide	0.20	0.19	15	0.093
Chloroacetonitrile	1.0	0.83	4.7	0.12
1-Chlorobutane	1.0	0.87	6.6	0.18
trans-Dichloro-2-Butene	1.0	1.3	8.7	0.36
1,1-Dichloropropanone	5.0	4.2	7.7	1.0
cis-1,3-Dichloropropene	0.20	0.20	3.1	0.020
trans-1,3-Dichloropropene	0.10	0.11	14	0.048
Diethyl Ether	1.0	0.92	9.5	0.28
Ethyl Methacrylate	0.20	0.23	3.9	0.028
Hexachloroethane	0.20	0.18	10	0.057
2-Hexanone	1.0	1.1	12	0.39
Methacrylonitrile	1.0	0.92	4.2	0.12
Methylacrylate	1.0	1.2	12	0.45
Methyl Iodide	0.20	0.19	3.1	0.019
Methylmethacrylate	1.0	1.0	13	0.43
4-Methyl-2-Pentanone	0.40	0.56	9.7	0.17
Methyl-tert-Butylether	0.40	0.52	5.6	0.090
Nitrobenzene	2.0	2.1	18	1.2
2-Nitrobenzene	1.0	0.83	6.2	0.16
Pentachloroethane	0.20	0.23	20	0.14
Propionitrile	1.0	0.87	5.3	0.14
Tetrahydrofuran	5.0	3.9	13	1.6

[a]Data obtained using Column 4 with the open split interface and an ion trap mass spectrometer.

TABLE 8. ACCURACY AND PRECISION FROM FOUR DETERMINATIONS OF METHOD ANALYTES IN THREE WATER MATRICES FORTIFIED AT 20 µG/L[a]

	REAGENT WATER			RAW WATER			TAP WATER		
Compound	Mean (µg/L)	Dev. (%)	(% of True Value)	Mean (µg/L)	Dev. (%)	(% of True Value)	Mean (µg/L)	Dev. (%)	(% of True Value)
Acetone	19	12%	95%	21	3.7%	105%	22	8.2%	110%
Acrylonitrile	20	4.7%	100%	22	3.4%	110%	21	1.3%	105%
Allyl Chloride	20	5.1%	100%	20	2.8%	100%	19	3.5%	95%
2-Butanone	17	11%	85%	19	7.3%	95%	17	5.6%	85%
Carbon Disulfide	19	6.4%	95%	18	2.5%	90%	18	3.0%	90%
Chloroacetonitrile	20	4.1%	100%	23	4.7%	115%	23	1.3%	115%
1-Chlorobutane	18	6.4%	90%	19	2.2%	95%	17	2.2%	85%
t-1,2-Dichloro-2-Butene	19	4.1%	95%	22	2.9%	110%	21	0.90%	105%
1,1-Dichloropropanone	20	5.6%	100%	22	6.4%	110%	21	7.7%	105%
Diethyl Ether	18	6.7%	90%	22	3.4%	110%	22	2.6%	110%
Ethyl Methacrylate	20	3.7%	100%	23	2.6%	115%	22	1.8%	110%
Hexachloroethane	20	6.1%	100%	21	2.5%	105%	21	2.0%	105%
2-Hexanone	19	6.3%	95%	21	3.8%	105%	21	4.0%	105%
Methacrylonitrile	20	3.4%	100%	23	2.9%	115%	22	2.0%	110%
Methylacrylate	20	3.7%	100%	22	3.1%	110%	21	2.1%	105%

TABLE 8. ACCURACY AND PRECISION FROM FOUR DETERMINATIONS OF METHOD ANALYTES IN THREE WATER MATRICES FORTIFIED AT 20 µG/L[a]

	Reagent Water			Raw Water			Tap Water		
Compound	Mean (µg/L)	Dev. (%)	(% of True Value)	Mean (µg/L)	Dev. (%)	(% of True Value)	Mean (µg/L)	Dev. (%)	(% of True Value)
Methyl Iodide	20	4.4%	100%	19	3.8%	95%	19	3.0%	95%
Methylmethacrylate	20	3.7%	100%	23	3.3%	115%	23	2.7%	115%
4-Methyl-2-Pentanone	19	8.7%	95%	21	5.5%	105%	22	7.2%	110%
Methyl-tert-Butylether	19	3.5%	95%	22	2.5%	110%	22	3.6%	110%
Nitrobenzene	20	5.4%	100%	22	4.8%	110%	21	2.4%	105%
2-Nitropropane	20	6.1%	100%	23	5.1%	115%	22	3.2%	110%
Pentachloroethane	19	5.2%	95%	21	2.6%	105%	22	1.7%	110%
Propionitrile	20	4.5%	100%	23	3.9%	115%	23	2.4%	115%
Tetrahydrofuran	20	2.8%	100%	24	3.2%	120%	21	2.9%	105%

[a]Data obtained using Column 4 with the open-split interface and an ion trap mass spectrometer with all Table 8 analyses in the same reagent water solution (1).

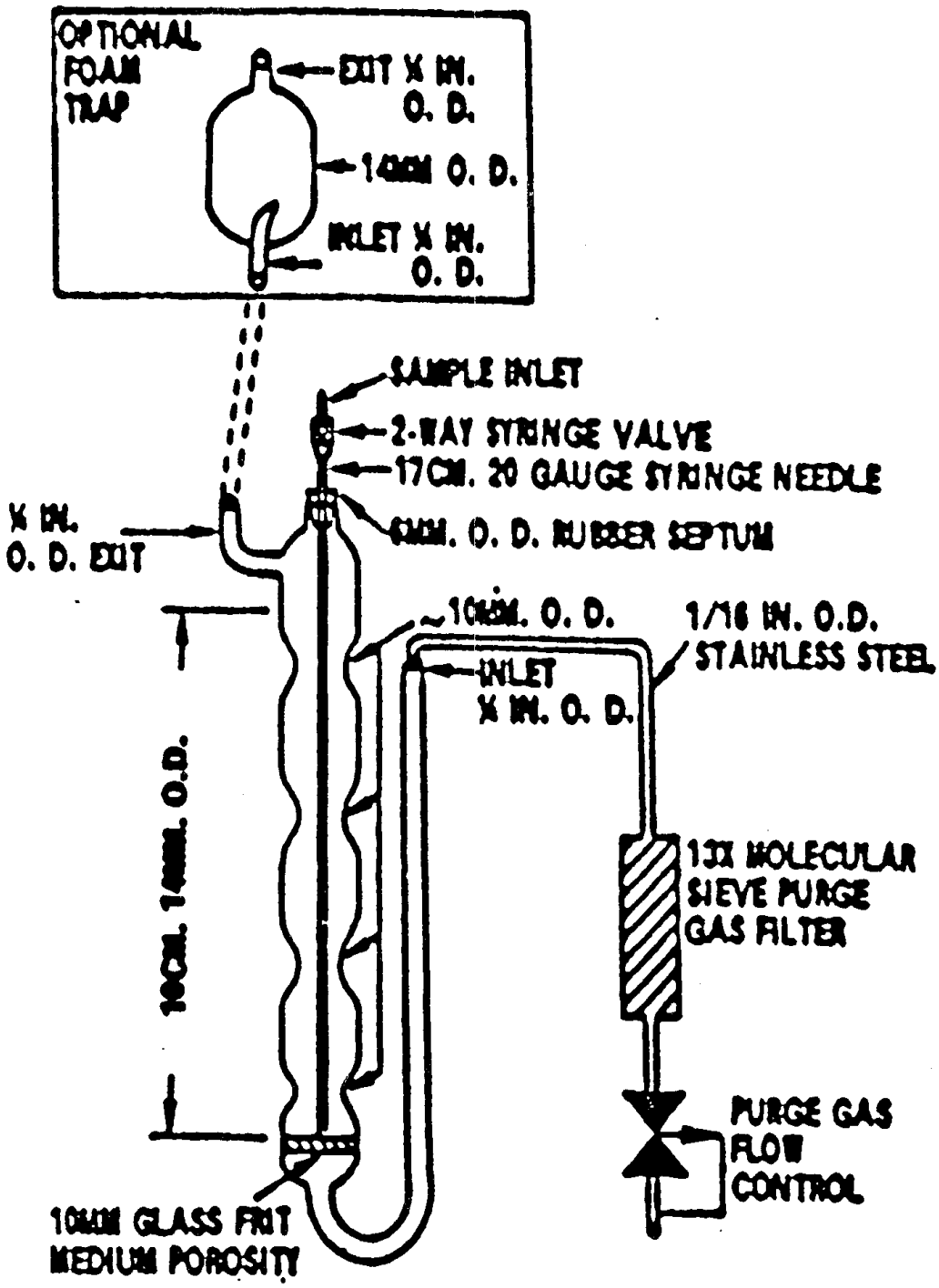


FIGURE 1. PURGING DEVICE

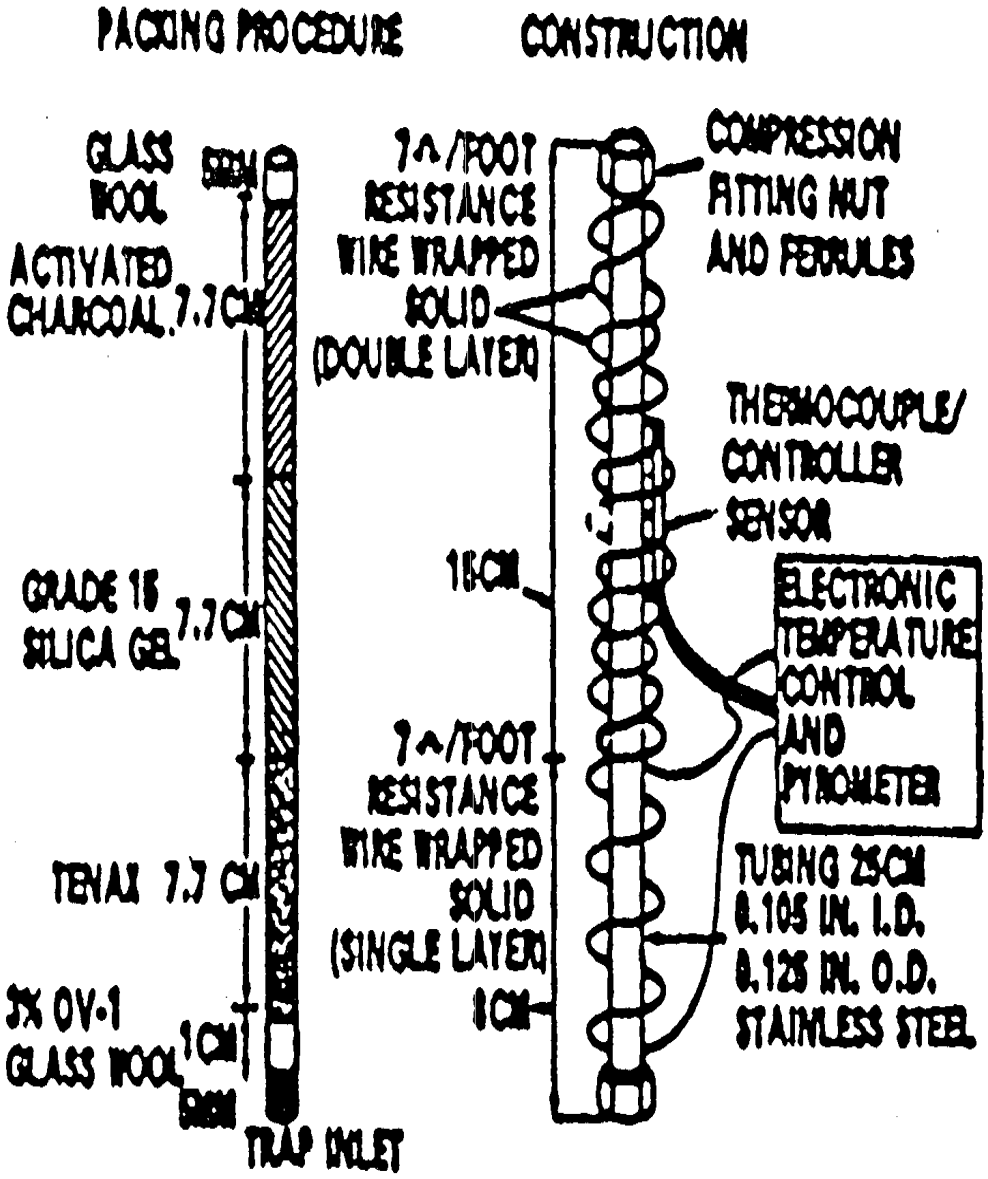


FIGURE 2. TRAP PACKINGS AND CONSTRUCTION TO INCLUDE DESORB CAPABILITY

FIGURE 3. NORMALIZED TOTAL ION CURRENT CHROMATOGRAM FROM A VOLATILE COMPOUND CALIBRATION MIXTURE CONTAINING 25 ng (5 µg/L) OF MOST COMPOUNDS. THE COMPOUND IDENTIFICATION NUMBERS ARE GIVEN IN TABLE 6.

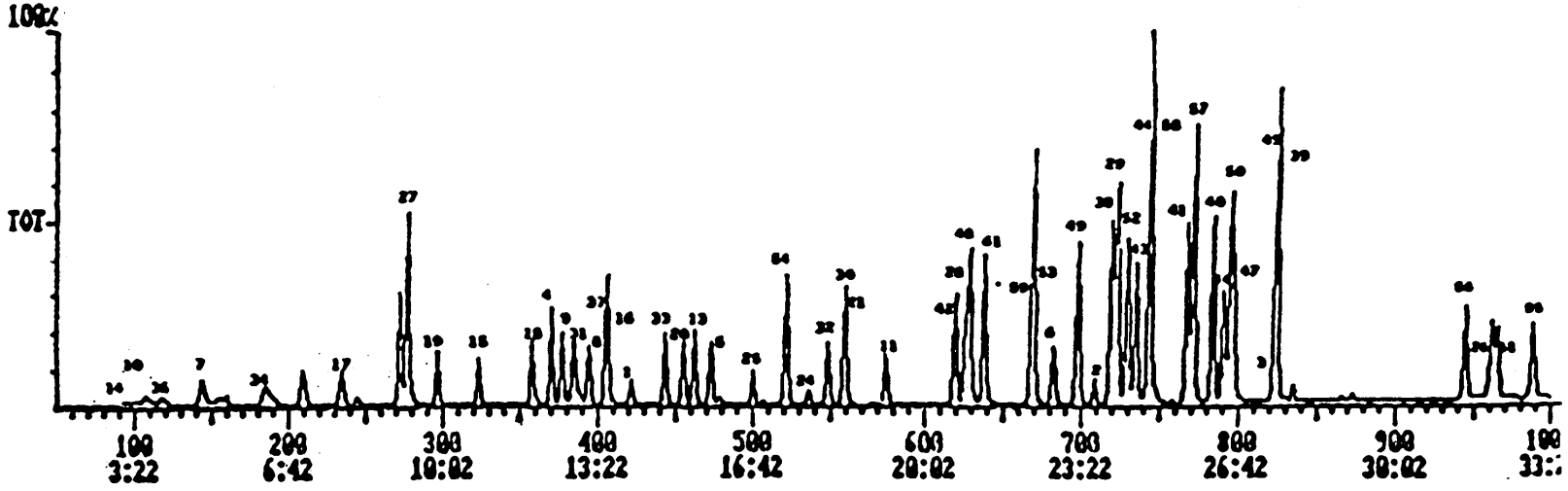
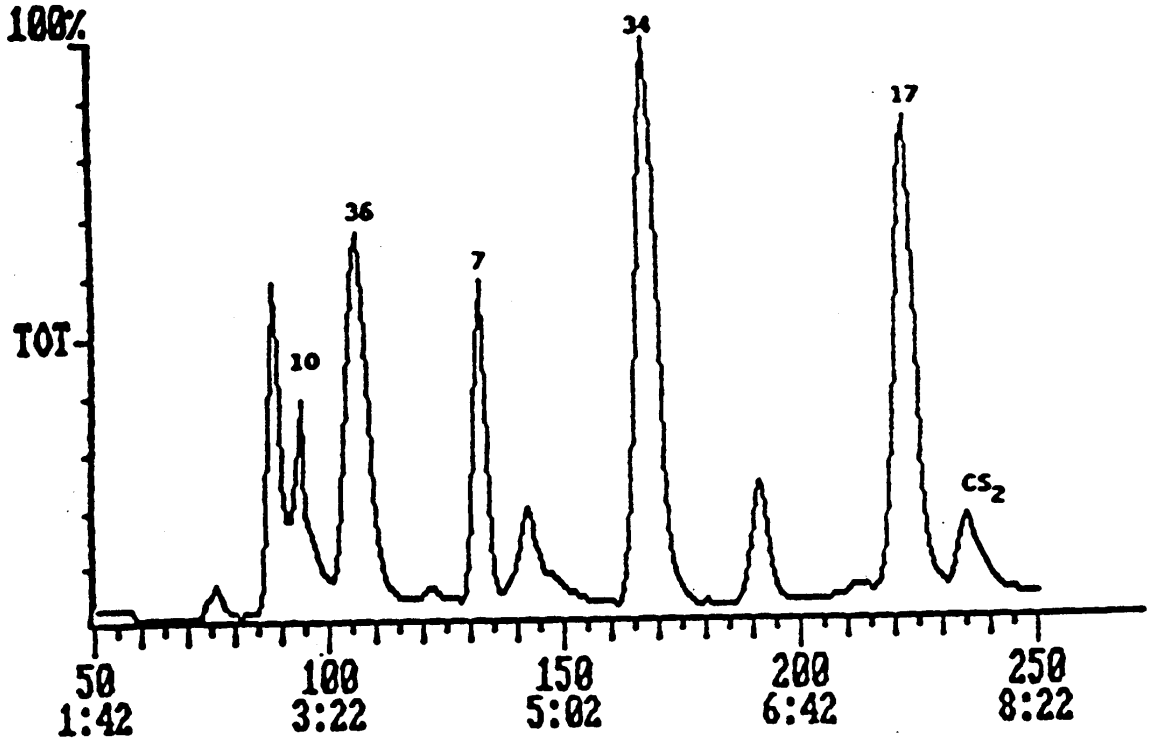


FIGURE 4. AMPLIFIED FIRST EIGHT MINUTES OF A TOTAL ION CURRENT CHROMATOGRAM FROM A VOLATILE COMPOUND CALIBRATION MIXTURE CONTAINING 25 ng (5 µg/L) OF EACH COMPONENT. THE COMPOUND IDENTIFICATION NUMBERS ARE GIVEN IN TABLE 6.



WECK LABORATORIES, INC.

Analytical Method Information

Analyte	MDL	MRL	Units	% Recovery	DUP RPD	Matrix Spike		Blank Spike		CASNumber
						% R	RPD	% R	RPD	
Arsenic - EPA 200.8 by EPA 200.8 (Water)										
Arsenic, Total	0.074	0.40	ug/l	-	30	70-130	30	85-115	30	7440-38-2
Barium - EPA 200.8 by EPA 200.8 (Water)										
Barium, Total	0.071	0.50	ug/l	-	30	70-130	30	85-115	30	7440-39-3
Cadmium - EPA 200.8 by EPA 200.8 (Water)										
Cadmium, Total	0.041	0.10	ug/l	-	30	70-130	30	85-115	30	7440-43-9
Chromium - EPA 200.8 by EPA 200.8 (Water)										
Chromium, Total	0.035	0.20	ug/l	-	30	70-130	30	85-115	30	7440-47-3
Copper - EPA 200.8 by EPA 200.8 (Water)										
Copper, Total	0.13	0.50	ug/l	-	30	70-130	30	85-115	30	7440-50-8
EPA 524.2 - Volatile Organic Compounds by EPA 524.2 (Water)										
1,1,1,2-Tetrachloroethane	0.10	0.50	ug/l	-	30	70-130	30	70-130	30	630-20-6
1,1,1-Trichloroethane	0.11	0.50	ug/l	-	30	70-130	30	70-130	30	71-55-6
1,1,2,2-Tetrachloroethane	0.20	0.50	ug/l	-	30	70-130	30	70-130	30	79-34-5
1,1,2-Trichloroethane	0.19	0.50	ug/l	-	30	70-130	30	70-130	30	79-00-5
1,1-Dichloroethane	0.12	0.50	ug/l	-	30	70-130	30	70-130	30	75-34-3
1,1-Dichloroethene	0.16	0.50	ug/l	-	30	70-130	30	70-130	30	75-35-4
1,1-Dichloropropene	0.14	0.50	ug/l	-	30	70-130	30	70-130	30	563-58-6
1,2,3-Trichlorobenzene	0.19	0.50	ug/l	-	30	70-130	30	70-130	30	87-61-6
1,2,4-Trichlorobenzene	0.17	0.50	ug/l	-	30	70-130	30	70-130	30	120-82-1
1,2,4-Trimethylbenzene	0.20	0.50	ug/l	-	30	70-130	30	70-130	30	95-63-6
1,2-Dichloroethane	0.12	0.50	ug/l	-	30	70-130	30	70-130	30	107-06-2
1,2-Dichloropropane	0.13	0.50	ug/l	-	30	70-130	30	70-130	30	78-87-5
1,3,5-Trimethylbenzene	0.17	0.50	ug/l	-	30	70-130	30	70-130	30	108-67-8
1,3-Dichloropropane	0.11	0.50	ug/l	-	30	70-130	30	70-130	30	142-28-9
1,3-Dichloropropene, Total		0.50	ug/l	-		-		-		542-75-6
2,2-Dichloropropane	0.17	0.50	ug/l	-	30	70-130	30	70-130	30	594-20-7
2-Butanone	1.5	5.0	ug/l	-	30	70-130	30	70-130	30	78-93-3
2-Chlorotoluene	0.15	0.50	ug/l	-	30	70-130	30	70-130	30	95-49-8
2-Hexanone	1.2	5.0	ug/l	-	30	70-130	30	70-130	30	591-78-6
4-Chlorotoluene	0.15	0.50	ug/l	-	30	70-130	30	70-130	30	106-43-4
4-Methyl-2-pentanone	1.8	5.0	ug/l	-	30	70-130	30	70-130	30	108-10-1
Benzene	0.15	0.50	ug/l	-	30	70-130	30	70-130	30	71-43-2
Bromobenzene	0.15	0.50	ug/l	-	30	70-130	30	70-130	30	108-86-1
Bromochloromethane	0.15	0.50	ug/l	-	30	70-130	30	70-130	30	74-97-5
Bromodichloromethane	0.090	0.50	ug/l	-	30	70-130	30	70-130	30	75-27-4
Bromoform	0.19	0.50	ug/l	-	30	70-130	30	70-130	30	75-25-2
Bromomethane	0.27	0.50	ug/l	-	30	70-130	30	70-130	30	74-83-9
Carbon tetrachloride	0.12	0.50	ug/l	-	30	70-130	30	70-130	30	56-23-5
Chlorobenzene	0.15	0.50	ug/l	-	30	70-130	30	70-130	30	108-90-7
Chloroethane	0.17	0.50	ug/l	-	30	70-130	30	70-130	30	75-00-3
Chloroform	0.12	0.50	ug/l	-	30	70-130	30	70-130	30	67-66-3
Chloromethane	0.23	0.50	ug/l	-	30	70-130	30	70-130	30	74-87-3
cis-1,2-Dichloroethene	0.11	0.50	ug/l	-	30	70-130	30	70-130	30	156-59-2
cis-1,3-Dichloropropene	0.11	0.50	ug/l	-	30	70-130	30	70-130	30	10061-01-5
Dibromochloromethane	0.20	0.50	ug/l	-	30	70-130	30	70-130	30	124-48-1
Dibromomethane	0.20	0.50	ug/l	-	30	70-130	30	70-130	30	74-95-3
Dichlorodifluoromethane (Freon 12)	0.45	0.50	ug/l	-	30	70-130	30	70-130	30	75-71-8
Di-isopropyl ether	0.34	2.0	ug/l	-	30	70-130	30	70-130	30	108-20-3

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Analytical Method Information

Analyte	MDL	MRL	Units	% Recovery	DUP RPD	Matrix Spike		Blank Spike		CASNumber
						% R	RPD	% R	RPD	
Ethyl tert-butyl ether	0.40	2.0	ug/l	-	30	70-130	30	70-130	30	637-92-3
Ethylbenzene	0.21	0.50	ug/l	-	30	70-130	30	70-130	30	100-41-4
Freon 113	1.5	5.0	ug/l	-	30	70-130	30	70-130	30	76-13-1
Hexachlorobutadiene	0.40	0.50	ug/l	-	30	70-130	30	70-130	30	87-68-3
Isopropylbenzene	0.18	0.50	ug/l	-	30	70-130	30	70-130	30	98-82-8
m,p-Xylene	0.33	0.50	ug/l	-	30	70-130	30	70-130	30	179601-23-1
m-Dichlorobenzene	0.14	0.50	ug/l	-	30	70-130	30	70-130	30	541-73-1
Methyl tert-butyl ether (MTBE)	0.19	2.0	ug/l	-	30	70-130	30	70-130	30	1634-04-4
Methylene chloride	0.14	0.50	ug/l	-	30	70-130	30	70-130	30	75-09-2
Naphthalene	0.35	0.50	ug/l	-	30	70-130	30	70-130	30	91-20-3
n-Butylbenzene	0.29	0.50	ug/l	-	30	70-130	30	70-130	30	104-51-8
n-Propylbenzene	0.18	0.50	ug/l	-	30	70-130	30	70-130	30	103-65-1
o-Dichlorobenzene	0.19	0.50	ug/l	-	30	70-130	30	70-130	30	95-50-1
o-Xylene	0.20	0.50	ug/l	-	30	70-130	30	70-130	30	95-47-6
p-Dichlorobenzene	0.18	0.50	ug/l	-	30	70-130	30	70-130	30	106-46-7
p-Isopropyltoluene	0.25	0.50	ug/l	-	30	70-130	30	70-130	30	99-87-6
sec-Butylbenzene	0.24	0.50	ug/l	-	30	70-130	30	70-130	30	135-98-8
Styrene	0.19	0.50	ug/l	-	30	70-130	30	70-130	30	100-42-5
Tert-amyl methyl ether	0.59	2.0	ug/l	-	30	70-130	30	70-130	30	994-05-8
tert-Butylbenzene	0.18	0.50	ug/l	-	30	70-130	30	70-130	30	98-06-6
Tetrachloroethene	0.18	0.50	ug/l	-	30	70-130	30	70-130	30	127-18-4
THMs, Total		0.50	ug/l	-		-		-		NA
Toluene	0.14	0.50	ug/l	-	30	70-130	30	70-130	30	108-88-3
trans-1,2-Dichloroethene	0.11	0.50	ug/l	-	30	70-130	30	70-130	30	156-60-5
trans-1,3-Dichloropropene	0.15	0.50	ug/l	-	30	70-130	30	70-130	30	10061-02-6
Trichloroethene	0.18	0.50	ug/l	-	30	70-130	30	70-130	30	79-01-6
Trichlorofluoromethane	0.18	0.50	ug/l	-	30	70-130	30	70-130	30	75-69-4
Vinyl chloride	0.18	0.50	ug/l	-	30	70-130	30	70-130	30	75-01-4
Xylenes, Total		0.50	ug/l	-		-		-		1330-20-7
1,2-Dichlorobenzene-d4	-	-	Surrogate	70-130		-		-		2199-69-1
4-Bromofluorobenzene	-	-	Surrogate	70-130		-		-		460-00-4
Lead - EPA 200.8 by EPA 200.8 (Water)										
Lead, Total	0.031	0.20	ug/l	-	30	70-130	30	85-115	30	7439-92-1
Mercury - EPA 245.1 by EPA 245.1 (Water)										
Mercury, Total	0.017	0.050	ug/l	-	20	70-130	20	85-115	20	7439-97-6
Nickel - EPA 200.8 by EPA 200.8 (Water)										
Nickel, Total	0.045	0.80	ug/l	-	30	70-130	30	85-115	30	7440-02-0
Selenium - EPA 200.8 by EPA 200.8 (Water)										
Selenium, Total	0.14	0.40	ug/l	-	30	70-130	30	85-115	30	7782-49-2
Silver - EPA 200.8 by EPA 200.8 (Water)										
Silver, Total	0.062	0.20	ug/l	-	30	70-130	30	85-115	30	7440-22-4

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Sampling Guide

Analysis	SpecificMethod	Container	Preservation	Hold (days)	Amount Needed
Metals by EPA 200 Series Methods in Water					
Mercury - EPA 245.1	EPA 245.1	250-mL Poly-Metals, HNO3	HNO3	28	250 mL
Selenium - EPA 200.8	EPA 200.8	250-mL Poly-Metals, HNO3	HNO3	180	250 ml
Lead - EPA 200.8	EPA 200.8	250-mL Poly-Metals, HNO3	HNO3	185	250 mL
Nickel - EPA 200.8	EPA 200.8	250-mL Poly-Metals, HNO3	HNO3	180	250 ml
Copper - EPA 200.8	EPA 200.8	250-mL Poly-Metals, HNO3	HNO3	180	250 mL
Chromium - EPA 200.8	EPA 200.8	250-mL Poly-Metals, HNO3	HNO3	180	250 mL
Cadmium - EPA 200.8	EPA 200.8	250-mL Poly-Metals, HNO3	HNO3	180	250 mL
Barium - EPA 200.8	EPA 200.8	250-mL Poly-Metals, HNO3	HNO3	180	250 mL
Arsenic - EPA 200.8	EPA 200.8	250-mL Poly-Metals, HNO3	HNO3	180	250 mL
Silver - EPA 200.8	EPA 200.8	250-mL Poly-Metals, HNO3	HNO3	180	250 mL
Volatile Organic Compounds by P&T and GC/MS in Water					
EPA 524.2 - Volatile Organic Compounds	EPA 524.2	40-mL VOA-524, Ascorbic(25mg), HCl(0.5ml)	<6°C, Ascorbic (If Cl2), HCl, pH<2	14	120 mL

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Title: Flame AA - Lead Analysis

Owner: Andrew Ikeda

APPROVALS

	02/26/2019		02/28/2019
Kamash Ramanathan Regional Laboratory Director, West	Date	Tim Costello Regional Quality Assurance Manager, West	Date

1.0 SCOPE & APPLICATION

1.1 This method is applicable to Paint Chip, Bulk and Wipe sample types.

1.2 Reporting unit options for paint chip and bulk samples are parts per million (ppm), Percentage (%), and milligram per kilogram (mg/kg). Reporting units for wipe samples are Micrograms per square foot ($\mu g/ft^2$).

2.0 SUMMARY

2.1 This method is based on the NIOSH Method 7082 and EPA Method 7000B for Lead Paint Chip, Bulk, and Wipe samples.

2.2 This method describes the digestion and use of Flame AA to obtain lead concentration results for environmental wipe and paint chip and bulk samples.

3.0 DEFINITIONS

3.1 **Analytical Batch** – A group of no more than 20 samples of the same matrix (Wipe Matrix or Paint Chip/Bulk Matrix), which are processed together using the same method, the same lots of reagents, and at the same time or in continuous, sequential time periods. Quality Control samples are not included in the batch count limit of 20 samples.

3.2 **Instrument Calibration Blank (ICB)** – A standard solution of 10% HNO_3 that contains no analyte. The ICB sample is used for initial calibration and for zeroing instrument response. It is run once at the beginning of each analytical batch run.

3.3 **Continuing Calibration Blank (CCB)** – See Instrument Calibration Blank (ICB). The CCB is equivalent to the ICB. The CCB is used to verify blank responses and freedom for carryover. It is run every 10 samples and/or at the end of each analytical batch run.

3.4 **Standard 1 (S1)** – A standard solution of 10% HNO_3 spiked with an aqueous primary source lead standard, to a concentration of 0.5 parts per million (ppm). It is run once at the beginning of each analytical batch run.

3.5 **Standard 2 (S2)** – A standard solution of 10% HNO_3 spiked with an aqueous primary source lead standard, to a concentration of 1.0 parts per million (ppm). It is run once at the beginning of each analytical batch run.

3.6 **Continuing Calibration Verification (CCV)** – See Standard 2. The CCV sample is considered a CCV sample when it is re-run every 10 samples and/or at the end of every analytical batch.

3.7 **Standard 3 (S3)** – A standard solution of 10% HNO_3 spiked with an aqueous primary source lead standard, to a concentration of 2.0 parts per million (ppm). It is run once at the beginning of each analytical batch run.

3.8 **Instrument Calibration Verification (ICV)** – A standard solution of 10% HNO_3 spiked with an aqueous secondary source lead standard, to a concentration of 1.0 parts per million (ppm). It is run once at the beginning of each analytical batch run.

3.9 **Matrix Spike (MS)** – The Matrix Spike Quality Control sample analysis is an environmental sample spiked with a known concentration of lead.

3.10 **Matrix Duplicate (MD)** –For Paint Chip/Bulk sample matrix, the Matrix Duplicate is a separate duplicate preparation of an original client sample. For wipe samples, the entire client wipe sample must be used in the original preparation and therefore cannot be prepped in duplicate.

3.11 **Matrix Spike Duplicate (MSD)** – A duplicate preparation of the Matrix Spike Sample. See Matrix Spike.

3.12 **Laboratory Control Sample (LCS)** – Used to assess general method performance based on the ability of the laboratory to successfully recover target analyte from a control matrix. The LCS is similar in composition to the method blank in that it is an aliquot of analyte-free reagent to which known amounts of the method analytes are added. The LCS helps determine if the system is running properly (i.e. within pre-defined limits). The LCS analysis must be prepared and analyzed for each analytical batch.

3.13 **Reporting Limit Verification (RLV)** – The RLV is the lowest point of quantification (i.e. the lowest concentration on the calibration curve). The RLV is verified by spiking a 10% HNO_3 solution with a known concentration of aqueous lead standard. The RLV is included with the analysis of every analytical batch.

3.14 **Matrix Blank (MB)** – Matrix Blanks are analyzed to assess background interference or contamination that exists in the analytical system that might lead to the reporting of elevated concentration levels or false positive data. The method blank is an interference-free blank matrix of 10% HNO_3 added to powdered paint or an ASTM approved blank wipe. MB results should be below the limit of detection for the target analyte being tested. An MB is included with the analysis of every analytical batch.

4.0 INTERFERENCES

4.1 The most troublesome type of interference in atomic absorption spectrophotometry is usually termed “chemical” and is caused by lack of absorption of atoms bound in molecular combination in the flame. This phenomenon can occur when the flame is not sufficiently hot to dissociate the molecule as in the case of phosphate interference with magnesium, or when the dissociated atom is immediately oxidized to a compound that will not dissociate further at the temperature of the flame.

4.2 Chemical interferences may also be eliminated by separating the metal from the interfering material. Although complexing agents are employed primarily to increase the sensitivity of the analysis, they may also be used to eliminate or reduce interferences.

4.3 The presence of high dissolved solids in the sample may result in interference from nonatomic absorbance such as light scattering. If background correction is not available, a nonabsorbing wavelength should be checked. Preferably, samples containing high solids should be extracted.

4.4 Ionization interferences occur when the flame temperature is sufficiently high to generate the removal of an electron from a neutral atom, giving a positively charged ion. This type of interference can generally be controlled by the addition, to both standard and sample solutions, of a large excess (1,000 PPM) of easily ionized element such as K, Na, Li or Cs.

4.5 Spectral interference can occur when an absorbing wavelength of an element present in the sample but not being determined falls within the width of the absorption line of the element of interest. The results of the determination will then be erroneously high, due to the contribution of the interfering element to the atomic absorption signal. Interference can also occur when resonant energy from another element in a multi element lamp, or from a metal impurity in the lamp cathode, falls within the band pass of the slit setting when that other metal is present in the sample. This type of interference may sometimes be reduced by narrowing the slit width.

4.6 Samples and standards should be monitored for viscosity differences that may alter the aspiration rate.

5.0 SAFETY

5.1 Employees must abide by the policies and procedures in the Corporate Safety Manual and this document.

5.2 Extreme heat is produced during furnace operation. Unit should be allowed to cool before attempting any adjustments on furnace or source lamps.

5.3 Samples that contain high concentrations of carbonates or organic material or samples that are at elevated pH can react violently when acids are added.

5.4 The digested sample is injected onto a graphite surface, which is exposed to high temperature induced by electromagnetic force. This may interfere with pacemakers, hearing aids, and metallic implants.

5.5 The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 EQUIPMENT & INSTRUMENTATION

6.1 Acetylene gas tank

6.2 Air Compressor

6.3 Analytical Balance (accurate to ± 0.1 mg)

6.4 Atomic Absorption Spectrophotometer with an air-acetylene burner head and background correction.

6.5 Centrifuge

6.6 Hot block digester

6.7 Kim Wipes

6.8 Microwave Digestion Apparatus

6.9 Microwave 50ml tube digestion vessel rack

6.10 Metal Microlab Spatula

6.11 Nitrile or Latex Gloves

6.12 Safety Glasses

6.13 Thermometer (Range 110° C)

6.14 500ml polyethylene bottles

6.15 5ml disposable pipettes

6.16 20 – 200µ pipette

6.17 20 – 200µ pipette tips

6.18 10µ pipette

6.19 10µ pipette tips

6.20 Digestion vessels (e.g. 50 ml conical tubes)

6.21 Volumetric flasks

6.22 2 sets of 50g and 0.1g weights

7.0 MEDIA & REAGENTS

7.1 Powdered Paint (Environmental Paint matrix determined to be Lead-Free)

7.2 Deionized (Distilled) water

7.3 Ghost Wipe™ or any wipe that meets all ASTM designation E1792 specifications for sampling materials for lead in surface dust

7.4 Nitric Acid HNO_3, trace metal grade (65%-70% by weight)

7.5 Aqueous 1000ug/ml Lead (Pb) commercial standard (Primary Source)

7.6 Aqueous 1000ug/ml Lead (Pb) commercial standard (Secondary Source)

7.7 Powdered Lead Paint (Environmental Paint matrix determined to have a known concentration of lead)

8.0 SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

8.1 Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance and/or specific contract or client requests. This method does not have any referenced holding time.

9.0 QUALITY ASSURANCE

9.1 Handwritten or verbal changes to Standard Operating Procedures are not allowed.

9.2 The following Quality Control Samples are required:

9.2.1. Instrument Calibration Samples (ICS) – The following samples are undigested Quality Control Samples that are prepped daily or once every 8 hours prior to the first analytical batch run. Alternatively, the ICS samples can be aliquoted from a pre-prepared stock solution on a daily basis or once every 8 hours prior to the first analytical batch run. The Instrument Calibration Blank (ICB) and 3 Standards (S1, S2, and S3) must be analyzed each day to establish a calibration curve with an "r-value" of ≥ 0.995 before the instrument can be considered calibrated. Analysis cannot proceed without a valid instrument calibration documented.

a. Instrument Calibration Blank (ICB) / Continuing Calibration Blank (CCB).

i. 10% HNO_3 solution

- The ICB sample is considered a CCB sample when it is re-run every 10 samples and/or when it is re-run at the end of every analytical batch.

- *Acceptance limits*: Absolute value not more than 50% of the lowest regulatory limit for the sample matrix analyzed or minimum level of concern.

b. Standard 1 (S1)

i. 10% HNO_3 solution spiked, using an aqueous primary source lead standard, to a concentration of 0.5 parts per million (ppm).

c. Standard 2 (S2) / Continuing Calibration Verification (CCV).

i. 10% HNO_3 solution spiked, using an aqueous primary source lead standard, to a concentration of 1.0 parts per million (ppm).

- The S2 samples is considered a CCV sample when it is re-run every 10 samples and/or at the end of every analytical batch.

- *Acceptance limits*: Within ± 20% of the known value.

d. Standard 3 (S3)

i. 10% HNO_3 solution spiked, using an aqueous primary source lead standard, to a concentration of 2.0 parts per million (ppm).

e. Instrument Calibration Verification (ICV)

i. 10% HNO_3 solution spiked using an aqueous **secondary** source lead standard to a concentration of 1.0 parts per million (ppm).

ii. *Acceptance limits*: Within ± 10% of the known value.

9.2.2. Analytical Batch Quality Control Samples – The following samples are separately prepped, digested, and analyzed for each analytical batch.

a. Matrix Spike (MS)

i. Wipe sample Matrix: 10% HNO_3 and ASTM approved blank wipe sample spiked using 0.1g powdered lead paint. The entire client wipe sample from the field must be consumed in analysis and therefore cannot be used as a Matrix Spike.

ii. Paint Chip/Bulk sample Matrix: 10% HNO_3 and ~0.25 g (±0.1mg) of field sample, spiked, using an aqueous **primary** source lead standard, to a concentration of 1 ppm. Powdered paint may be used as an equivalent field sample, particularly when client samples are

too small or difficult to homogenize and split in order to obtain samples for matrix spike evaluation or replicate analysis.

iii. *Acceptance limits*: Within ± 25% of the known value. The Relative Percent Difference (RPD) of the MS and MSD result is expected to be ± 25%. Statistical acceptance and warning limits are calculated for the MS to detect trends (see section 9.8 and 9.9). However, the above static limits are used to determine pass/fail for batches. The statistically calculated acceptance criteria must not exceed the static limits.

b. Matrix Spike Duplicate (MSD) - Prepared in the same manner as the Matrix Spike (MS) sample.

i. Wipe sample Matrix: 10% HNO_3 and ASTM approved blank wipe sample, spiked, using 0.1g (±0.1mg) powdered lead paint.

ii. Paint Chip/Bulk sample Matrix: 10% HNO_3 and ~0.25 g (±0.1mg) of field sample, spiked, using an aqueous **primary** source lead standard, to a concentration of 1 ppm. Powdered paint may be used as an equivalent field sample, particularly when client samples are too small or difficult to homogenize and split in order to obtain samples for matrix spike evaluation or replicate analysis.

iii. *Acceptance limits*: Within ± 25% of the known value. The Relative Percent Difference (RPD) of the MS and MSD result is expected to be ± 25%. Statistical acceptance and warning limits are calculated for the MSD to detect trends (see section 9.8 and 9.9). However, the above static limits are used to determine pass/fail for batches. The statistically calculated acceptance criteria must not exceed the static limits.

c. Matrix Duplicate (MD)

i. Wipe sample Matrix: The entire wipe sample must be used in the original client sample preparation. Therefore, a separate duplicate preparation of a client wipe sample is not possible.

ii. Paint Chip/Bulk sample Matrix: A separate duplicate preparation of the original client sample.

iii. *Acceptance limits*: Within ± 25% Relative Percent Difference (RPD) Statistical acceptance and warning limits are calculated for the MD to detect trends (see section 9.8 and 9.9). However, the above static limit is used to determine pass/fail for batches. The

statistically calculated acceptance criteria must not exceed the static limits.

d. Laboratory Control Sample (LCS)

i. Paint Chip/Bulk sample Matrices ONLY: 10% HNO_3 spiked, using 0.1g (±0.1mg) of powdered lead paint.

ii. *Acceptance limits*: Within ± 20% of the known value. Statistical acceptance and warning limits are calculated for the LCS to detect trends (see section 9.8 and 9.9). However, the above static limits are used to determine pass/fail for batches. The statistically calculated acceptance criteria must not exceed the static limits.

e. Reporting Limit Verification (RLV)

i. Wipe sample Matrix: 10% HNO_3 solution and ASTM approved blank wipe, spiked using an aqueous primary source lead standard, to a concentration of 0.2ppm.

ii. Paint Chip/Bulk sample Matrix: 10% HNO_3 solution and powdered paint, spiked using an aqueous primary source lead standard, to a concentration of 0.2ppm.

iii. *Acceptance limits*: Within ± 20% of the known value.

f. Matrix Blank (MB)

i. Wipe sample Matrix: 10% HNO_3 solution and ASTM approved blank wipe.

ii. Paint Chip/Bulk sample Matrix: 10% HNO_3 solution and ~0.25 g (±0.1mg) powdered paint.

iii. *Acceptance limits:* Is the absolute value not more than 10% of the regulatory limit or the minimum level of concern.

9.3 **Pipettes** need to be verified on a monthly basis following SOP EM-EQ-S-1584 “Calibration and Maintenance of Lab Equipment” and calibrated annually using an ISO 17025 accredited vendor and the calibration certificate needs to include uncertainty of measurement.

9.4 The **Balance** must be verified each day of use following SOP EM-EQ-S-1584 “Calibration and Maintenance of Lab Equipment” using weights calibrated by a 17025 vendor and the calibration certificate needs to include uncertainty of

measurement. Laboratory must have 2 sets of weights. Each set must be certified each year by a 17025 vendor on its calibration due date. The 2 sets will ensure that there is no down time if 1 set is out for calibration. The balance must be calibrated annually using an ISO 17025 accredited vendor and the calibration certificate needs to include uncertainty of measurement.

9.5 Centrifuge Tube Volume Verification

9.5.1. Centrifuge tube volumes must be verified for each new batch obtained from the manufacturer to ensure that the 50ml final volume mark is accurate within 2%. Verification is performed by weight with the use of a 4 sig. fig. balance.
9.5.2. Obtain the “Volumetric Verification” worksheet ,(Doc # EM-EQ-WS-8465)
9.5.3. Obtain 3 centrifuge tubes
9.5.4. Fill out basic information on worksheet (Lot #, Balance S/N, Water source, Date and Initials)
9.5.5. Insert 50ml centrifuge tube into the holder within the balance without its cap
9.5.6. Tare or auto zero the balance with the tube in the holder
9.5.7. Remove the centrifuge tube and use DI water to fill to the 50ml mark on the tube
9.5.8. Ensure that the bottom of the meniscus is at the 50ml mark
9.5.9. Insert the tube back into the holder within the balance
9.5.10. Record the results of the weight onto the worksheet in the “Test (g)” column”
9.5.11. Check to see if results fall within the 2% criteria using the chart on the worksheet
9.5.12. Circle Pass or Fail
9.5.13. Repeat for the next 2 centrifuge tubes
9.5.14. If all three centrifuge tubes are within 2% of the 50 ml mark. The verification passes.

9.6 Reporting Limit – The reporting limit must be set at no less than two times the calculated Method Detection Limit (MDL) and no more than ten times the calculated Method Detection Limit (MDL).

9.6.1. The reporting limit cannot be more than 50% of the national regulatory limit (40 ug/ft2) for Wipe samples.
9.6.2. The reporting limit cannot be more than 20% of the national regulatory limit (5000 mg/kg) for Paint Chip/Bulk samples.

9.7 Method Detection Limits

9.7.1. MDL studies are performed once a year on both wipe and paint chip/bulk matrices.
9.7.2. The analyst must prepare at least 7 replicate spikes and all replicates must be reported. To save time and effort, it is particularly important to review prior MDL studies before selecting spike concentrations.

9.7.3. Each of the replicate spikes are extracted or digested in the same manner as samples. Routine cleanup steps are included as well as QC samples.

9.7.4. If any replicates are not detected, the detection limit study is invalid and should be repeated at a higher concentration.

9.7.5. The standard deviation of the 7 replicates is multiplied by the student t value of 3.143 to determine the MDL.

9.8 Acceptance Limits/Warning Limits for Trending Analysis

9.8.1. Matrix Spike (MS), Matrix Spike Duplicate (MSD), and Laboratory control Sample (LCS).

a. The data set used for matrix spike (MS), matrix spike duplicate (MSD), and laboratory control sample (LCS) is the percentage recovery of the spiked sample to the true value using at least twenty samples.

b. Acceptance Limits are set at the mean of the data set ± 3 times the standard deviation

c. Warning Limits are set at the mean of the data set ± 2 times the standard deviation.

9.8.2. Matrix Duplicate (MD)

a. The data set used for matrix duplicate (MD) is the percentage relative percent difference (% RPD) of the original and matrix duplicate sample using at least twenty pairs of samples.

b. Acceptance Limits are set at the mean of the data set ± 3 times the standard deviation

c. Warning Limits are set at the mean of the data set ± 2 times the standard deviation.

9.9 Control Charts and Trends – The laboratory must control chart all LCS, MS, MSD to determine trends. If any of the trends listed below is observed a root cause analysis and corrective action must be performed to address the trend.

9.9.1. One data point is outside the acceptance limits

9.9.2. Two consecutive data points are outside warning limits

9.9.3. Five consecutive data points are ascending above the mean or descending below the mean.

9.9.4. Seven consecutive data points either below or above the mean.

9.10 An **Initial Demonstration of Capability (IDOC)** must be completed for each analyst every six months. The IDOC must consist of the Completion of four Independent test runs of sample preparation and instrument analysis. Results must be ± 20% of the certified value for 75% of analysis.

9.11 A maintenance log is required to document all maintenance of the instrument. The log shall include descriptions of the problem or service, dates and types of repair, organization and person performing repair, and contact phone number shall be recorded.

9.11.1. A vendor work order can be attached to the log if all required fields are complete.

9.12 All logs that include calculations, specifically calibration logs must be reviewed by a second analyst.

10.0 PROCEDURE

10.1 Client Sample Preparation

10.1.1. Separate all samples into Analytical Batches (see **Definitions**: Analytical Batch).

10.1.2. Label a digestion vessel for each sample with a printed sample label. Alternatively, the digestion vessel can be labeled with an indelible marker indicating the EMLab ID number and the unique sample id number.

10.1.3. Paint Chip/Bulk Matrix samples must be weighed to the nearest 0.1 milligrams.

a. For Paint Chip samples, attempt to remove any non-paint matrix material from the sample.

b. For Bulk samples (samples with no observable paint layer), attempt to obtain a representative portion of the bulk sample including all observable layers.

c. Using gloved fingertips, homogenize the sample by breaking, tearing or grinding the paint/bulk into small pieces.

d. Weigh approximately 0.25 grams of the homogenized paint chip or bulk sample into the labeled digestion vessel. Reject the sample if less than 0.025 grams of material available.

i. When less than 0.025 grams of material available, task the Project manager to inform client that the sample cannot be processed.

e. In a chemical fume hood, add 5ml of concentrated Nitric Acid (70% by weight) to each prepped sample digestion vessel.

f. Stir the sample by swirling the digestion vessel as the reaction settles, then loosely cap the digestion vessel.

10.1.4. Wipe Matrix samples:

a. Add the entire wipe sample into the labeled digestion vessel.

b. In a chemical fume hood, add 2ml of concentrated Nitric Acid (70% by weight) to each prepped sample digestion vessel.

c. Stir the sample by swirling the digestion vessel as the reaction settles. Note: The reaction will be violent as the wipe sample reacts to the acid. Adding only 2ml of concentrated Nitric Acid initially ensures the reaction does not overflow the digestion vessel.

d. Add the remaining 3ml of concentrated Nitric Acid once the reaction settles.

e. Loosely cap the digestion vessel.

10.1.5. Choose a digestion method:

a. Hot Block digestion method

i. Place samples into Hot Block digester (100 ±5°C) inside a fume hood for approximately 1 hour.

b. Microwave digestion method

i. Place samples into rotating turntable units segregated by matrix type.

ii. Program the Microwave device with the following settings:

- Power Level – 35%
- Run Time – 3 Minutes
- Setting Type – Open Beaker

iii. Place the rotating turntable unit with the samples into the microwave, securely close the door, and start the microwave cycle.

iv. When the cycle is complete, allow the samples to cool before handling.

v. Place the samples in fume hood and remove the caps to allow the samples to vent.

10.1.6. Dilute each digested sample to 50ml with DI water and centrifuge each sample for approximately 2 minutes at 2000 Revolutions per Minute (RPM).

10.2 Sample Analysis

10.2.1. Turn on the Flame AA instrument

a. Turn on the air compressor and check that it is running at 100psi.

b. Open the primary valve on the acetylene tank and check that it is running at greater than 85psi.

c. Open the secondary valve on the acetylene tank and check that it is running at no more than 15psi.

d. Ensure that the burner head is aligned.

e. Turn on instrument lamp. Allow at least 15 minutes for the lamp to warm up prior to aspirating any samples.

10.2.2. Start the instrument software and create the Method Profile for the following Instrument Calibration Samples (ICS) using the below referenced labeling sample codes. The Method Profile can be re-used for each analytical batch run performed that day.

a. Instrument Calibration Blank – Labeled as ICB

b. Standard 1 – Labeled as S1

c. Standard 2 – Labeled as S2

d. Standard 3 – Labeled as S3

10.2.3. In the instrument software program create an Analytical Batch Profile. Each Analytical Batch Profile must be uniquely created for each analytical batch run. The Analytical Batch Profile should be set in the following sample order using the below referenced labeling sample codes:

a. Matrix Spike – Labeled as MS

b. Matrix Spike Duplicate – Labeled as MSD

c. Instrument Calibration Verification – Labeled as ICV

d. Reporting Limit Verification – Labeled as RLV

e. Matrix Blank – Labeled as MB

f. Laboratory Control Sample – Labeled as LCS (Paint Chip/Bulk Matrix ONLY)

g. Client sample 1 – Labeled using the client sample id (e.g. 1)

h. Matrix Duplicate – Labeled as MD followed by the original client sample id (e.g. MD-1).

i. Client sample/s 2-10 (if applicable) – Labeled using the client sample id.

j. Continuing Calibration Verification – Labeled as CCV.

k. Continuing Calibration Blank – Labeled as CCB

l. Client sample/s 11-20 (if applicable) – Labeled using the client sample id

m. Continuing Calibration Verification – Labeled as CCV.

i. If less than 11 samples in the analytical batch then this second CCV sample is not necessary.

n. Continuing Calibration Blank – Labeled as CCB.

i. If less than 11 samples in the analytical batch then this second CCB sample is not necessary.

10.2.4. Once the lamp has had at least 15 minutes to warm up, ignite the burner head acetylene flame on the Flame AA instrument.

10.2.5. Run the instrument on continuous mode which reads aspirated samples according to Absorbance Level units.

a. Briefly aspirate ICS sample S2 (Standard 2) to ensure valid Absorbance Level results are being obtained. If Absorbance Levels are invalid evaluate causes and make all necessary adjustments before proceeding.

b. Briefly aspirate each client sample to determine if dilutions are necessary.

c. Dilutions are necessary when the Absorbance Level result of a client sample is greater than the Standard 3 Absorbance Level. Dilute client samples according to the following steps:

i. Record the Absorbance Level of the Standard 2 sample on the client sample digestion vessel.

ii. Record the Absorbance Level of the Client sample requiring dilution on the digestion vessel.

iii. Divide the Absorbance Level of the client sample by the Absorbance Level of the Standard 2 sample to obtain the dilution factor by weight in grams.

- For example, given a client sample Absorbance level of 0.8 and a Standard 2 Absorbance Level of 0.02, the dilution factor required for the client sample would be 0.8/0.02 = 40 or a 1:40 gram dilution.

- Client samples with a calculated dilution factor greater than or equal to 50 will require additional dilutions.

iv. Label a new digestion vessel for the diluted client sample.

v. Using a pipette weigh 1 gram weight by volume of the original client sample to the nearest 0.01 grams.

vi. Add sufficient 10% HNO3 Solution to achieve the final calculated dilution factor in grams. For example, given a 1:40 gram dilution, ~39 grams of 10% HNO3 solution would need to be added to 1 gram of client sample.

10.2.6. Run the Method Profile and aspirate each sample in the designated order.

10.2.7. Run the Analytical Batch Profile and aspirate each sample in the designated order.

10.2.8. Save the final instrument results obtained from the Method and Analytical Batch Profiles and store electronically in a secure server filing system. Name each batch file by the LabServe Batch ID number.

10.2.9. Transcribe relevant sample preparation details and instrument result values into the LabServe terminal database. The Lead Bench Spreadsheet (Doc # EM-BC-WS-8450 and/or Doc # EM-BC-WS-8451) can be used as a temporary alternative to the LabServe terminal database if the internet or Network LIMS system is inoperable.

11.0 CALCULATIONS

11.1 Paint Chip/Bulk – (Mean Concentration (ppm) x Final Amount (ml) / Sample Weight (g)) x Dilution = mg/kg (which is equivalent to ppm).

11.2 Paint Chip/Bulk – ((Mean Concentration (ppm) x Final Amount (ml) / Sample Weight (g)) x Dilution) / 10,000 = Percentage (%).

11.3 Wipes - (Mean Concentration (ppm) x Final Amount (ml) / Area (ft^2)) x Dilution = µg/unit

12.0 METHOD PERFORMANCE

12.1 Employees must abide by the training policies and procedures in the Quality Assurance Manual, SOP EM-AD-S-1646 "General Training" and this document. This method has been determined to be fit for its intended use.

13.0 POLLUTION CONTROL & WASTE MANAGEMENT

13.1 It is EMLab P&K's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantities needed, preparation of reagents based on anticipation usage and reagent stability).Employees must abide by the policies in Section 13 of the Corporate Environmental Health and Safety Manual for "Waste Management and Pollution Prevention."

14.0 REFERENCES/CROSS-REFERENCES

14.1 Volumetric Verification Worksheet (Doc # EM-EQ-WS-8465)

14.2 Lead Bench Spreadsheet (Doc # EM-BC-WS-8450 and/or Doc # EM-BC-WS-8451)

14.3 NIOSH 7082 (Doc # EM-BC-R-8457)

14.4 EPA Method 7000B (Doc #EM-BC-R-8458)

14.5 Laboratory Quality System Requirements (LQSR) Doc# EM-BC-R-8459

15.0 METHOD MODIFICATIONS

15.1 N/A

16.0 ATTACHMENTS

16.1 N/A

17.0 REVISION HISTORY

17.1 Revision 00, August 2016.

17.1.1. Original issue.

17.2 Revision 01, October 2016.

17.2.1. Added ppm as a final reporting unit and the calculations to determine final concentration.
17.2.2. Changed method reference form EPA method 7420 to EPA method 7000.
17.2.3. Added Analytical balance to the equipment list.
17.2.4. Updated acceptance limits for ICB, MS, MSD and MD.
17.2.5. Added acceptance limits for ICV and CCV.
17.2.6. Added document control numbers for worksheets.

17.3 Revision 02, November 2016.

17.3.1. Updated the MS, MSD MD and LSC acceptance criteria in sections 9.2.2.a.iii, 9.2.2.b.iii, 9.2.2.c.iv and 9.2.2.d.ii.
17.3.2. Added pipette verification and calibration procedure in section 9.3
17.3.3. Added balance verification and calibration procedure in section 9.4
17.3.4. Added centrifuge tube volumetric verification procedure in section 9.5
17.3.5. Added reporting limit requirement in section 9.6
17.3.6. Added MDL procedures in section 9.7
17.3.7. Added acceptance limit calculation procedure in section 9.8
17.3.8. Added Control Charting and trending requirements in section 9.9
17.3.9. Added IDOC requirements in section 9.10
17.3.10. Revised dilution water from DI water to 10% HNO3 in DI Water in section 10.2.5.vi
17.3.11. The statement “This method has been determined to be fit for its intended use” has been added to section 12.1

17.4 Revision 03, December 2016.

17.4.1. Updated the MS and MSD definition in section 3.9 and updates the procedure to include client samples if possible in sections 9.2.2.a and 9.2.2.b.
17.4.2. Updated the procedure to determine the reporting limit for paint samples in section 9.6.2

17.4.3. Updated the method duplicate sample acceptance criteria in section 9.8.2

17.5 Revision 04, December 2016.

17.5.1. Updated the method duplicate sample acceptance limits in section 9.2.2.c.iii
17.5.2. Clarified the matrix spike, matrix spike duplicate and laboratory control sample acceptance criteria for trending in section 9.8.1.
17.5.3. Updated the method duplicate sample acceptance criteria for trending in section 9.8.2
17.5.4. Up the IDOC requirements in section 9.10

17.6 Revision 05, June 2017.

17.6.1. Added the bulk sample type to sections 1.0, 2.0, 9.6.2, 10.1.3, 11.1 and 11.2.
17.6.2. Updated the matrix spike requirements in sections 3.9 and 9.2.2.a
17.6.3. Updated the matrix spike duplicate requirements in section 9.2.2.b
17.6.4. Updated the matrix duplicate requirements in sections 3.10 and 9.2.2.c
17.6.5. Updated the method blank requirements in sections 3.14 and 9.2.2.f
17.6.6. Updated the laboratory control sample requirements in section 9.2.2.d
17.6.7. Updated the reporting limit verification requirements in section 9.2.2.e
17.6.8. Added Powdered paint and powdered lead paint to media and reagent sections 7.1 and 7.7
17.6.9. Updated dilution pipette weight in section 10.2.5
17.6.10. Revised procedure for instrument data storage in section 10.2.8
17.6.11. Added the LabServe data entry procedure to section 10.2.9
17.6.12. Added volumetric verification worksheet and the LQSR to reference sections 14.1 and 14.5.
17.6.13. Added control document references to all documents in section 14.0

17.7 Revision 06, February 2019.

17.7.1. Updated and added equipment to the Equipment section. See sections 6.14, 6.15, 6.17, 6.18, 6.19, 6.21 and 6.22.
17.7.2. Updated balance calibration requirement in section 9.11
17.7.3. Added requirement for secondary review of logs in section 9.12.

ATTACHMENT 6

Laboratory Quality Assurance Manuals and Certifications

Quality Assurance Manual Cover Page

Eastern Region	Western Region	
MARLTON **(ML)** 3000 Lincoln Drive East, Suite A Marlton, NJ 08053	NORTH PHOENIX **(PX)** 1501 W. Knudsen Dr. Phoenix, AZ 85027	SOUTH SAN FRANCISCO**(SSF)** 6000 Shoreline Court Suite 205 South San Francisco, CA 94080
FLORIDA **(FL)** 6301 NW 5th Way, Ste. 1410 Ft. Lauderdale, FL 33309	HOUSTON **(HS)** 10900 Brittmoore Park Dr., Suite G, Houston, TX 77041	IRVINE **(IV)** 17461 Derian Ave. Suite 100 Irvine, CA. 92614
VIRGINIA **(VA)** 3929 Old Lee Highway, Unit 91C Fairfax, VA 22030	DENVER **(DE)** 4955 Yarrow St. Arvada, CO 80002	SACRAMENTO **(SA)** 880 Riverside Parkway West Sacramento, CA 95605
CHICAGO **(CH)** 1815 W. Diehl Rd. Suite 800 Naperville, IL 60563	LAS VEGAS. **(LV)** 6100 Mountain Vista St. Suite 160 Las Vegas, NV 89014	NORTH SEATTLE **(SE)** 19515 North Creek Pkwy N. Suite 100 Bothell, WA 98011
ATLANTA **(AT)** 6500 McDonough Dr. Suite C-10 Norcross, GA 30093	GLENDALE **(GL)** 1010 N Central Avenue Ste. 420, Glendale, CA 91202	SAN DIEGO **(SD)** 8304 Clairemont Mesa Blvd., Ste. 103, San Diego, CA 92111

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Quality Assurance Manual
Approval Signatures

Western and Central Regional Laboratory Director – Kamash Pillai — 5/17/2018 Date

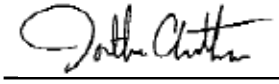
Eastern Regional Laboratory Director - Michael Berg — 5/17/2018 Date

Western Regional Quality Manager - Tim Costello — 5/21/2018 Date

Central Regional Quality Manager - Dan Shelby — 5/22/2018 Date

Eastern Regional Quality Manager - Claudia Palermo — 5/21/2018 Date

Technical Manager, **(Marlton)** – Ariunaa Jalsrai — 5/22/2018 Date



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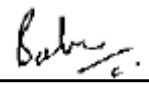
Technical Manager, **(Fairfax)** – Francina Thadigiri — 5/23/2018 Date



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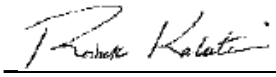
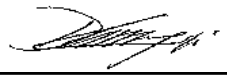
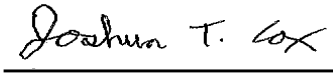


Technical Manager, **(Glendale)** – Roshanak Kalantari — 5/24/2018 Date

	5/22/2018
Technical Manager, **(Houston)** – Magzoub Ismail	Date
	5/22/2018
Technical Manager, **(Irvine)** – Danny Li	Date
	5/22/2018
Laboratory Manager, **(Phoenix)** – Joshua Cox	Date
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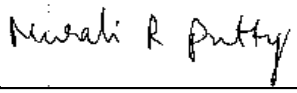
Technical Manager, **(Sacramento)** – Joyce Van Ommen	Date
	5/22/2018
Technical Manager, **(South San Francisco)** - Murali Putty	Date
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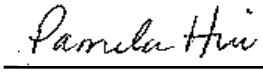
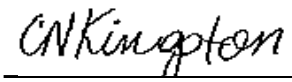
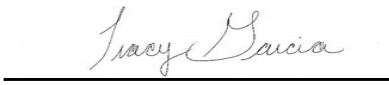
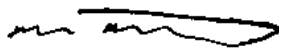
Technical Manager, **(South San Francisco)** - Amin Suliman	Date
	5/22/2018
Technical Manager, **(San Diego)** - Pamela Hui	Date
	5/24/2018
Technical Manager, **(North Seattle)** - Justin Ford	Date
	5/22/2018
Technical Manager, **(Las Vegas)** - Charlene Kingston	Date
	5/23/2018
Technical Manager, **(Atlanta)** - Tracy Garcia	Date
	5/22/2018
Technical Manager, **(Denver)** - Noah Lazarte	Date

SECTION 2. TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

REFERENCED CORPORATE SOPs AND POLICIES

SOP / Policy Reference	Title
CA-I-P-002	Electronic Reporting and Signature Policy
CA-L-P-002	Contract Compliance Policy
CW-L-S-004	Subcontracting ~~Procedures~~
CA-Q-M-002	Corporate Quality Management Plan
CA-Q-S-001	Solvent and Acid Lot Testing and Approval
CA-Q-S-002	Acceptable Manual Integration Practices
CA-Q-S-006	Detection Limits
CA-Q-S-009	Root Cause Analysis
CA-T-P-001	Qualified Products List
CW-E-M-001	Corporate Environmental Health & Safety Manual
CW-F-P-002	Company-Wide Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CW-F-S-007	Capital Expenditure, Controlled Purchase Requests and Fixed Asset Capitalization
CW-L-P-004	Ethics Policy
CW-L-S-002	Internal Investigation
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CW-Q-S-003	Internal Auditing
CW-Q-S-004	Management Systems Review
CW-Q-S-005	Data Recall Process
CA-C-S-001	Work Sharing Process

REFERENCED LABORATORY SOPs

SOP Reference	Title
EM-QA-S-2059	Document Control & Updating (Document Control and Control of Records, Sec. 3.4.1)
EM-CS-S-1709	Complaint Resolution (Resolving Client Concerns and Soliciting Client Feedback, Sec .10.1)
EM-QA-S-2059	Data Scanning (Document Control and Control of Records – Sec. 14.1.4)
EM-AD-S-1646 EM-AD-S-1261	Lab Training (General Training, Asbestos Analysis Training, Sec. 17.3)
EM-QA-S-2059	Writing SOPs (Document Control and Control of Records, Sec. 19.2)

EM-AD-S-1646 EM-AD-S-3548 EM-AD-S-1619	DOCs (General Training, Selection and Validation of Analytical Methods, Nonstandard Methods for Analysis Sec. 19.4.2)
EM-QA-S-1994 EM-QA-S-1259	MDLs (Quality Control for Sample Analysis, Quality Control for Asbestos Analysis, Sec. 19.7)
EM-AD-S-1601 EM-AD-S-1884	MI (Laboratory Service Management, QAzilla and LabServe Enhancement Procedure, Sec. 19.14.1)
EM-SM-S-1288 EM-SM-S-1993	Sample Receipt / Login, etc… (Sample Receiving, Sample Log In, Sec. 23.2.1.3)

SECTION 3. INTRODUCTION, SCOPE AND APPLICABILITY

3.1 Introduction and Compliance References

EMLab P&K's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving EMLab P&K's, as well as TestAmerica's, data quality goals. The EMLab P&K network of laboratories maintains a local perspective in its scope of services and maintains a national perspective in terms of quality and client relations.

The QAM has been prepared to assure compliance with The NELAC Institute (TNI) Standard, dated 2009, Volume 1 Modules 2 and 4, and ISO/IEC Guide 17025:2005(E). 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. It 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:

- ANSI/ASQC, E4-1994, "Specifications and Guidelines for Quality Management Systems for Environmental Data Collection and Environmental Technology Programs" (American National Standard, January 5, 1995, or most recent version)
- "EPA Requirements for Quality Management Programs" (QA/R-2) (EPA/240/B-01/002, May 31, 2006).
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* EPA, March 1979.
- *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; Final Update V, August 2015.*
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005) (DW labs only)*

- APHA, *Standard Methods for* the Examination of Water and Wastewater, 18th Edition, 19th, 20th, 21st, 22nd , and on-line Editions.
- Marine Protection, Research, and Sanctuaries Act (MPRSA).
- Toxic Substances Control Act (TSCA).
- AIHA-LAP, LLC Accreditation Policy Modules
- NIST NVLAP Handbook 150 and 150-3

3.2 Terms and Definitions

A Quality Assurance 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 (i.e. CA-ELAP, TCEQ, NYS DOH, etc.), as well as applicable accrediting bodies. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. 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, but are not limited to, air, potable and non-potables water, bulks, wipes, swabs, dust, soils, etc. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for physical and biological parameters. The Program also contains guidelines on 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 to all EMLab P&K clients. Analytical techniques include, but are not limited to:

- Culturable Air Analysis for fungi and bacteria
- Non-culturable Analysis-Spore Traps for fungal analysis and direct examination for fungal analysis
- Bulk Sample analysis for fungal and bacterial analysis
- Environmental water analysis
- Quantitative culturable analysis for bulks, dusts, swabs, and other samples
- Coliform screening, Sewage clearance, and Sewage Assessment
- Identification of Molds, Bacteria, Legionella, and Yeasts
- Microbiological analysis for Drinking Water
- Materials Testing
- Analysis of machining fluids for microbial organisms

- Asbestos analysis of bulk and air samples
- Allergen testing for cat, dog, dust mites, cockroach, rat, mouse and mold allergens.
- Pollen Identification and Differentiation.
- Lead analysis of paint chips and wipes.

The specific list of test methods used by the laboratory can be found **in LabServe Services List.** Additional information, such as facility specific scopes of accreditation, may be found on the EMLab P&K, LLC website.
The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet these requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) 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 and the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and the QA Manager must determine if it is in the lab'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 Corporate Quality Management Personnel to assure that it remains in compliance with Section 3.1. This manual itself is reviewed annually by senior laboratory management, Quality Assurance Managers, and facility Technical Managers 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 revised sections of the document. All updates will be reviewed by the senior laboratory management staff, Quality Assurance Managers and facility Technical Managers. The laboratory updates and approves such changes according to our Document Control & Updating procedures (refer to SOP No. EM-QA-S-2059).

SECTION 4. MANAGEMENT REQUIREMENTS

4.1 Overview

EMLab P&K, LLC is a TestAmerica Company operating under joint ownership with TestAmerica Environmental Laboratories. The organizational structure, responsibilities and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., President and Chief Executive Officer (CEO), Chief Operating Officer (COO), Executive Vice President (VP) Operations, Corporate Quality, etc.). The laboratory operational and support staff of each EMLab P&K facility work under the direction of a Regional Laboratory Director. The organizational structure for both Corporate TestAmerica & the EMLab P&K network is presented in Figure 4-1.

4.2 Roles and Responsibilities

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance 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 EMLab P&K laboratory network.

4.2.2 President and Chief Executive Officer (CEO)

The President and CEO is a member of the Board of Directors and is ultimately responsible for the quality and performance of all TestAmerica facilities. The President and CEO establishes the overall quality standard and data integrity program for the Analytical Business, providing the necessary leadership and resources to assure that the standard and integrity program are met.

4.2.3 Chief Operation Officer (COO)

The COO reports directly to the President and CEO of TestAmerica. The COO~~VPO~~ oversees the operations of all TestAmerica laboratories and the EMLab P&K business unit. The VP's of Operations report directly to COO

4.2.4 Vice President of Operations

Each VP of Operations reports directly to the Executive VP of Operations and is a part of the Executive Committee. Each VP of Operations is responsible for the overall administrative and operational management of their respective laboratories. The VP's responsibilities include allocation of personnel and resources, long-term planning, goal setting, and achieving the financial, business, and quality objectives of TestAmerica. The VP's ensure timely compliance with Corporate Management directives, policies, and management systems reviews. The VP's are also responsible for restricting any laboratory from performing analyses that cannot be consistently and successfully performed to meet the standards set forth in this manual.

4.2.5 Vice President of Quality and Environmental Health and Safety (VP-QA/EHS)

The Vice President (VP) of QA/EHS reports directly to the President and CEO. With the aid of the Executive Committee, Laboratory Directors, Quality Directors, Safety Manager, EH&S Coordinators and QA Managers, the VP-QA/EHS has the responsibility for the establishment, general overview and Corporate maintenance of the Quality Assurance and EH&S Programs within TestAmerica. Additional responsibilities include:

- Review of QA/QC and EHS aspects of Corporate SOPs & Policies, national projects and expansions or changes in services.
- Work with various organizations outside of TestAmerica to further the development of quality standards and represent TestAmerica at various trade meetings.
- Preparation of a monthly report that includes quality metrics across the analytical laboratories and a summary of any quality related initiatives and issues.
- Preparation of a monthly report that includes EH&S metrics across the analytical laboratories and a summary of any EH&S related initiatives and issues.
- Work with various organizations outside of TestAmerica to further the development of quality standards and represent TestAmerica at various trade meetings.
- With the assistance of the Corporate Senior Management Teams and the EHS Directors, development and implementation of the TestAmerica Environmental, Health and Safety Program.

4.2.6 Vice President of Client Service

The VP of Client Services leads the Client Service Organization (CSO) and is responsible for client satisfaction, driving operational excellence and improving client responsiveness. The VP provides direction to the Client Service Directors, Programs Managers and Project Managers.

4.2.7 Quality Assessment Director

The Quality Assessment Director reports to the VP-QA/EHS. The Quality Assessment Director has QA oversight of laboratories; responsible for the internal audit system, schedule and procedure; monitors laboratory internal audit findings; identifies common laboratory weaknesses; and monitors corrective action closures. Together with the Quality Compliance Director, the Quality Systems Director, and the VP-QA/EHS, the Quality Assessment Director has the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within TestAmerica.

4.2.8 Quality Compliance Director

The Quality Compliance Director reports to the VP-QA/EHS. The Quality Compliance Director has QA oversight of laboratories; monitors and communicates DoD / DoE requirements; develops corporate tools for ensuring and improving compliance; develops corporate assessment tools; identifies common laboratory weaknesses; and monitors corrective action closures. Together with the Quality Assessment Director, Quality Systems Director and the VP-QA/EHS, the Quality Compliance Director has the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within TestAmerica.

4.2.9 Quality Systems Director

The Quality Systems Director reports to the VP-QA/EHS. The Quality Systems Director has QA oversight of laboratories; develops quality policies, procedures and management tools; monitors and communicates regulatory and certification requirements; identifies common laboratory weaknesses; and monitors corrective action closures. Together with the Quality Assessment Director, Quality Compliance Director and the VP-QA/EHS, the Quality Systems Director has

the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within TestAmerica.

4.2.10 Quality Information Manager

The Quality Information Manager is responsible for managing all company official documents (e.g., Policies, Procedures, Work Instructions), the company's accreditation database, intranet websites, external laboratory subcontracting, regulatory limits for clients on the company's TotalAccess website; internal and external client support for various company groups (e.g., Client Services, EH&S, Legal, IT, Sales) for both quality and operational functions. The Quality Information Manager reports to the VP-QA/EHS; and works alongside the Quality Assessment, Quality Compliance and Quality System Directors and EHS Managers to support both the Analytical Quality Assurance and EHS Programs within TestAmerica.

4.2.11 Technical Services Director

The Technical Services Director is responsible for establishing, implementing and communicating TestAmerica's Analytical Business's Technical Policies, SOPs, and Manuals. Other responsibilities include conducting technical assessments as required, acting as a technical resource in national contracts review, coordinating new technologies, establishing best practices, advising staff on technology advances, innovations, and applications.

4.2.12 Ethics and Compliance Officers (ECOs)

TestAmerica has designated two senior members of the Corporate staff to fulfill the role of Ethics and Compliance Officer (ECO) – Corporate Counsel & VP of Human Resources and the VP-QA/EHS. Each ECO acts as a back-up to the other ECO and both are involved when data investigations occur. Each ECO has a direct line of communication to the entire senior Corporate and lab management staff.

The ECOs ensure that the organization distributes the data integrity and ethical practices policies to all employees and ensures annual trainings and orientation of new hires to the ethics program and its policies. The ECO is responsible for establishing a mechanism to foster employee reporting of incidents of illegal, unethical, or improper practices in a safe and confidential environment.

The ECOs monitor and audit procedures to determine compliance with policies and to make recommendations for policy enhancements to the President and CEO, VPOs, Laboratory Director or other appropriate individuals within the laboratory. The ECO will assist the laboratory QA Manager in the coordination of internal auditing of ethical policy related activities and processes within the laboratory, in conjunction with the laboratories regular internal auditing function.

The ECOs will also participate in investigations of alleged violations of policies and work with the appropriate internal departments to investigate misconduct, remedy the situation, and prevent recurrence of any such activity.

4.2.13 Chief Information Officer (CIO)

The CIO is responsible for establishing, implementing and communicating TestAmerica's Information Technology (IT) Policies, SOPs and Manuals. Other responsibilities include coordinating new technologies, development of electronic communication tools such as TestAmerica's intranet and internet sites, ensuring data security and documentation of software, ensuring compliance with the NELAC standard, and assistance in establishing, updating, and maintaining Laboratory Information Management Systems (LIMS) at the various TestAmerica facilities.

4.2.14 Environmental Health and Safety Managers (Corporate)

The EHS Managers report directly to the VP-QA/EHS. The EHS Managers are responsible for the development and implementation of the TestAmerica Environmental, Health and Safety program. Responsibilities include:

- Consolidation and tracking all safety and health-related information and reports for the company, and managing compliance activities for TestAmerica locations.
- Coordination/preparation of the corporate Environmental, Health and Safety Manual Template that is used by each laboratory to prepare its own laboratory-specific Safety Manual/ CHP.
- Preparation of information and training materials for laboratory EHS Coordinators.
- Assistance in the internal and external coordination of employee exposure and medical monitoring programs to insure compliance with applicable safety and health regulations.
- Serving as Department of Transportation (D.O.T.) focal point and providing technical assistance to location management.
- Serving as Hazardous Waste Management main contact and providing technical assistance to location management.

4.3 General Manager

4.3.1 Job Summary

The General Manager (GM), reporting to the COO, provides comprehensive management of all technical, business and administrative activities for a group of labs. Provides support to the laboratory management at all business units and is responsible for the overall performance and viability of the lab's profitability. The GM is also responsible for generating positive operating margin and growing revenues for the company at the business unit level by supporting business and market strategy plans.

- Manages labs in accordance with business plan and analyzes financial performance to meet the business objectives.
- Monitors progress of business units toward objectives and key performance indicators (KPI's) to improve financial performance, customer service and revenue growth daily.
- Provides weekly and monthly reports to management to ensure that goals and objectives are being achieved and to recognize opportunities for development.
- Conducts supervisory responsibilities with direct reports to foster and maintain strong staff performance.
- Prepares annual capital and operating budgets for business units yearly to meet financial goals and objectives.

- Responsible for establishing new business developments and additive growth to meet financial objectives.
- Facilitates local and company-wide initiatives and activities weekly to promote cooperation and consistency across their group and the company.
- Communicates with employees daily concerning objectives, company direction and expectations to create a positive work environment and improve staff performance.
- Supports all company policies and procedures daily to ensure compliance with standard operating procedures (SOP's).
- Meets with clients on a regular basis to evaluate lab performance and respond to changing customer requirements
- Reviews audit findings and ensures corrective actions are taken as needed to maintain compliance.
- Assists laboratory management personnel with operational issues including contract negotiations, sales and service issues, customer relations, and key proposals in order to ensure smooth operating systems and meet customer needs.
- Participates in corporate and group lab meetings to support key TestAmerica initiatives and provide supervision at remote facilities.

4.4 Regional Director

4.4.1 Job Summary

The Regional Directors are responsible for overseeing the analytical operations of the EMLab P&K, LLC laboratories in their region. EMLab P&K, LLC's laboratories are grouped by geographical regions (see cover page). These positions represent the analytical departments in corporate planning and implementation of policies. This includes assuring the quality of all processes through training and placement of departmental personnel in key roles and coordination of department activities with other corporate departments and assuring the smooth flow of work on a daily basis. The Regional Director directly or indirectly manages their client service personnel who are the contacts for clients regarding analytical services and advice. The Regional Director will work closely with the General Manager in monitoring, reviewing and directing laboratory personnel through the individual Regional Managers and Supervisors. The Regional Directors are also responsible for implementing the safety policies for their facilities.

Specific Job Responsibilities Overall responsibility for the operation of the analytical laboratories in their region

- Coordinates and supervises all activities related to EMLab P&K, LLC analytical processes
- Implements any Corrective Actions in the laboratory regarding analytical procedures or processes
- Represents analytical services in corporate planning and vision
- Develops new and alternate analytical services
- Oversees training programs
- Performs periodic reviews of their direct staff and oversees evaluation of analyst and/or laboratory technician performance and provides written feedback regarding performance
- Reviews analytical methods on an biennial basis
- Ensures that the EHS program is enforced and the EHS Manual is implemented in the facilities under their control (ref. EHSM Section 2.4).
- Responsible for training and support issues in region

- Responsible for ensuring adherence to written SOPs and company policies
- Can act as the AIHA Technical Manager or NVLAP Approved Signatory if approved by respective regulatory agency.
- **Departmental Relations**
- Reports directly to the General Manager.
- Works directly with the Quality Assurance Manager to ensure accuracy and precision of all analytical results
- Works with managers to coordinate implementation of corporate policies
- Works with departmental staff to implement departmental policies
- **Qualifications (Minimum)**
- An earned life science degree, minimally at the baccalaureate level and a minimum of two years of full time equivalent documented relevant environmental microbiological work experience (mycological and/or bacteriological) and/or an earned physical or biological science degree, minimally at the baccalaureate level.
- The individual must be familiar with indoor air quality, bacteriological sampling and analytical methodology.

4.5 Quality Assurance (QA) Manager or Designee

4.5.1.1 The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system.

The QA Manager reports directly to the Laboratory Director and their Corporate Quality Director. 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 quality assurance related items.

4.5.1.2 Job Summary

The Quality Assurance Managers are responsible for establishing and maintaining the integrity of the EMLab P&K, LLC Quality Assurance program. The Quality Assurance Managers work with all other management and supervisory staff to research and maintain all required accreditations and certifications and to provide leadership to analytical and support staff. The Quality Assurance Managers are responsible for disseminating the information contained in the Quality Assurance Manual to all laboratory employees. The Quality Assurance Managers are responsible for keeping current on all issues regarding quality control procedures and literature. Quality Assurance Managers may act as signatory for technical documents and quality assurance programs.

Specific Job Responsibilities

- Implements and oversees the EMLab P&K, LLC Quality Assurance program for the main laboratories and satellite laboratories (microlabs).
- Maintains and updates the Quality Assurance Manual.
- Maintains all quality control statistical data and other quality control documentation.
- Annually audits the Quality Assurance program, reporting procedures, and other documentation at each laboratory in their region.
- Serves as the AIHA-LAP, LLC Quality Assurance Manager.
- Works with supervisors to review, develop, and implement appropriate QA steps throughout process flow to ensure high quality of work and reasonable documentation.

- Assesses and implements requirements for current ISO 17025:2005, AIHA-LAP, LLC EMLAP, IHLAP and NVLAP accreditation, along with any other accreditations, such as state specific accreditations/certifications (i.e. CA-ELAP, NY-ELAP, etc.).
- Responsible for ensuring that the laboratory is compliant to the current ISO 17025 standard, the AIHA-LAP, LLC, the NVLAP accreditation policies, and additional accreditations as they apply.
- Produces the monthly quality assurance report
- Responsible for training in Quality Assurance department.
- Maintains and controls all Quality Assurance documents and records.
- Researches and obtains new accreditations/licensing as required.
- Maintains regional facility accreditations/licensing and proficiency testing programs.
- **Departmental Relations**
- Has a dual reporting relationship with the Regional Director and Corporate Quality Assurance.
- Works with managers and supervisors to implement QA policies
- QA representative at company meetings
- Coordinates with supervisors and Regional Director to develop QA procedures
- Works with laboratory personnel to develop an open atmosphere regarding quality control issues
- **Qualifications (Minimum)**
- A baccalaureate degree in an applicable basic or applied science and have at least one year of non-academic analytical experience.
- Quality Assurance Manager shall have documented training in statistics or laboratory quality assurance/quality control.
- Experience with applicable QA\QC procedures 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.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs are temporarily suspended following the procedures outlined in Section 12.
- Evaluation of the thoroughness and effectiveness of training.

4.6 Regional Manager

4.6.1 Job Summary

The Regional Manager is responsible for overseeing the analytical operations of one or more of the different EMLab P&K, LLC main laboratories and satellite laboratories (microlabs). They are also responsible for the coordination of department activities with other corporate departments and assuring the smooth flow of work on a daily basis. The Regional Manager will work closely with the Regional Director in monitoring, reviewing and directing laboratory work and analytical quality.

Specific Job Responsibilities

- Overall responsibility for the operation of the analytical laboratory
- Coordinates and supervises all activities related to EMLab P&K, LLC analytical processes

- Implements any Corrective Actions in the laboratory regarding analytical procedures or processes.
- Oversees training programs, if applicable
- Reviews analytical methods on an biennial basis and keeps track of current revisions to procedures to ensure the laboratory is compliant with the current operating protocols
- Responsible for ensuring that the laboratory is compliant to the current ISO 17025 standard, the AIHA-LAP, LLC accreditation policies, the NVLAP accreditation policies, and additional accreditations as they apply.
- Can act as the AIHA Technical Manager or NVLAP Approved Signatory if approved by respective regulatory agency.
- **Departmental Relations**
- Reports directly to the Regional Director.
- Works directly with the Quality Assurance Manager to ensure accuracy and precision of all analytical results.
- Works with managers to coordinate implementation of corporate policies.
- Works with departmental staff to implement departmental policies.
- **Qualifications (Minimum)**
- An earned life science degree, minimally at the baccalaureate level and a minimum of two years of full time equivalent documented relevant environmental microbiological work experience (mycological and/or bacteriological) and/or an earned physical or biological science degree, minimally at the baccalaureate level.
- The individual must be familiar with indoor air quality, bacteriological sampling and analytical methodology.

4.7 Laboratory Manager

4.7.1 Job Summary

The Laboratory Manager is responsible for maintaining positive operating margin to the company at the laboratory level and for meeting and exceeding the annual budget. He/she supervises all operations personnel and provides guidance and direction as needed. In addition, he/she is responsible for ensuring compliance and integration of facility operation with corporate and regulatory policies and procedures.

Specific Job Responsibilities

- Manages the laboratory to provide positive operating margin for the company and meet annual budgetary goals.
- Maintains positive customer relationships through direct interaction with customers, as needed.
- Ensures that the employee health and safety procedures are implemented and followed to maintain facility operations that are compliant with appropriate policies and regulations.
- Ensures the laboratory follows all policies and regulations to be compliant with the laboratory accrediting and regulatory agencies.
- Provides assistance with Quality Assurance SOPs for the facility – through the Regional QA Manager – and ensures their implementation so that the facility is operated in a compliant manner that allows it to produce defensible data.
- Prioritizes the activities of the operations groups to ensure key goals are achieved and customer service needs are addressed.

- Provides periodic reports to Regional Director to ensure that goals and objectives are being achieved and to recognize opportunities for development.
- Interfaces with analysts to assure that quality analytical data is provided to clients and on – time delivery dates are met.
- Communicates facility – specific goals and objectives to employees.
- Communicates and implements company initiatives designed to foster teamwork and communication.
- Fulfills supervisory responsibilities with direct reports to achieve strong staff performance.
- Evaluates and maintains appropriate staffing levels to support operational needs and budgetary requirements.
- Supports the Human Resources function to ensure that all policies and programs are applied consistently throughout the laboratory.
- Ensures that the facility has appropriate Information Technology resources and that they are being used effectively to support operational requirements.
- Actively participates in the process of sharing and adopting best practices within EMLab P&K. Provides technical assistance to other EMLab P&K laboratories as needed to improve productivity and customer service.
- Approves of all laboratory purchases including capital spending approvals to support the business plan and maintain profitability.
- Provides technical support to the laboratory, as needed.
- Prepares and performs analysis on client samples for microbial identification. Helps other analysts in identification of microbial organisms.
- Provides assistance and helps in the training of new analysts on the different analytical procedures and other laboratory functions.
- Coordinates maintenance and repair on existing laboratory equipment as necessary and helps in the inventory maintenance of common laboratory supplies and requests supplies as needed.
- **Departmental Relations**
- May report to Regional Director or Regional Manager
- **Qualifications**
- BS/BA in Microbiology or biological sciences. MS or higher preferred.
- Minimum 5 years experience in biological testing laboratories.
- Minimum of 3 years supervisory experience and/or management experience.
- Minimum 5 years bench level analytical experience plus formal QA training or 2 years QA experience.
- Minimum 2 years experience conducting formal location quality system assessments.
- Knowledge of the accreditations/certifications of NELAC, AIHA-LAP, NVLAP and DOD/DOE programs.

4.8 EMLAP Technical Manager Qualifications (Not an Internal Position)

- An earned science degree, minimally at the baccalaureate level, with a minimum of one year relevant laboratory experience, three months of which must be full time equivalent documented environmental microbiological work experience (mycological and/or bacteriological).

- The individual must be experienced in the selection and use of bioaerosol, surface, fluid and raw material sampling methods and in sample processing for the quantification and identification of mesophilic and thermophilic bacteria, and mesophilic, xerophilic, hydrophilic and thermotolerant fungi (molds and yeasts) isolated by those methods.
- The individual must be present on-site at least 20 hours per week, or 50% of the laboratory working hours (whichever is greater) to address technical issues for laboratory staff and clients.

4.9 IHLAP Technical Manager Qualifications (Not an Internal Position)

- The technical manager or their designee shall be responsible for all technical operations and shall be available to address technical issues for laboratory staff and customers concerning IHLAP related analyses.
- The technical manager shall ensure and document the competence of all who operate specific equipment, perform tests, evaluate results, and sign test reports. The competence determination shall be based on appropriate education, training, experience and/or demonstrated skills.
- The technical manager shall ensure that adequate supervision is provided for all laboratory technical personnel
- The individual must be present on-site at least 20 hours per week, or 50% of the laboratory working hours (whichever is greater) to address technical issues for laboratory staff and clients.

4.10 ELLAP Technical Manager Qualifications (Not an Internal Position)

- The technical manager or their designee shall be responsible for all technical operations and shall be available to address technical issues for laboratory staff and customers concerning ELLAP related analyses.
- The technical manager shall ensure and document the competence of all who operate specific equipment, perform tests, evaluate results, and sign test reports. The competence determination shall be based on appropriate education, training, experience and/or demonstrated skills.
- The technical manager shall ensure that adequate supervision is provided for all laboratory technical personnel
- The individual must be present on-site at least 20 hours per week, or 50% of the laboratory working hours (whichever is greater) to address technical issues for laboratory staff and clients.

4.11 Senior Analyst

4.11.1 Job Summary

Senior analysts may oversee other departmental analyses, such as mycology and/or bacteriology. Senior Analysts will provide leadership to analytical and support staff. A Senior Analyst is responsible for providing high quality analyses and excellent client service. Senior analysts may also

oversee asbestos, allergen and other analytical testing done in the laboratory.

Specific Job Responsibilities

- May supervise and coordinate laboratory work flow and analyses
- Performs analysis
- May train new analysts
- Maintains client relations and technical support when applicable
- Assists in research and development of new analytical services as required
- Assists the QA manager in development, implementation and data collection of QA processes for analytical services
- Performs independent data reviews for other analyst's work
- **Departmental Relations**
- Reports to the Regional Director or Regional Manager.
- Implements and performs mycological, bacteriological, asbestos and other analytical training as required by the Regional Director
- Supports other Supervisors, Regional Managers or Regional Directors when necessary
- Can act as the AIHA-LAP, LLC Technical Manager or NVLAP Approved Signatory if approved by respective regulatory agency.
- **Qualifications (Minimum)**
- **Environmental Microbiology Laboratory Program (Fungi and Bacteria)**
- An earned science degree, minimally at the baccalaureate level and a minimum of three years of full time equivalent documented environmental microbiological work experience (mycological and/or bacteriological).
- **Industrial Hygiene Laboratory Accreditation Program (PCM Asbestos)**
- An earned physical or biological science degree, minimally at the baccalaureate level and a minimum of three years relevant nonacademic analytical chemistry experience. A minimum of two years' experience must be in asbestos analyses. The remaining one year can be substituted for work experience.
- Completion of NIOSH 582 (or equivalent) training course for PCM analyses.
- **National Voluntary Laboratory Accreditation Program (PLM Asbestos)**
- Understand polarized light microscopy and its application to crystalline materials sufficiently to conduct analyses. That they understand what the various optical properties are, how they are measured or observed in the microscope, and how the data are used to form a conclusion about the identity of the component, (e.g., an analyst using central and/or annular focal screening (dispersion staining) to measure refractive index must be able to explain what produces the observed color and how that color is used to determine refractive index) Analysts are competent with the polarized light microscope, Can properly align the microscope and identify all of the crucial parts.
- Completion of McCrone (or equivalent) training course for PLM analyses if deemed necessary.

4.12 Analyst

4.12.1 Job Summary

Analysts perform a range of analyses based upon specific area of responsibility, including but not limited to, aerobiological, environmental,

asbestos and drinking water samples. Analysts are responsible for high quality analyses and excellent client service.

Specific Job Responsibilities May Include

- Analyzes samples for fungal and/or bacterial parameters
- Identify macrofungi and microfungi
- Analyzes samples for bacterial parameters, including drinking waters for coliforms and *E. coli*
- Process and prepare samples for analysis Analyze samples for asbestos
- Analyze samples for allergens
- Digest and analyze samples for lead analysis.
- Accurately records and reports analytical data
- Performs specific tasks related to Quality Control
- Maintains analytical quality control records
- Performs regular analysis of reference materials and other quality control samples
- Performs independent data reviews for other analysts' work
- **Departmental Relations**
- Reports to Regional Director, Regional Manager, or Facility Manager.
- Works with management and support staff for optimal teamwork
- Works with project management staff to clarify technical matters.
- Can act as the AIHA Technical Manager and NVLAP Approved Signatory if approved by respective regulatory agency
- **Qualifications (Minimum)**
- Environmental Microbiology Laboratory Program (Fungi and Bacteria)
- A bachelor's degree in physical or biological science and six months of documented on-the-job training as an analyst trainee under the supervision of a Senior Analyst. For fungal air direct exam (spore trap), analysts are required to undergo three months of documented on-the-job training as a spore trap analyst trainee under the supervision of a Senior Analyst.
- Industrial Hygiene Laboratory Accreditation Program (Asbestos)
- A bachelor's degree in a physical or biological science, and a minimum of one year relevant nonacademic analytical chemistry experience.
- Completion of training courses for PCM analyses.
- **Environmental Lead Laboratory Accreditation Program (ELLAP)**
- A bachelor's degree in physical or biological science and one month of documented on-the-job training as an analyst trainee under the supervision of a Senior Analyst.
- National Voluntary Laboratory Accreditation Program (PLM Asbestos)
- Understand polarized light microscopy and its application to crystalline materials sufficiently to conduct analyses. That they understand what the various optical properties are, how they are measured or observed in the microscope, and how the data are used to form a conclusion about the identity of the component, (e.g., an analyst using central and/or annular focal screening (dispersion staining) to measure refractive index must be able to explain what produces the observed color and how that color is used to determine refractive index). Analysts are competent with the polarized light microscope, and can properly align the microscope and identify all of the crucial parts.
- Completion of McCrone (or equivalent) training course for PLM analyses if deemed necessary.

4.13 Laboratory Technician/Assistant

4.13.1 Job Summary

Laboratory technicians and assistants prepare bioaerosol and microbial samples for fungal and bacteriological analysis. Receive samples and complete required paperwork for processing and analysis of samples, where applicable.

Specific Job Responsibilities May Include

- Prepares bioaerosol and microbial samples for fungal and bacterial analysis
- Cultures fungi and bacteria from environmental samples for analysis
- Works with a variety of sampling media for optimal results
- Analyzes samples for fungal parameters
- Identify macrofungi and microfungi
- Analyzes samples for bacterial parameters, including drinking waters for coliforms and *E. coli*
- Analyze water samples for analysis
- Analyze samples for asbestos
- Analyze samples for allergens
- Digest and analyze samples for lead analysis.
- Accurately enters and reports analytical data
- Performs specific tasks related to Quality Control
- Performs required Quality Control procedures
- Maintenance of laboratory supplies, equipment, and routine lab reagents
- Prepare samples for ELISA analysis and perform ELISA analysis
- **Departmental Relations**
- Reports to Regional Manager, Regional Director or Facility manager
- Work with analysts to complete samples by required deadlines
- Work with log-in and receiving supervisors to control flow of work through the laboratory.
- Can act as the NVLAP Approved Signatory if approved by respective regulatory agency.
- **Qualifications (Minimum)**
- **Environmental Microbiology Laboratory Program (Fungi and Bacteria)**
- A high school diploma or GED and one year of documented on-the-job training as an analyst trainee under the supervision of a Senior Analyst. For fungal air direct exam (spore trap), analysts are required to undergo six months of documented on-the-job training as a spore trap analyst trainee under the supervision of a Senior Analyst.
- **Environmental Lead Laboratory Accreditation Program (ELLAP)**
- A high school diploma or GED and six months of documented on-the-job training as an analyst trainee under the supervision of a Senior Analyst.
- **National Voluntary Laboratory Accreditation Program (PLM Asbestos)**
- Understand polarized light microscopy and its application to crystalline materials sufficiently to conduct analyses. That they understand what the various optical properties are, how they are measured or observed in the microscope, and how the data are used to form a conclusion about the identity of the component, (e.g., an analyst using central and/or annular focal screening (dispersion staining) to measure refractive index must be able to explain what produces the observed color and how that color is used to

determine refractive index); b) analysts are competent with the polarized light microscope, Can properly align the microscope and identify all of the crucial parts.
- Completion of McCrone (or equivalent) training course for PLM analyses if deemed necessary.

4.14 Senior Systems Analysts

4.14.1 Job Summary

The Laboratory Information Management Systems Manager is responsible for the development and implementation of the laboratory data information system. Overall responsibility for the operation of the database system, including day to day operations and validation of software functioning. Works with the Computer Systems Operation Manager to ensure that the laboratory has the proper hardware for the maintenance of laboratory information and data.

Specific Job Responsibilities

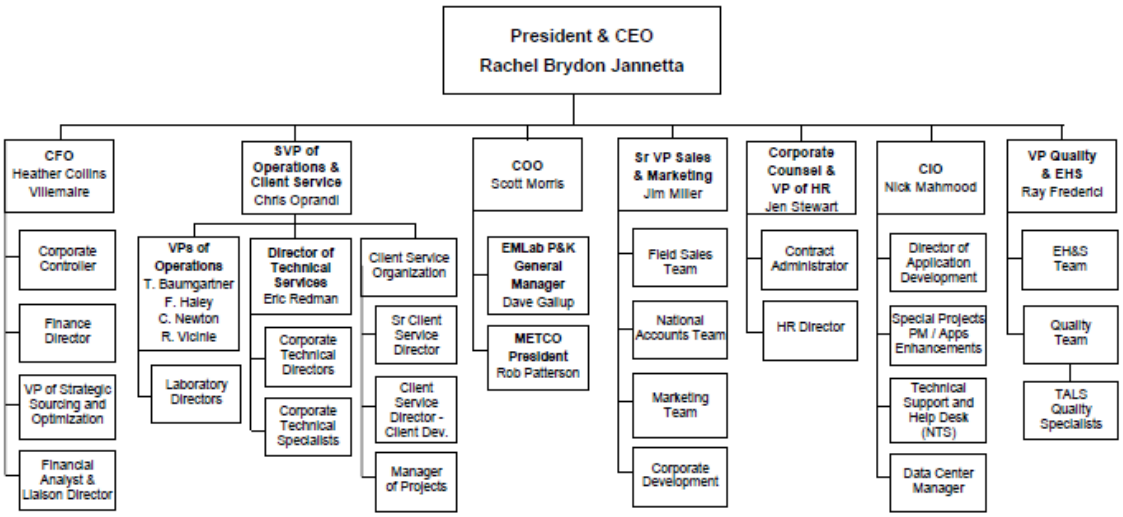
- Develops the EMLab P&K, LLC information system and database so that it meets the needs of the laboratory personnel and clients
- Maintains the information system at an acceptable level of performance
- Provides support service for laboratory personnel regarding database issues
- Trains personnel on the operation and maintenance of the EMLab P&K, LLC database system
- Develops and maintains the security and integrity of the database
- Develops a written manual on the operation of the database system
- Responsible for training and support issues in department
- **Departmental Relations**
- Reports directly to the Special Projects/Products and Services Manager
- Works with managers and supervisors to implement and maintain the database
- Coordinates with the QA Manager to ensure that the database meets accreditation requirements
- Works with laboratory personnel to train and answer questions regarding the operation of the database
- **Qualifications**
- Should have a baccalaureate degree in Computer Science and/or applicable computer experience.
- Laboratory or science experience preferred

4.15 Deputies

EMLab P&K Deputy Lists, documents EM-QA-R-7794 and EM-QA-R-7097 define who assumes the responsibilities of key personnel in their absence for the western region and the eastern region respectively.

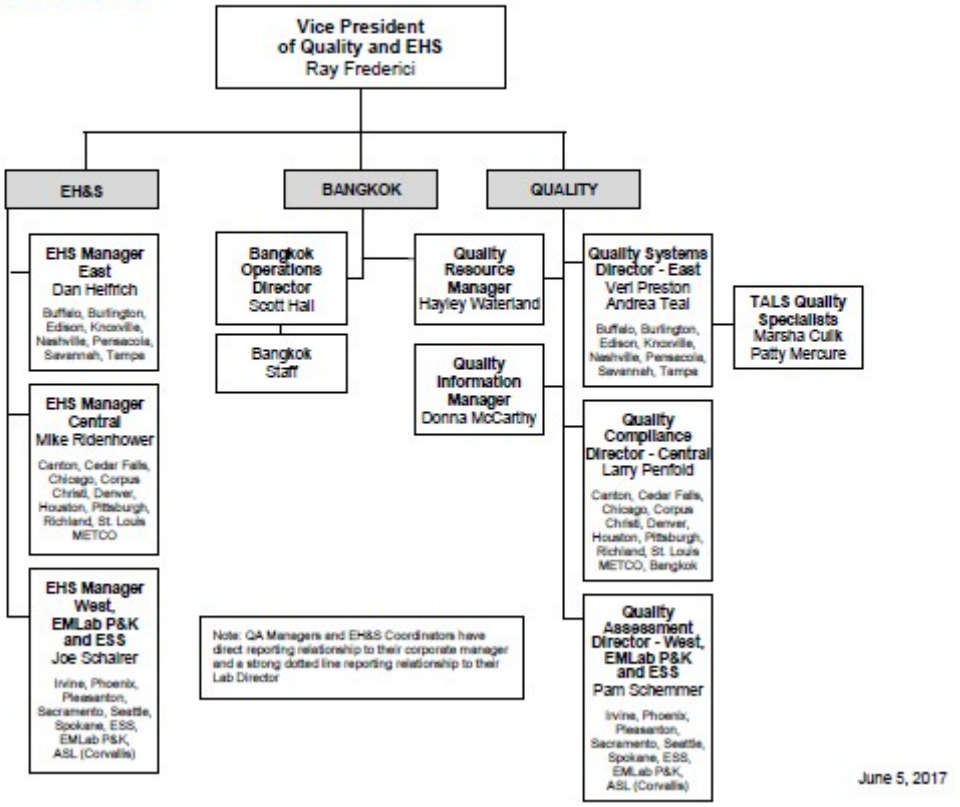
Figure 4-1. Corporate and Laboratory Organization Charts
(The following organization charts are provided as examples. Current organizational charts can be obtained upon request.)

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING



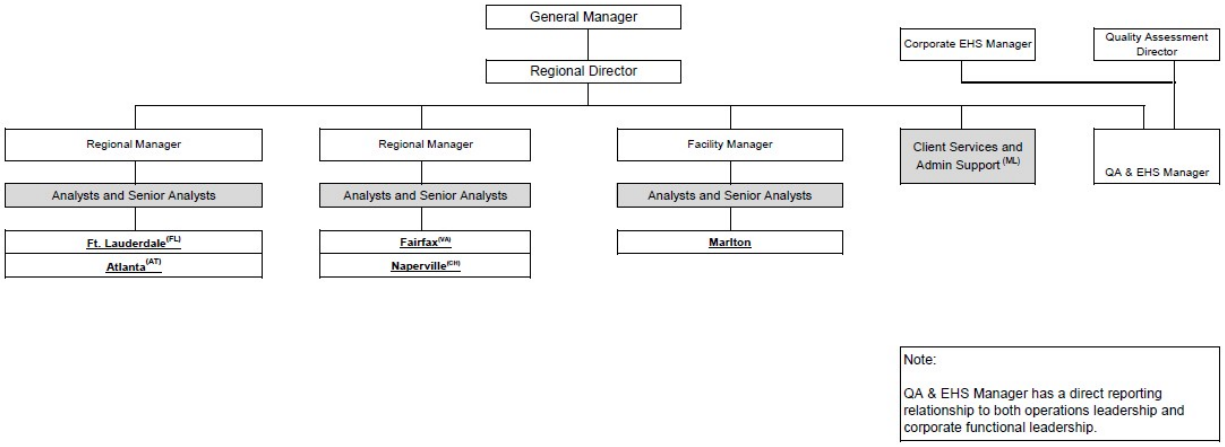
TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Quality, EHS, Bangkok



EMLab P&K
A TestAmerica Company

Eastern Region Organization



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 quality assurance 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 TNI Standard, as applicable, and to continually improve the effectiveness of the management system.

Every staff member at the laboratory plays an integral part in quality assurance 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 (ECOs).
- 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. CA-Q-S-005).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15).
- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (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.
    - EMLab P&K, LLC will provide a workplace that is free from any commercial, financial or other pressures which might adversely affect the quality of the employees' work. If personnel feel undue pressure that might diminish confidence in operational integrity, then the management team should be notified.

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 quality assurance 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
- Laboratory QA/QC Policy Memorandums

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), 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 take precedence over the CQMP in those cases.

5.4 QA/QC Objectives for the Measurement of Data

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control 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.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (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 data quality objectives of the EPA 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 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 reporting limit 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 reporting limits 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 wavelengths (identification), specific mass spectra (identification), specific electrodes (separation and 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).

5.5 Criteria for Quality Indicators

The laboratory maintains a *Quality Control Criteria Summary that contains tables* that summarize the precision and accuracy acceptability limits for performed analyses (EM-QA-R-5730). This summary includes an effective date, is updated each time new limits are generated and are managed by the laboratory's QA department. Unless otherwise noted, limits within these tables are laboratory generated. 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 is contained inEM-AD-S-3548, Selection and Validation of Analytical Methods...

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as NIOSH 7400) and programs (such as the AIHA-LAP, LLC Accreditation Program). The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The current limits in the laboratory are entered into the Laboratory Information Management System (LIMS), also referenced as LabServe. An archive of all limits used within the laboratory is maintained within the LIMS/LabServe and Bugzilla records. 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/LabServe 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/LabServe analyte database. As sample results and the related QC are entered into LIMS/LabServe, the sample QC values are compared with the limits in LIMS/LabServe to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be re-analyzed.

5.6.1 QC Charts

5.6.2 All QC analyses (duplicates, replicates, daily references) including data reviews, must be completed prior to release of results to clients**.** When QC analysis cannot be completed on the same day, the results must be qualified with a report comment.

5.6.3 Proficiency Testing results, and data from additional QC analyses may be used in determining analyst accuracy and precision, where applicable, for demonstration of continuing capability. If proficiency testing problems arise, the analysts will be asked to review the samples again to determine the source of error. If necessary, corrective actions will be implemented as determined by Quality Assurance, the facility manager and/or the regional director based on the nature of the problems.

5.6.4 Asbestos-PLM (Document EM-AS-S-1267)

5.6.4.1 Quality Control Requirements include duplicate analysis, Monthly Reference Sample, and Proficiency testing.

5.6.4.2 Replicate and duplicate analyses are performed to evaluate the precision of a particular analysis. The routine analysis portion is processed through the laboratory in a normal manner. After the analysis has been completed, LabServe automated programming triggers the selection of 5% of the completed bulk samples for replicate analysis and 5% for duplicate analysis, based upon service, analyst and batch. The primary data along with the replicate and duplicate data will be statistically analyzed and control limits will be determined for the analyses (also automated by Labserve).

5.6.4.3 Proficiency Testing results and data from additional QC analyses may be used in determining analyst accuracy and precision, where applicable, for demonstration of continuing capability. If proficiency testing problems arise, the analysts will be asked to review the samples again to determine the source of error. If necessary, corrective actions will be implemented as determined by Quality Assurance, the facility manager and/or the regional director based on the nature of the problems.

5.6.5 Asbestos - PCM (Document EM-AS-S-1260)

5.6.5.1 Microscopes must be adjusted at least once a day, per analyst. Also, the phase-shift detection limit of the microscope must be checked weekly using the HSE/NPL phase-contrast test slide.

5.6.5.2 Quality Control Requirements include duplicate analysis at the rate of 10%, Daily Reference Sample, Round Robin and Proficiency testing.

5.6.5.3 The Reference Sample Quality Control Analysis (PCM) is performed by each analyst per day of analysis to evaluate the precision and accuracy of each analyst for fiber identification. The goal of performing Daily Reference Sample Quality Control Analysis is for continuous improvement. The samples for the Daily Reference Sample Quality Control Analysis consist of reference permanent slides, each of which contains varying asbestos or non-asbestos fiber. Each analyst will analyze a randomly selected slide for each day, recording their results for the fiber counts. The identification by each analyst will be compared with the known standard through LabServe QC criteria automation. Any discrepancies in data comparison trigger an automated failure task for the analyst, who will be required to review the slide again to determine the source of error, and document any associated corrective actions.

5.6.5.4 Biannual ongoing demonstration of analyst proficiency using Proficiency Analytical Testing (PAT) samples is required.

5.6.6 Training of Analysts (Document EM-AD-S-1646 and EM-AS-S-1261)

5.6.6.1 All new analysts will receive documented training on EMLab P&K, LLC analysis and sample preparation procedures as it relates to their individual job functions. The extent and duration of the training will depend on the level of education and experience of the trainee as outlined in Documents EM-AD-S-1646 and EM-AS-S-1261.

5.6.6.2 All analytical training will include, but not be limited to, maintaining documentation of the training procedures and duration, a list of criteria documenting that the required steps involved have been addressed during the training, testing using reference materials where available, comparison of trainee results against analyst results, and providing the trainee with training documents and reference texts.

5.6.6.3 Analysts and technicians will be authorized to perform a specific task and operate specific instruments once the applicable Training Acknowledgment and Authorization forms have been completed and signed by the trainee and trainer and all related data, reviews, and records have been submitted to Quality Assurance for final review and inclusion in analyst training records.

5.6.7 Analysis of Unknown Samples and Reference Materials

5.6.7.1 Unknowns-

5.6.7.1.1 Where applicable to job responsibilities, analysts will analyze unknown bacterial and/or fungal organisms at least monthly to ensure the consistency of identification. Selection of organisms will be made randomly from laboratory stock cultures.

5.6.7.1.2 Where applicable to job responsibilities, analysts will analyze unknown samples for asbestos identification and quantitation.

5.6.7.1.3 Documentation of the analyses will be maintained by the Quality Assurance department.

5.6.7.2 Reference Materials -

5.6.7.2.1 EMLab P&K, LLC maintains a library of reference materials that are accessible to all analysts. Each facility is responsible for maintaining an individual list of reference texts which are maintained in LabServe.

5.6.7.2.2 EMLab P&K, LLC maintains a library of cultures and reference slides. EMPAT and other microbiological reference materials are grown and analyzed by the laboratory on a routine basis.

5.6.7.2.3 Asbestos reference samples such as NIST SRM #1866 and SRM #1867, or equivalent, are also maintained in applicable laboratories, if available.

5.6.7.2.4 The laboratory retains and utilizes proficiency testing materials for use as in-house instructional materials. The proficiency test results are used to verify accuracy and precision for each analyst and to judge the analysts' overall performance. Proficiency test results are used for inter-analyst comparisons and entered into the laboratory's management system records. The laboratory determines precision on the qualitative and quantitative analyses of samples by: repeatability - repeat analyses by the same analyst; -comparison of results from multiple slide mounts of the same material; reproducibility - analysis of samples by multiple analysts if possible (single analyst laboratories require more interlaboratory data); and interlaboratory analysis - analysis of samples by other laboratories. The laboratory also determines the accuracy of the qualitative and quantitative analyses of samples by: analysis of proficiency testing materials; analysis of standards either prepared in-house or purchased; and analysis of samples using independent methods (e.g., XRD, gravimetric, etc.).

5.6.7.3 When analyzing QC samples (duplicates, replicates) or reference samples, analysts must complete the analysis and enter the results into Labserve or record them on appropriate data sheets, without any assistance from or discussions with other analysts.

5.6.7.4 Analysts should not edit the result they reported in Labserve or recorded on appropriate data sheets.

5.6.8 Demonstration of Capability: (Document EM-AD-S-1646)

5.6.8.1 Semi-annual demonstrations of capability may be accomplished by successful completion of:

5.6.8.2 duplicate analyses;

5.6.8.3 replicate analyses;
5.6.8.4 daily reference analyses and
5.6.8.5 proficiency testing samples.
5.6.8.6 Acceptable performance criteria for Ongoing Demonstrations of competency are based on the performance characteristics for the method, established either from the data collected from the analysis of QC check samples, those already promulgated by the method, those set by an outside provider or an error rate of ≤1% for Asbestos PLM, and ≤5% for other analyses over a six month period.
5.6.8.7 For example, if an analyst is qualified to perform bacterial analyses and is required to participate in the AIHA EMPAT Bacterial Culturable Proficiency Testing program, the acceptable performance for their Ongoing Demonstration of Competency would be a score of ≥85%, which is set by the provider

5.6.9 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 Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions 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 SOP No. EM-QA-S-2059. All documents that are part of the EMLab P&K quality assurance system, either internally generated or external, are controlled through the EMLab P&K LabServe Document Control system. The formal distribution of documents to EMLab P&K employees is conducted through a company wide electronic release of revisions in LabServe. All users with log in credentials are afforded access to current revisions of released documents through the LabServe Document control module.

The laboratory QA Department also maintains access to various references and document sources 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 laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, 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 personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department and Regional Laboratory Directors. In some cases, the document owner and/or facility technical managers/approved signatories, may be asked to review controlled documents prior to release. In order to develop a new document, a document owner/author submits an electronic draft to the QA Department for suggestions, review, and approval before use. Upon approval, QA personnel add the identifying version information to the document and retains that document as the official document on file. That document is then electronically registered and distributed to applicable facilities via LabServe Document Control. Changes to documents stored electronically will be strictly controlled by the LabServe document control system. Handwritten changes to SOPs are not allowed.

The QA Department maintains a list of the official versions of controlled documents. A Master List of EMLab P&K Controlled Documents is maintained in LabServe and can be accessed by all employees using the "My Docs" tab on the LabServe home page.

Quality System Policies and Procedures will be reviewed at a minimum of every two years and revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 Procedures for Document Control Policy

For changes to the QA Manual, and all other quality documents, refer to SOP No. EM-QA-S-2059 Uncontrolled copies must not be used within the laboratory. Printing of EMLab P&K SOPs is not permissible unless strictly and exclusively used for review or training purposes. Any document printed for this purpose must be labeled as "UNCONTROLLED" or "OBSOLETE" to indicate it is not a controlled copy. Any official document printed for these purposes must be discarded/shredded immediately following completion of review or training. Previous revisions are removed from general access points and stored within the LabServe Document Control module, and are not accessible to lab personnel. Current electronic copies are stored within LabServe Document Control and are accessible to personnel via the "MyDocs" link after logging in with individual system credentials.

For changes to SOPs, refer to SOP No. EM-QA-S-2059, Document Control and Control of Records.

Forms, worksheets, work instructions and information are organized by department in the LabServe Document Control module. The procedure for the care of these documents is in SOP EM-QA-S-2059.

6.4 Obsolete Documents

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. In general, obsolete documents are removed from general access points in LabServe Document Control. A copy of the obsolete document is archived within LabServe Document Control according to SOP No. EM-QA-S-2059.

SECTION 7. SERVICE TO THE CLIENT

7.1 Overview

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's and/or Chains of Custody (COC) 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.

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 and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these 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 turnaround time 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, whether to another EMLab P&K facility or to an outside firm, 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 EMLab P&K, are documented in writing.

All contracts, chains of custody (COC), QAPPs, Sampling and Analysis Plans (SAPs), 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.

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 of standard COC submissions by the receiving and log in staff is considered adequate. The receiving and log in staff confirm 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 the clients turn around needs. Routine project submission reviews are performed according to SOP No. EM-SM-S-1288, Sample Receiving, and EM-SM-S-1993, Sample Log-In.

For new, complex or large projects, the proposed contract is given to the Regional Account Manager or Project Manager, 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 scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (not necessarily in the order below)

- Contract Administrator
- VP of Operations / General Manager
- Laboratory Project Manager
- Laboratory Directors and/or Corporate Technical Managers
- Laboratory Directors and/or Corporate Information Technology Managers
- Account Executives
- Laboratory and/or Corporate Quality
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors

- The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility.

The Sales Director, Contract Administrator, Account Executive or Proposal Coordinator then submits the final proposal to the client.

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 Contracts Department maintains copies of all signed contracts**.** Locally, account specific contracts/agreements are maintained within client accounts and specific projects, as applicable, in LabServe.

7.3 Documentation

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes. Locally, account specific contracts/agreements are maintained within client accounts and specific projects, as applicable, in LabServe.

The contract will be distributed to and maintained by the appropriate sales/marketing personnel and the Regional Account Manager. A copy of the contract and formal quote will be filed with the laboratory PM and the Laboratory Director.

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 Regional Account Manager and/or Project Manager documents conversations with the client within the LabServe client account.

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, a Project Manager (PM) is assigned to each 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 QC requirements.

PM's are the primary client contact and they ensure resources are available to meet project requirements. Although PM's 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, turnaround times, holding times, methods, analyte lists, reporting limits, 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, project notes 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 either during operations meetings or via LabServe project tasks. 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 facility Manager. After the modification is implemented into the laboratory process, documentation of the modification is made as a data qualifier within data report(s), where applicable.

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).

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

Project managers 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. Project management will maintain ongoing client communication throughout the entire client project.

Technical Managers and/or Regional Laboratory Directors are available to discuss any technical questions or concerns that the client may have.

7.6 Reporting

The laboratory works with our 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. EMLab P&K's Sales and Marketing teams periodically develops 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 EMLab P&K laboratories. The phrase "work sharing" refers to internal transfers of samples between the EMLab P&K 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 because 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 EMLab P&K's Sample Receiving SOP (EM-SM-S-1288for Subcontracting Procedures (CW-L-S-004) and the Work Sharing Process.

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 in TNI/ISO 17025 and/or the client's Quality Assurance Project Plan (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.

Project Managers (PMs), Client Relationship Managers or Account Executives (AE) (or others as defined by the lab) for the Export Lab (EMLab P&K laboratory that transfers samples to another laboratory) are responsible for obtaining client approval prior to subcontracting any samples. The laboratory will advise the client of a subcontract arrangement in writing and when possible approval from the client shall be retained in the project folder. Standard EMLab P&K Terms & Conditions include the flexibility to subcontract samples within the EMLab P&K laboratories. Therefore, additional advance notification to clients for intra-laboratory subcontracting is not necessary unless specifically required by a client contract. Unless the client has specified a particular location where EMLab P&K, LLC is to perform its services,

EMLab P&K, LLC may perform services for the client at any laboratory in its network provided that for the samples being subcontracted, the subcontract lab has the same requested services on its Scope of Accreditation as the lab to which the samples were originally sent. Before samples are subcontracted, EMLab P&K, LLC will advise the client of the arrangement in writing by requesting a Transfer Approval/Disapproval Agreement to be completed by the client. These agreements will be kept on file for future use. Every attempt will be made to gain the client's approval in writing using the Transfer Approval/Disapproval Agreement. If the client does not respond to the approval request, EMLab P&K, LLC retains the right, at its discretion, to subcontract services ordered by the client to another EMLab P&K, LLC laboratory or other laboratories.

Note: In addition to the client, some regulating agencies (e.g., USDA) or contracts require notification prior to placing such work.

8.2 Qualifying and Monitoring Subcontractors

Whenever a PM or Regional Account Manager 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:

- Subcontractors specified by the client - In these circumstances, the client assumes responsibility for the quality of the data generated from the use of a subcontractor.
- Subcontractors reviewed by EMLab P&K – Firms which have been reviewed by the company and are known to meet standards for accreditations (e.g., AIHA-LAP, LLC, NVLAP, State specific accreditations, TNI, etc.); technical specifications; legal and financial information.

A listing of vendors is available on the TestAmerica intranet site.

All EMLab P&K and 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).

EMLab P&K, LLC will be held responsible for data produced as a result of subcontracting of work, except in the case where the client or a regulatory authority specifies which subcontractor is to be used.

Prior to submitting samples to subcontractors the samples may be logged into the LIMS/LabServe and assigned an EMLab Project ID number. A Chain of Custody (COC) must be signed to document transfer to the subcontracting laboratory. All data reported from a subcontractor shall list the name of the laboratory performing the analysis. A copy of the COC must be part of the report sent to EMLab P&K, LLC after completion of the analysis by the subcontractor.

8.2.1 When the potential sub-contract laboratory has not been previously approved, Account Executives or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Client Relations Manager (CRM) or Laboratory Director. The CRM or Laboratory Director requests that the QA Manager or PM begin the process of approving the subcontract laboratory as outlined in Corporate SOP No. CW-L-S-004, Subcontracting Procedures.

Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to the Corporate Quality Information Manager (QIM) for review. After the Corporate QIM reviews the documents for completeness, the information is forwarded to the Finance Department for formal signature and contracting with the laboratory. The approved vendor will be added to the approved subcontractor list on the intranet site and the finance group is concurrently notified for JD Edwards.
The client will assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are known to meet minimal standards. TestAmerica does not certify laboratories. The subcontractors on our approved list can only be recommended to the extent that we would use them.

8.3 Oversight and Reporting

8.3.1 The status and performance of qualified subcontractors will be monitored by the Corporate Quality department. Any problems identified will be brought to the attention of TestAmerica's Corporate Finance, Legal and 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. CSO personnel 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 CSO Personnel, Laboratory Directors, QA Managers and Sales Personnel.

Prior to initially sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. The information is documented within the project records.

8.3.2 For continued use of a subcontractor, verification of certification is placed upon the subcontractor for the defined project. Samples are subcontracted under Chain of Custody with the program defined as 'Accreditation Required' and the following statement for verification upon sample receipt:

Note: Since laboratory accreditations are subject to change, TestAmerica Laboratories, Inc. places the ownership of method, analyte & accreditation compliance upon our subcontract laboratories. This sample

shipment is forwarded under Chain of Custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analytes/tests/matrix being analyzed, the samples must be shipped back to the TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to TestAmerica Laboratories, Inc. attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to TestAmerica Laboratories, Inc.

For TestAmerica laboratories, certifications can be viewed on the company's TotalAccess Database.

8.3.3 All subcontracted samples must be accompanied by an EMLab P&K Chain of Custody (COC). A copy of the original COC sent by the client must be available in LabServe for all samples workshared 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.

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 laboratories EDD (i.e., imported), 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

The full qualification of a subcontractor may be waived 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 COC.

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 use of any emergency subcontractor will require the PM to complete a JDE New Vendor Add Form in order to process payment to the vendor and add them to TALS. This form requires the user to define the subcontractor's category/s of testing and the reason for testing.

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 Capital Expenditure, Controlled Purchase Requests and Fixed Asset Capitalization, SOP No. CW-F-S-007.

Contracts will be signed in accordance with TestAmerica's Company-Wide Authorization Matrix Policy, Policy No. CW-F-P-002. Request for Proposals (RFP's) 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). RFP's 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.

9.3 Reagents, Standards & Supplies

Purchasing guidelines for equipment, consumables, 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 & Acid Lot Testing & Approval, SOP No. CA-Q-S-001. Approval information for the solvents and acids tested under SOP CA-Q-S-001 is stored on the TestAmerica Sharepoint, under Solvent Approvals. A master list of all tested materials, as well as the certificates of analysis for the materials, is stored in the same location.

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. This information is contained in the method SOP. Requests for reagents, standards, or supplies are directed to facility

managers. For labs using on-site consignment, analyst may check the item out of the on-site consignment system that contains items approved for laboratory use.

9.3.2. Receiving

It is the responsibility of the facility manager, or designee, to receive the shipment. It is the responsibility of the receiving personnel to document the date materials were received. Once the ordered reagents or materials are received, the receiver compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. This is documented through the addition of the received date and initials to the information present on the packing slip. All reagents and media received by the laboratory for internal use must be dated and initialed upon receipt, and assigned an expiration date if one is not assigned by the manufacturer. All items are to be stored according to manufacturer's instructions and SDS (MSDS) requirements. The Certification of Analysis and other Quality Control records for specific medium and reagent lots supplied by the vendors are maintained at each facility. (Supply Receiving and Distribution East, Document EM-MR-S-1209, and Supply Receiving and Distribution West, Document EM-MR-S-7350)

Materials may not be released for use in the laboratory until they have been inspected, verified as suitable for use, and the inspection/verification has been documented.

Any media or reagents generated by the laboratory must follow the prescribed procedure for quality control checking prior to use in analysis. In-house generated standards or reagents must complete quality control checks, before being used in the processing of samples. All standards and reagents produced by the laboratory are produced with a description of content, preparer's initials, manufacturer and lot number of parent material, pH (if applicable), assigned lot numbers and expiration dates.

All standards used to calibrate instruments or measuring devices must be traceable to the NIST, or equivalent national or international standard.

Safety Data Sheets (SDSs) 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.

9.3.2 Specifications

Methods 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.

Reagents, media, and 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 or recommended retest dates are not provided, the laboratory may contact the manufacturer to

determine an expiration date. If no recommended expiration is available, the laboratory will assume a 5 year expiration from date of manufacture.

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.

Where applicable, compressed gases in use are checked for pressure and secure positioning daily. To prevent a tank from going to dryness, or introducing potential impurities, the pressure should be closely watched as it decreases to approximately 15% of the original reading, at which point it should be replaced. For example, a standard sized laboratory gas cylinder containing 3,000 psig of gas should be replaced when it drops to approximately 500 psig. 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 meet the applicable water quality requirements noted in individual method SOPs.

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.

Purchased bottleware used for sampling must be certified clean and the certificates must be maintained. If uncertified sampling bottleware is purchased, all lots must be verified clean prior to use. This verification must be maintained. (Reference SOPs EM-MR-S-1209 and EM-MR-S-7350.)

9.3.3 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 method SOPs or manufacturer instructions.

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 Facility/Regional Manager and/or the Regional Laboratory Director. 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 as to 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. Its 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 Section 19). For software, its 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 the QA Department. The manufacturer's operation manual is retained locally at each facility.

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 Technical Managers. The service providers that perform the services are approved by the Technical Manager, Quality Assurance Manager, and/or the Facility Manager.

Analytical balances are serviced and calibrated annually in accordance with SOP EM-EQ-S-1584. The calibration and maintenance services are performed on-site, and the balances are returned to use immediately following successful calibration. When the calibration certificates are received (usually within two weeks of the service), they are reviewed, and documentation of the review is filed with the certificates. If the calibration was unsuccessful, the balance is immediately removed from service and segregated pending either further maintenance or disposal.

Calibration services for support equipment such as thermometers, weight sets, autopipettors, etc., are obtained from vendors with current and valid ISO 17025 accreditation for calibration of the specific piece of equipment. Prior to utilizing the vendor's services, the vendor's accreditation status is verified. Once the equipment has been calibrated, the calibration certificates are reviewed by the QA department, and documentation of the review is filed with the calibration certificates. The equipment is then returned to service within the laboratory

9.6 Suppliers

TestAmerica and EMLab P&K select vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the 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/EMLab P&K 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

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/EMLab P&K 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 Regional Laboratory 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 following EM-CS-S-1709, Resolving Client Concerns and Soliciting Client Feedback, and/or EM-QA-S-3553, Root Cause and Corrective Actions, as applicable.

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to (EM-CS-S-1709).

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 laboratory and Quality Director 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

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 / report comment to the final

results and/or making a notation in the project log. 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. (This may be done via LabServe task system.) The supervisor may elect to discuss it with the Technical Manager or have a representative contact the client to decide on a logical course of action. Once an approach is agreed upon, it must be documented via the LabServe project task system. This information can then be supplied to the client in the form of a report comment, where applicable.

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 an analyte that the lab does not normally report. The lab would not have validated the method for this analyte 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 QA Manager and the Regional Laboratory Director, documented and included in the project record. Deviations **must** also be noted on the final report with a statement that the analyte is not reported in compliance with 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

Under certain circumstances, the Laboratory Director, a Technical Manager, or a member of the QA team 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 project logs and/or LabServe tasks 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 facility Senior Management within 24-hours. The Senior Management staff is comprised_of the Laboratory Director, the QA Manager, and the Technical Managers. The reporting of issues involving alleged violations of the company's Data Integrity procedures must be conveyed to an ECO (e.g., the VP-QA/EHS) and the laboratory's Quality Director 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 Laboratory Director, QA Manager, ECOs, VP of Operations 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.

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.

Corporate SOP entitled Data Recalls (CW-Q-S-005) is the procedure to be followed when it is discovered that erroneous or biased data may have been reported to clients or regulatory agencies.

Corporate SOP entitled Internal Investigations (CW-L-S-002) is the procedure to be followed for investigation and correction of situations involved alleged incidents of misconduct or violation of the company's ethics policy.

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-Q-S-005.

11.4 Prevention of NonConforming 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, 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 analyte 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 4.

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 Laboratory Director.

The Laboratory Director 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 VP of Operations 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 Laboratory Director 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 (Laboratory Director, 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, and 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.

SECTION 12. CORRECTIVE ACTION

12.1 Overview

A major component of TestAmerica's and EMLab P&K's Quality Assurance (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 the LabServe Task System and Corrective Action Reports (CAR) (refer to Figure 12-1).

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..

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility(s) for investigating.
- 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 LabServe Task System - 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

12.2.2 Corrective Action Report (CAR) - is used to document the following types of corrective actions:

- Questionable trends that are found in the review of LabServe tasks.
- Issues found while reviewing tasks 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. A LabServe task 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 Technical Manager, Laboratory Director, or QA Manager 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 Labserve task 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. Corporate SOP Root Cause Analysis (No. CA-Q-S-009), as well as EMLab P&K SOP, Conducting Root Cause Investigations and Implementing Corrective Actions,(Document EM-QA-S-3553)describe the procedure.

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 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 Facility 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. Facility Managers are accountable to the Regional Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- Each CAR is entered into a database for tracking purposes and a monthly summary of all corrective actions is provided in the monthly QA report for review to aid in ensuring that the corrective actions have taken effect.
- TestAmerica laboratories, including EMLab P&K, began using the Incident/Corrective Action Tracker (iCAT) database developed by the company in 2015. (Previously, a local database [QAzilla] served this purpose.) An incident is an event triggering the need for one or more corrective actions as distinct from a corrective action, a potential deficiency stemming from an incident that requires investigation and possibly fixing. The database is independent of LabServe, available to all local and corporate managers, and capable of notifying and tracking multiple corrective actions per event, dates, and personnel. iCAT allows associated

document upload, categorization (such as, external/internal audit, client service concerns, data quality issues, proficiency testing, etc.), and trend analysis. Refer to Figure 12-1.

- The QA Manager reviews monthly 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 quality control have occurred (refer to Section 11). The documentation of these procedures is through the use of a Labserve task 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 quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier. Where sample results may be impaired, the Project Manager is notified by an LabServe task and appropriate corrective action (e.g., reanalysis) is taken and documented.

12.5Basic 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.

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, Technical Manager(s))*	- 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, Technical Manager(s))*	- % 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.

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Matrix Spike / Matrix Spike Duplicate (MS/MSD) *(Analyst, Data Reviewer)*	- % Recovery within limits documented in ***(state where limits are maintained)***.	- 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.
Laboratory Control Sample (LCS) *(Analyst, Data Reviewer)*	- % Recovery within limits specified in ***(state where limits are maintained).***	- 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.
Method Blank (MB) *(Analyst, Data Reviewer)*	< Reporting Limit	- 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 reporting limit AND is > 1/10 of the amount measured in the sample.

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
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.
Daily References *(QA Manager(s), Analysts)*	SOP EM-QA-S-1194, Quality Control for Sample Analysis SOP EM-QA-S-1259, Quality Control for Asbestos Analysis Reference EM-QA-R-5730, Quality Control Criteria Summary	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat sample analysis to show the problem is corrected.
Duplicate Samples *(QA Manager(s), Analysts)*	SOP EM-QA-S-1194, Quality Control for Sample Analysis SOP EM-QA-S-1259, Quality Control for Asbestos Analysis Reference EM-QA-R-5730, Quality Control Criteria Summary	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat sample analysis to show the problem is corrected.
Replicate Samples *(QA Manager(s), Analysts)*	SOP EM-QA-S-1194, Quality Control for Sample Analysis SOP EM-QA-S-1259, Quality Control for Asbestos Analysis Reference EM-QA-R-5730, Quality Control Criteria Summary	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat sample analysis to show the problem is corrected.
Internal / External Audits *(QA Manager, Technical Manager(s), 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.
Reporting / Calculation Errors (Depends on issue – possible individuals include: Analysts, Data Reviewers, Project Managers, Technical Managers, QA Manager, Corporate QA, Corporate Management)	- SOP CW-Q-S-005, Data Recall	- Corrective action is determined by type of error. Follow the procedures in SOP CW-L-S-002 or EM-QA-S-3533.

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Client Complaints *(Project Managers, 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, *Technical Manager(s)*)	- 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 (Safety Officer, Lab Director/Manager, *Technical Manager(s)*)	- Environmental Health and Safety (EHS) Manual.	- Non-conformance is investigated and corrected through CAR system.

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. (EM-QA-S-7577, Continuous Improvement and Preventive Actions)

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, the laboratory continually strives to improve customer service and client satisfaction through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered through any of the following:

- review of the monthly QA Metrics Report,
- trending CARs,
- review of control charts and QC results,
- trending proficiency testing (PT) results,
- performance of management system reviews,
- trending client complaints,
- review of processing operations, or
- staff observations.

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. The metrics report is reviewed monthly be the laboratory management, Corporate QA and TestAmerica's Executive Committee. 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.

Items identified as continuous improvement opportunities to the management system may be issued as goals from the annual management systems review, recommendations from internal audits, white papers, Lesson Learned, Technical Services audit report, Technical Best Practices, or as Corporate or management initiatives.

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 and non-conformances provides a valuable mechanism for identifying preventive action opportunities.

13.1.1 The following elements are part of a preventive action/process improvement system:

- Identification of an opportunity for preventive action or process improvement.
- Process for the preventive action or improvement.
- Define the measurements of the effectiveness of the process once undertaken.
- Execution of the preventive action or improvement.
- Evaluation of the plan using the defined measurements.
- Verification of the effectiveness of the preventive action or improvement.
- Close-Out by documenting any permanent changes to the Quality System as a result of the Preventive Action or Process Improvement. Documentation of Preventive Action/process Improvement is incorporated into the monthly QA reports, corrective action process and management review.

13.1.2 Any Preventive Actions/Process Improvement 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. Exceptions for programs with longer retention requirements are discussed in Section 14.1.2.

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. More detailed information on retention of specific records is provided in EM-QA-S-2059, Document Control and Control of Records. Quality records are maintained by the QA department 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 local facility management. LabServe technical records are maintained by IT.

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	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals - Published Methods	~~5 Years from document retirement date*~~ Indefinitely
QA Records	- Certifications - Method and Software Validation / Verification Data	Indefinitely

	Record Types [1]:	Retention Time:
QA Records	- Internal & External Audits/Responses - Corrective/Preventive Actions - Management Reviews - Data Investigation	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 Documents - Contracts and Amendments - Correspondence - QAPP - SAP - Records of Telephone communications - Lab Reports	5 Years from analytical report issue*
Administrative Records	Financial and Business Operations	Refer to CW-L-WI-001
	EH&S Manual, Permits	Indefinitely
	Disposal Records	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	Refer to HR Manual
	Administrative Policies	Indefinitely
	Technical Training Records	Throughout period of employment, and for a minimum of three years subsequent to end of employment.
	Legal Records	Indefinitely
	HR Records	Refer to CW-L-WI-001
	IT Records	Refer to CW-L-WI-001
	Corporate Governance Records	Refer to CW-L-WI-001
	Sales & Marketing	5 years
	Real Estate	Indefinitely

[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.

14.1.1 All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or main regional facility 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 are maintained on-site at the laboratory for at least 1 month 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.

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	10 years (lab reports and raw data)
AIHA-LAP ELLAP (Lead)	5 years (project records) (quality control laboratory records required to support retained data and associated reporting for AIHA-LAP ELLAP (lead) will be maintained for a minimum of 6 years)
NYS DOH	5 years (quality control laboratory records required to support retained data and associated reporting for NYS DOH will be maintained for a minimum of 6 years)
OSHA	30 years

[1]Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 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 19.14.1 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 (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.

- 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 in chronological order. The chain of custody 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 log or instrument sequence is maintained 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, where applicable and not part of LabServe direct entry. Standard and reagent information is recorded in logbooks or entered into LabServe 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/LabServe 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 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/LabServe 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 benchsheet.
- 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, sample processing/dilution/plating, incubation 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**;**
- quality control protocols and assessment**;**
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected quality control requirements.

14.2.4 All logbooks used during receipt, preparation, storage, analysis, and reporting of samples or monitoring of support equipment shall undergo a documented supervisory or peer review.

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 quality

control measures, including analysts' work sheets and data output records (including instrument response readout records);

- 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. Records are considered archived when noted as such in the records management system (a.k.a., document control.)

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.

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 Auditing, SOP No. CW-Q-S-003. 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 staff.

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 QA Technical Audits	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CW-Q-S-003)	QA Technical Audits Frequency: 50% of methods annually
SOP Method Compliance	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CW-Q-S-003)	SOP Compliance Review Frequency: • Every 2 years •
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, TNI quality systems, AIHA-LA LLC quality systems, NIST NVLAP 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 assess data authenticity and analyst integrity. These 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 report comments. . Manual calculations are checked. QA technical audits will include all methods within a two-year period. All analysts should be reviewed over the course of a two year period through at least one QA Technical Audit.

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 Technical Manager or qualified designee at least every two years.

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

EMLab P&K, LLC participates in external proficiency testing programs consistent with the requirements outlined by the Laboratory's accreditation, licensing, or registration bodies, and at the frequency required to remain compliant with such programs.

The laboratory generally participates in the following types of PT studies, where applicable and/or required by external accreditation, licensing, or registration bodies: AIHA-PAT LLC (EMLAP, IHLAP), NIST NVLAP Bulk Asbestos, Legionella proficiency testing, potable and non-potable water, etc.

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.

When the analysis includes subjective analyst evaluation (e.g., microscopic identification and/or quantitation), all analysts, including those in sub-facilities, are required to participate in proficiency testing, with each analyst separately analyzing, recording, and reporting test results.

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.

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 Facility 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.

SECTION 16. MANAGEMENT REVIEWS

16.1 Quality Assurance Report

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, Facility Managers, their Quality Director as well as the VP of Operations. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director, VP of Operations 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 Senior Management Team and VPs of Operations.

16.2 Annual Management Review

The senior lab management team conducts a review annually of its quality systems and LIMS/LabServe 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. The LIMS/LabServe review consists of examining any audits, complaints or concerns that have been raised through the year that are related to the LIMS/LabServe. 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. CW-Q-S-004 and Work Instruction No. CW-Q-WI-003) 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.
    - 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.

A report is generated by the QA Manager and management. The report is distributed to the appropriate VP of Operation 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)].

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 Internal Investigations 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 President and CEO, Executive VP of Operations, VP of Client & Technical Services, VPs of Operations and Quality Directors receive a monthly report from the VP-QA/EHS summarizing any current data integrity or data recall investigations. The VPs of Operations 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 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.

17.2 Education and Experience Requirements for Technical Personnel

The laboratory makes every effort to hire analytical staffs that possess a college degree (AA, BA, BS) in an applied science with some biology 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 testing the laboratory performs. Job Descriptions are located on the TestAmerica intranet site's 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	Education	Experience
Sample Processing	H.S. Diploma or GED	On the job training (OJT)
Laboratory Technician / Assistant	H.S. Diploma or GED	One year of documented on-the-job training as an analyst trainee under the supervision of a Senior Analyst. For fungal air direct exam (spore trap) and/or lead, analysts are required to undergo six months of documented on-the-job training as a spore trap analyst trainee under the supervision of a Senior Analyst.

Specialty	Education	Experience
Laboratory Technician / Assistant (PLM Asbestos)	H.S. Diploma or GED Understand polarized light microscopy and its application to crystalline materials sufficiently to conduct analyses. That they understand what the various optical properties are, how they are measured or observed in the microscope, and how the data are used to form a conclusion about the identity of the component, (e.g., an analyst using central and/or annular focal screening (dispersion staining) to measure refractive index must be able to explain what produces the observed color and how that color is used to determine refractive index). Analysts are competent with the polarized light microscope, and can properly align the microscope and identify all of the crucial parts. Completion of McCrone (or equivalent) training course for PLM analysis if deemed necessary.	
Senior Analyst – Mycology/Bacteriology	An earned science degree, minimally at the baccalaureate level.	Minimum of three years of full time equivalent documented environmental microbiological work experience (mycological or bacteriological)
Senior Analyst – PCM Asbestos	An earned physical or biological science degree, minimally at the baccalaureate. Level. Completion of NIOSH 582 (or equivalent) training course for PCM analyses.	A minimum of three years relevant nonacademic analytical chemistry experience. A minimum of two years' experience must be in asbestos analyses. The remaining one year can be substituted for work experience.

Specialty	Education	Experience
Senior Analyst – PLM Asbestos	Understand polarized light microscopy and its application to crystalline materials sufficiently to conduct analyses. That they understand what the various optical properties are, how they are measured or observed in the microscope, and how the data are used to form a conclusion about the identity of the component, (e.g., an analyst using central and/or annular focal screening (dispersion staining) to measure refractive index must be able to explain what produces the observed color and how that color is used to determine refractive index) Analysts are competent with the polarized light microscope. Can properly align the microscope and identify all crucial parts. Completion of McCrone (or equivalent) training course for PLM analysis if deemed necessary.	
Analyst (Fungi/Bacteria)	A bachelor's degree in physical or biological science.	Six months of documented on-the-job training as an analyst trainee under the supervision of a Senior Analyst (For fungal air direct exam (spore trap), analysts are required to undergo three months of documented on-the-job training as a spore trap analyst trainee under the supervision of a Senior Analyst.)
Analyst (PCM Asbestos)	A bachelor's degree in a physical or biological science. Completion of training course for PCM analysis.	A minimum of one year relevant nonacademic analytical chemistry experience.

Specialty	Education	Experience
Analyst (PLM Asbestos)	Understand polarized light microscopy and its application to crystalline materials sufficiently to conduct analyses. That they understand what the various optical properties are, how they are measured or observed in the microscope, and how the data are used to form a conclusion about the identity of the component, (e.g., an analyst using central and/or annular focal screening (dispersion staining) to measure refractive index must be able to explain what produces the observed color and how that color is used to determine refractive index). Analysts are competent with the polarized light microscope, and can properly align the microscope and identify all of the crucial parts. Completion of McCrone (or equivalent) training course for PLM analysis if deemed necessary.	
Analyst (Lead)	A bachelor's degree in physical or biological science.	One month of documented on-the-job training as an analyst trainee under the supervision of a Senior Analyst.
Technical Managers – **General (NOT INTERNAL POSITION) AIHA-LAP LLC EMLAP, IHLAP, ELLAP**	An earned science degree, minimally at the baccalaureate level. (For bacteria/fungi: The individual must be experienced in the selection and use of bioaerosol, surface, fluid and raw material sampling methods and in sample processing for the quantification and identification of mesophilic and thermophilic bacteria, and mesophilic, xerophilic, hydrophilic and thermotolerant fungi (molds and yeasts) isolated by those methods.)	A minimum of one year relevant laboratory experience, three months of which must be full time equivalent documented environmental microbiological work experience (mycological and/or bacteriological).

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Technical 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.

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

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 are 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.
- Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics violations). 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.
- Analysts 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.

Further details of the laboratory's training program are described in the Laboratory Training SOP (EM-AD-S-1646, General Training).

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 project manager 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

Each EMLab P&K facility is a 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.

Each 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 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.

Each laboratory is separated into specific areas for sample receiving, sample preparation, microbiological sample analysis, asbestos sample analysis, lead sample analysis, and administrative functions.

18.2 Environment

Laboratory accommodation, test areas, energy sources, lighting are adequate to facilitate proper performance of tests. Each 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.

Each 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 temperature of in use equipment and within the laboratory, where applicable. Monitoring also includes environmental monitoring for airborne molds, bacterial contaminants, surface lead and total airborne fibers, including asbestos, which is performed on a predetermined schedule per facility.

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When any of the method or regulatory required environmental conditions change 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/LabServe are regulated to protect against raw data loss.

18.3 Work Areas

There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

- Microbiological culture handling and sample incubation areas/ reagent preparation areas.
- Asbestos sample handling and preparation of reagents.

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 each 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 and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

Refer to the following documents and procedures for specific requirements for microbiological laboratory facility requirements.

- Standard Methods, 20th Ed., 9020B, Sec. 2
- TNI V1M5, 1.7.3.7.a
- CW-E-M-001, TestAmerica Environmental Health and Safety Manual, Section 16
- EM-HS-S-1639, Housekeeping and Decontamination

18.4 Floor Plan

A floor plan for each main regional EMLab P&K facility can be found in Appendix 1.

18.5 Building Security

Building keys are distributed to employees as necessary.

Visitors to the laboratory sign in and out in a visitor's logbook. 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.

SECTION 19. TEST METHODS AND METHOD VALIDATION

19.1 Overview

The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (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 (SOPS)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures.. Where method SOPs are derived from the most recently promulgated/approved, published methods, they 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 SOP EM-QA-S-2059, Document Control and Control of Records.
- SOPs are reviewed at a minimum of every 2 years (annually for Drinking Water and DoD/DOE SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

19.3 Laboratory Methods Manual

For each test method based on a published reference method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

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 Project Manager. 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 both in-house developed methodology and standard EPA-approved 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 methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used.

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:

- *Perkins, R.L., and Harvey, B.W., Test Method: Method for the Determination of Asbestos in Bulk Building Materials. EPA 600/R-93/116. Washington. D.C. July 1993*
- *Code of Federal Regulations (CFR) 40, Part 763, Appendix C to Subpart E, Asbestos Model Accreditation Plan*
- *Water quality- Enumeration of Legionella. International Standard ISO 11731:2017-05.*
- *USP <797> Pharmaceutical Compounding – Sterile Preparations, Revision Bulletin, The United States Pharmacopeia Convention, 2008*
- *EPA Method 7000B*
- *NIOSH 7082*
- *NIOSH 7400*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th/21st/22nd 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.*

- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)* ***(DW labs only)***
- *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 quality control samples.

A demonstration of capability (DOC, Lab SOP # EM-AD-S-1646) is performed whenever there is a change in instrument type (e.g., new instrumentation), matrix, method or personnel (e.g., analyst hasn't performed the test within the last 12 months).

Note: The laboratory shall have a DOC for all analytes included in the methods that the laboratory performs, and proficiency DOCs for each analyst shall include all analytes that the laboratory routinely performs. Addition of non-routine analytes does not require new DOCs for all analysts if those analysts are already qualified for routine analytes tested using identical chemistry and instrument conditions.

The initial demonstration of capability must be thoroughly documented and approved by the Facility 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 client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted, where applicable: *Reporting Limit based on the low standard of the calibration curve.*

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

19.4.3.1 All analysts and technicians are required to demonstrate their ability to produce reliable results before they perform analysis without direct supervision and document on an Initial Demonstration of Capability (IDOC) form. This form is to be completed by the QA Manager and maintained as part of the employee's training record. (SOP EM-AD-S-1646)

19.4.3.1.1 The Initial Demonstration of Capability (IDOC) form is to be completed per procedure/analysis prep.

19.4.3.2 Training timeframes and minimum sample counts are defined by analysis type and are applicable to initial training. A list of training requirements may be found in the General Training SOP, EM-AD-S-1646. Where training requirements are undefined, a detailed training plan is required.

19.4.3.3 Where an analyst has previous documented training, and has met the required timeframe and minimum sample count for same/like analytical methods, the timeframe and noted sample count will not be required. Sample training in these situations require development of a training plan with an appropriate timeframe and appropriate number of minimum samples.

An authorization statement (refer to Figure 19-1 as an example shall be used to document the completion of each initial demonstration of capability. A copy of the authorization is archived in the analyst's training folder.

19.5 Laboratory Developed Methods and Non-Standard Methods

EMLab P&K employs the use of in-house developed methods as well as published reference methods 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 compounds 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.

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.

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 Documentation of Method – The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an SOP Attachment describing the specific differences in the new method is acceptable in place of a separate SOP.

19.6.1.8 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 (MDL) / Limits of Detection (LOD)

Method detection limits (MDL) 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 can be differentiated from blanks. 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. [To allow for some flexibility, this low level standard may be analyzed every batch or every week or some other frequency rather than doing the study all at once. In addition, a larger number of data points may be used if the appropriate t-value multiplier is used]

Refer to the laboratory's SOP No. EM-AD-S-3548 for details on the laboratory's method validation 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 IDL is > than the MDL, it may be used as the reported MDL.

19.9 Verification of Detection and Reporting Limits

Once an MDL is established, it must be verified, on each instrument, by analyzing a quality control sample (prepared as a sample) at no more than 3 times the calculated MDL for single

analyte analyses (e.g. most wet chemistry methods, Atomic Absorption, etc.) and no more than 4 times the calculated MDL for multiple analyte methods (e.g. GC, GCMS, ICP, etc.). The analytes must be qualitatively identified. This verification does 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 MDL does not verify, then the lab will not report to the MDL, or redevelop their MDL or use the level where qualitative identification is established.

19.10 Estimation of Uncertainty of Measurement

19.10.1 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 measurand" (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, 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.

19.10.2 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.

19.10.3 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.

19.10.4 To calculate the uncertainty for the specific result reported, refer to SOP EM-QA-S-1960.

19.10.5 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.

19.11 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. 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 samples. See the Laboratory Director if unsure.

19.12 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.

19.12.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. The laboratory is currently running LabServe which is a highly customized, proprietary in-house developed LIMS system. It is referred to as LIMS for the remainder of this section. The LIMS utilizes a Microsoft SQL database which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

19.12.1.1 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.
- Custom built software applications, as well as significantly modified off the shelf software, are validated for performing accurate mathematical calculations and transposition of non-numerical information. Whenever the computer software is edited or changed, the computation and transposition processes are revalidated using a computerized test suite in the potentially affected areas prior to the software being used to gather or report data. Data are checked for the following processes:
    - Data accuracy during data collection and storage
    - Data integrity and confidentiality during data storage
    - Integrity of data following electronic transmission to clients
- All software validations and associated process checks are to be fully documented within the Bugzilla system. All supporting spreadsheets, documents, etc. are to be attached to the validation record within Bugzilla.

19.12.1.2 **Ensure Information Availability** – Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.12.1.3 **Maintain Confidentiality** – Ensure data confidentiality through physical access controls such as password protection or website access approval when electronically transmitting data.

19.12.2 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 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.

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.

19.12.2.1 All raw data must be retained with the project record, computer file (if appropriate), and/or appropriate 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.

19.12.3 Detection and reporting limits for analyses are unique to the method being performed. Detection and reporting limits are defined within the respective analytical procedures, where applicable. They are also listed on final reports, where applicable.

19.12.4 Due to the nature of biological data the number of significant figures that are used for interpretation should generally be one or two. Therefore data generated by the laboratory is reported with a maximum of two significant figures, unless the use of additional significant figures is warranted by specific analytical reporting requirements.

19.12.4.1 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.

19.12.4.2 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, 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 tape file.

19.12.5 Logbook / Worksheet Use Guidelines

Logbooks and 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.)

- 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, signed and dated.
- Worksheets are created with the approval of the Regional Director and QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

19.12.6 Review / Verification Procedures

Review procedures are outlined in several SOPs (e.g. Sample Receiving (EM-SM-S-1288), Sample Log In (EM-SM-S-1993), Technical Report Review and Release Procedures (EM-SM-S-1637) to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data is reported. The general review concepts are discussed below, more specific information can be found in the SOPs.

19.12.6.1 Log-In Review - The data review process starts at the sample receipt stage. Sample control personnel review chain-of-custody forms and project instructions from the project management group. This is the basis of the sample information and analytical instructions entered into the LIMS. The log-in instructions are reviewed by the personnel entering the information.

19.12.6.2 First Level Data Review - The next level of data review occurs with the analysts. As data are generated, analysts review their work to ensure that the results meet project and SOP requirements. First level reviews include inspection of all raw data (e.g., raw data sheets, logs, etc.) , evaluation of QC data, and reliability of sample results. The analyst transfers data not already directly entered into LIMS, data qualifiers are added as needed. All first level reviews are documented.

19.12.6.3 Second Level Data Review – All analytical data are subject to review by a second qualified analyst or supervisor. Second level reviews include inspection of all raw data. The second review also includes evaluation of QC data, reliability of sample results, qualifiers.. Manual calculations are checked in second level review. All second level reviews are documented.

Issues that deem further review may 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
- Transcription errors
- Results outside of calibration range

19.12.6.4 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, Project Manager, Quality Manager, Technical Manager, or Supervisor for further investigation. Corrective action is initiated whenever necessary.

19.12.6.5 The review process includes, but is not limited to, verifying that the COC is followed, report comments are present where necessary, comments are appropriate, and project specific requirements are met.

Figure 19-1. Example - Demonstration of Capability Documentation

Date:

Laboratory Name:

Laboratory Address:

Analyst(s) Name(s):

Matrix:

Method number:

We, the undersigned, CERTIFY that:

1. The analysts identified above, using the cited test method(s), which is in use at this facility for the analyses of samples under the _____ have met the Demonstration of Capability.
2. The test method(s) was performed by the analyst(s) identified on this certification. The analyst was trained on all aspects of the identified method.
3. A copy of the test method(s) and the laboratory-specific SOPs are available for all personnel on-site.
4. The data associated with the initial demonstration capability are true, accurate, complete and self-explanatory (1).
5. All raw data, including a copy of this certification form and evidence of all applicable SOP Training Acknowledgement forms, necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized assessors.

_____ _____
Quality Assurance Manager Signature Date

_____ _____
Manager/Technical Manager Signature Date

This certification form must be completed each time a demonstration of capability study is completed.

(1) **True:** Consistent with supporting data.
Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.
Complete: Includes the results of all supporting performance testing.
Self-Explanatory: Data properly labeled and stored so that the results are clear and require no additional explanation.

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, i.e. pump rentals) 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 SOP EM-EQ-S-1584. A list of laboratory instrumentation, per facility, is maintained by Quality Assurance in QA server folders.

Equipment is only operated by authorized and trained personnel. Manufacturer's instructions for equipment use are readily accessible to all appropriate laboratory personnel.

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 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 failure to continually meet one of the quality control criteria.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Facility Manager and/or designee to ensure that instrument maintenance logs are kept for all equipment in his/her facility. Preventative maintenance procedures are outlined in EM-EQ-S-1584 and may also be 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. 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 are to be maintained as part of facility equipment records.

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 and/or vendor 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 back-up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

At a minimum, if an instrument is sent out for service or transferred to another facility, it must be verified as functional upon return or repair 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, temperature measuring 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. Additional information and requirements may be found in SOP EM-EQ-S-1584.

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 prior to initial serviceable use with at least two certified ASTM type 1 weights spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). ASTM type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. 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 service representative, who supplies the laboratory with a 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.

- If the temperature measuring device is used over a range of 10°C or less, then a single point verification within the range of use is acceptable;
- If the temperature measuring device is used over a range of greater than 10°C, then the verification must bracket the range of use.

IR thermometers are calibrated every 6 months.

The NIST thermometer is recalibrated every five 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(s) have increments of 1 degree (0.5 degree or less increments are required for drinking water microbiological laboratories), and have ranges applicable to method and certification requirements. The NIST traceable thermometer is used for no other purpose than to calibrate other thermometers.

All of this information is documented in logs. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in equipment-specific logs. More information on this subject can be found in the *Calibration and Maintenance of Lab Equipment SOP, EM-EQ-S-1584.*

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 each working day, at minimum. Temperatures are recorded twice daily, with a minimum 4 hours between readings for days in use.

Ovens, waterbaths 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 2ºC and 8 ºC.

Specific temperature settings/ranges for other refrigerators, ovens, waterbaths, and incubators can be found in method specific SOPs.

All of this information is documented in Daily Temperature Logs.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices are given unique identification numbers and the delivery volumes are verified, at a minimum, on a monthly basis. Monthly pipette verification and annual calibration procedures are found in SOP EM-EQ-S-1584.

For those dispensers that are not used for analytical measurements, a label can be applied to the device stating that it is not calibrated and not for use in analysis. Any device not regularly verified cannot be used for any quantitative measurements. ***[Refer to an SOP on calibration procedures or expand this information into this section.]***

20.3.6 Autoclaves

Each autoclave requires routine maintenance and cleaning to ensure functionality of the unit. Process controls are in place daily, weekly, and quarterly to ensure that the unit is performing as required with respect to time, temperature and sterilization requirements. Details of required maintenance can be found in manufacturer manuals as well as SOP Autoclave Operation and Maintenance SOP, EM-EQ-S-1198.

20.3.7 Microscopes

The routine maintenance of microscopes is outlined in Document EM-EQ-S-1586 "Routine Maintenance of Microscopes".
Microscope Ocular Micrometers are calibrated annually with an NIST traceable micrometer per Document EM-EQ-S-1588 "Ocular Micrometer Calibration".
Records of the maintenance and ocular micrometer calibrations are maintained as part of the Quality System documentation.

For those microscopes used in PCM analysis, routine maintenance and alignment requirements are outlined with the analytical Document EM-AS-S-1260 "PCM Analysis for Asbestos and Other Fibers".
For those microscopes used in Asbestos PLM analysis, routine maintenance and alignment requirements are outlined with the analytical Document EM-AS-S-1267 "Sample Preparation and Analysis for Asbestos Fibers by Polarized Light Microscopy (PLM)".

20.3.8 Ventilation and Decontamination

Class II Biosafety hoods are certified on a semi-annual basis by a NSF accredited field certifier to ensure that the hoods are functioning according to the specifications outlined in NSF Standard 49 and the Chapter 13 of the ASHRAE Applications Notebook (1999). If hood is equipped with flow rate alarm, the certification may be performed annually. The records for the hood calibration are maintained at each facility.

All other Biohazard hoods, including Class I with HEPA filter used for asbestos, are certified on an annual basis by an ISO 17025:2005 accredited vendor.

Hoods used for asbestos analyses must operate at a minimum 75 fpm or they shall not be used for asbestos work.

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, response, type of calibration (Avg RF, 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.

If the initial calibration 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).

Note: Instruments are calibrated initially and as needed after that and at least annually.

20.4.1 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 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 reporting limit 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).

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.

20.4.1.1 Calibration Verification

20.4.1.2 The calibration relationship established during the initial 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.

20.4.1.3 All target analytes, 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.

20.4.1.4 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.

20.4.1.5 Generally, the initial calibrations must be verified at the beginning of each 12-hour analytical shift during which samples are analyzed. (Some methods may specify more or less frequent verifications). The 12-hour analytical shift begins with the injection of the calibration verification standard. 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.

20.4.1.6 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.

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 useable 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

Table 20-2. Example: Schedule of Routine Maintenance

Equipment	EMLab Calibration Frequency	EMLab Verification Frequency
Reference thermometer	Initial and every 5 years	N/A
Working thermometer	N/A	annual
IR thermometer	N/A	Every 6 months
Reference masses	Initial and every 5 years	N/A
Working masses	Initial	biennial
Stage micrometer	Initial	N/A
Balance	Annual	day of use
Mechanical Pipettes	Annual	monthly
pH meters	day of use	Day of use
Biological Safety Cabinets	Every 6 months (unless equipped with working flow rate alarm)	
Bench Top Hoods (PLM Asbestos)	Annual	Monitored regularly
Bench Top Hoods (PCM Asbestos and Mycology)	Must have flow rate recorded at least biennially	
HEPA Vacuums	Annual	

Refrigerators/Incubators		twice daily
Ocular micrometers	Annual	
Microscope (Alignment)		Day of use
Walton-Becket Graticule	Annual	Annual
PCM Microscope		Weekly resolution check

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 pipettes and other volumetric measuring devices. (Refer to Section 20.3). With the exception of Class A Glassware and Glass microliter syringes, quarterly accuracy checks (at minimum) 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.

- All reusable glassware and plasticware that is used in the analysis of samples must be cleaned, and where appropriate, sterilized according to Document EM-EQ-S-5810 "Glassware Cleaning".
- All glassware shall be inspected for cracks and chips before each time it is used. If cracks or chips are found, the glassware shall not be used and shall be repaired or discarded.

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 MRA (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.

21.3 Reference Standards / Materials

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared reference standards, to the extent available, are purchased from vendors that are accredited to ISO Guide 34 and ISO/IEC Guide 17025. All reference standards from commercial vendors shall be accompanied with a certificate that includes at least the following information:

- Manufacturer
- Analytes or parameters calibrated
- Identification or lot number
- Calibration method
- Concentration with associated uncertainties
- 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. The receipt of all reference standards must be documented. Reference standards are labeled with a unique ID and expiration date. All documentation received with the reference standard is retained as a QC record and references the unique ID.

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. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. These checks are generally performed as an integral part of the analysis method (e.g. calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. Refer to the Corporate Environmental Health & Safety Manual or laboratory SOPs. 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 Quality Assurance 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.

All manufacturer or vendor supplied Certificate of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained on-site with each facility's current QA/QC records. 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 facility Supply Receiving and Distribution SOPs.

Wherever possible, cultures purchased for use as control or reference cultures and inclusion in laboratory stock must be obtained from external sources traceable to Guide 34 such as, but not limited to, AIHA-PAT, LLC EMPAT proficiency testing rounds, American Type Culture Collection (ATCC), Hardy Diagnostics and other commercially available traceable culture catalogs.
All standards, reagents, and reference materials must be labeled in an unambiguous manner.
Records are maintained 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.

21.4.1 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Lot number
- Expiration Date (include prep date for reagents)
- Standard ID
- 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 on-site with each facility's current QA/QC records.
21.4.2 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 preparation/analytical batch records.

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

EMLab P&K, LLC does not offer sampling services. Rare exceptions have been made upon high profile client request. Such requests are to include client specified sampling plans and are reviewed and approved on a case by case basis by the Regional General Manager and Regional Director. Such requests and dictated protocols are documented as part of the client account records. Clients of the laboratory are supplied, upon request, with EMLab P&K, LLC Chain of Custody (COC) forms, and written information regarding the use of sampling devices and sampling procedures. Clients may also obtain these materials and a detailed list of sampling procedures from the EMLab P&K, LLC internet site.

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers. Certificates of cleanliness for bottles and preservatives are provided by the supplier and are maintained at the laboratory. Alternatively, the certificates may be maintained by the supplier and available to the laboratory on-line. Internally, a representative sample from new lots of sample containers are checked for sterility and records maintained per lot.

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:

- 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. 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 the laboratory SOPs 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 report comment. 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 (where applicable), gloves, and lab coats must be worn when preparing aliquots for analysis.

Only open asbestos samples in appropriate HEPA filtered hoods with a minimum flow rate of 75 fpm.

Guidelines on taking sample aliquots & subsampling are located in individual method SOPs.

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.

Consider every sample as potentially dangerous. Handle samples in manner that reduces the potential of contamination to others and the laboratory environment.

Wipe every surface involved in the processing of samples with disinfectant after working with the samples.

Do not leave the lids off of plates at any time, and if necessary reseal plates with parafilm after analysis.

It is every employee's responsibility to report any safety concerns or incidence of non-compliance to supervisors, quality assurance officer, safety coordinator, or corporate management.

23.1 Chain of Custody (COC)

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.

When the sampling personnel deliver the samples directly to EMLab P&K 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 personnel. 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 or to a TestAmerica courier. 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 only considered to be received by lab when personnel at the fixed laboratory facility 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.

23.1.1 Legal / Evidentiary Chain-of-Custody

If samples are identified for legal/evidentiary purposes on the COC, standard COC and sample handling procedures apply. EMLab P&K does not provide internal chain of custody.

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

The integrity of all samples received is checked during the Sample Receipt process outlined in Document EM-SM-S-1288 "Sample Receipt" prior to sample Log-in. It is the duty of the individual receiving the samples to ensure that the samples received are intact and not compromised in any fashion. The sample acceptance policy to be used as a guideline for assessing the integrity of received samples is contained within Document EM-SM-S-1288 "Sample Receiving".
Whenever a compromised sample is encountered, the information is documented in LabServe (Report Comments, Project Log, Project Tasks, Log-in Field or Account Details). The client must be contacted and at the very least, if possible, a message left to inform the client of the situation. If, at the client's request, a compromised sample is analyzed, a qualifying statement must be submitted with the written report describing that the integrity of the results are potentially compromised and that the interpretation of the data is left to the client. Clients are

informed on the condition of the sample in the final report. A record of pertinent discussions with clients must be maintained in LabServe (for example in the account details, project logs, tasks, etc.).

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, and .

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory.

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:

- sample holding times must be adhered to (Sampling Guide);
- All samples submitted must have a Chain of Custody (COC), or an equivalent sample request, to be received by the laboratory.
- Samples are checked for unique identifiers on each sample and that the number of samples matches the information on the COC. The project manager will be notified if any sample is received in damaged condition.

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, as needed.

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:

- The receiving staff separates the individual analysis types into bins and makes copies of the original COC for each bin as needed.
- The types of analyses, the number of samples received for each analysis, the type of sample and the requested turnaround time are recorded into the database. Any missing or extra samples received are recorded on the original COC and into the database.
- If any of the previous information is missing or incomplete, the information is documented into the database and the client is contacted.
- Samples are categorized by projects and analysis types into individual bins and queued for the Log-in process.

• The laboratory maintains a sample storage area that protects the samples from deterioration, loss, damage or from unauthorized access.

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or
- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the LIMS/LabServe according SOP No. EM-SM-S-1993. and assigned an EMLab P&K, LLC Project Number and unique laboratory identifiers for each sample in the project.
All client information, project information, analysis requests, sample identifier information, sample descriptions and miscellaneous notes are entered into the database. The information logged into the database is checked against the information on the original COC and Project Log before the samples are sent to a Receiving and Log- in Quality Control check.

In an effort to meet the needs of the client, EMLab P&K, LLC offers the client the ability to log samples in via the internet. Clients enter Chain of Custody (COC) information into the internet log-in screen and then print a COC form which is sent with the samples to the laboratory.
Upon receipt of the samples at the laboratory the COCs are signed by the receiving laboratory staff and the information logged in by the clients is compared with the samples received and the information on the printed client produced COC. Additional information regarding Sample Log In via the internet can be found in SOP EM-SM-S-1993.

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. Samples are never to be stored with reagents, standards or materials that may create contamination.

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.

23.5 Sample Shipping

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice where necessary to ensure the samples remain within required temperature range for desired analysis during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature where necessary). The chain-of-custody form is signed by the sample control technician and included in the shipment. 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, where necessary. The Environmental, Health and Safety Manual contains additional shipping requirements.

23.6 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 procedures (SOP: EM-HS-S-1286. All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than one month 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.

Figure 23-1. Example: Chain of Custody (COC)

CHAIN OF CUSTODY
www.EMLabPK.com

EMLab P&K
A TestAmerica Company

New Jersey: 3000 Lincoln Drive East, Suite A, Marlton, NJ 08053 * **(866) 871-1984**
Phoenix, AZ: 1501 West Knudsen drive, Phoenix, AZ 85027 * **(800) 651-4802**
SSF, CA: 6000 Shoreline Court, Suite 205, South San Francisco, CA 94080 * **(866) 888-6653**

Weather		Fog	Rain	Snow	Wind	Clear
Level	None	☐	☐	☐	☐	☐
	Light	☐	☐	☐	☐	
	Moderate	☐	☐	☐	☐	
	Heavy	☐	☐	☐	☐	

CONTACT INFORMATION

Company:		Address:
Contact:		Special Instructions:
Phone:		

PROJECT INFORMATION

Project ID:			
Project Description:			
Project Zip Code:		Sampling Date & Time:	
PO Number:		Sampled By:	

TURN AROUND TIME CODES (TAT)

STD – Standard (DEFAULT)	Rushes received after 2 pm or on weekends, will be considered received the next business day. Please alert us in advance of weekend analysis needs.
ND – Next Business Day	
SD – Same Business Day Rush	
WH – Weekend / Holiday	

Sample ID	Description	Sample Type (Below)	TAT (Above)	Total Volume / Area (as applicable)	Notes (Time of day, Temp, RH, etc.)

REQUESTED SERVICES
(Use checkboxes below)

Non-Culturable				Culturable										Other Requests			
Spore Trap		Tape Swab Bulk		BioCassette™, Andersen, SAS, Swab, Water, Bulk, Dust, Soil, Contact Plates													
Fungi – Spore Trap Analysis	Spore Trap Analysis – Other particles	Direct Microscopic Exam (Qualitative)	Quantitative Spore Count Direct Exam	1-Media Surface Fungi (Genus ID + Asp. spp.)	2-Media Surface Fungi (Genus ID + Asp. spp.)	3-Media Surface Fungi (Genus ID + Asp. spp.)	Culturable Air Fungi (Genus ID + Asp. spp.)	Gram Stain & Counts (Culturable Air & Surface Bacteria)	*Legionella* culture	Total Coliform, *E. coli* (Presence/Absence)	Membrane Filtration (specify organism):	MPN Bacteria (specify organism):	QuantiTray – Sewage Screen	Asbestos Analysis – PCM Airborne Fiber Count (NIOSH 7400)	Asbestos Analysis – PLM (EPA method 600/R-93-116)	PCR (specify test):	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
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SAMPLE TYPE CODES			
BC – BioCassette ™	**ST** – Spore Trap: Zefon, Allergenco, Burkard ...	**T** – Tape	**D** – Dust
A1S – Anderson		**SW** – Swab	**SO** – Soil
SAS – Surface Air Sampler	**P** – Potable Water	**B** – Bulk	
CP – Contact Plate	**NP** – Non-Potable Water	**O** – Other:	

RELINQUISHED BY	DATE & TIME	RECEIVED BY	DATE & TIME

By submitting this Chain of Custody, you agree to be bound by the terms and conditions set forth at http://www.emlab.com/s/main/serviceterms.html

Figure 23-2. Example: Sample Acceptance Policy

All incoming work will be evaluated against the criteria listed below and found with SOP EM-SM-S-1288. 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 ASAP after the receipt of the samples.

Per State and/or Federal Regulation, the client is responsible to ensure that samples are shipped in accordance with DOT/IATA requirements, and that radioactive materials may only be delivered to licensed facilities. Any samples containing (or suspected to contain) Source, Byproduct, or Special Nuclear Material as defined by 10 CFR should be delivered directly to facilities licensed to handle such radioactive material. Natural material or ores containing naturally occurring radionuclides may be delivered to any TestAmerica facility or courier as long as the activity concentration of the material does not exceed 270 pCi/g alpha or 2700 pCi/g beta (49 CFR Part 173).

Samples received are expected to display the following features:

1. Sealed correctly to eliminate cross contamination.
2. Clearly discernible markings and identifications.
3. Packing materials sufficient to appropriate to eliminate the risk of damage during delivery.
4. Sample volume/amount must meet minimum and maximum amount requirements for each analysis, if applicable.
5. Lead wipes must meet ASTM E1792 criteria.
6. Culture media within expiration dates and lot numbers clearly identified on the plate.
7. Asbestos PCM cassettes should not be packaged in Styrofoam and should be separated from PLM samples.
8. Bacteriology samples, where a state certification is applicable, should only be shipped to labs holding that certification and should meet the analysis' temperature and holding time requirements.

Samples will be placed on the Project Manager will contact the client if any of the following are observed:

1. Leakage from a sample.
2. Water intrusion into a sample.
3. Physical damage to a sample due to improper packaging during transport.
4. Breaking or otherwise discernible compromise to the integrity of the sample.
5. Illegible, ambiguous, or missing sample identification information.
6. Sample volume/amount does not meet minimum and maximum amount requirements for each analysis, if applicable.
7. Lead wipes do not meet the ASTM E1792 criteria.
8. Culture media that is expired, dried, or detached from the culture plate.
9. Asbestos PCM cassettes packaged in Styrofoam or with asbestos bulk samples.
10. Bacteriology samples submitted for an analysis for which state certification is not held at the laboratory of receipt, and/or not adhering to the temperature and hold time requirements

Sample and hold time requirements vary per method. These can be found in SOP EM-SM-S-1288.

1. Sample Holding Times
    a. EMLab P&K 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 (2 working days) remaining on the holding time for us to ensure analysis.

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 quality control measurements (e.g. Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), replicates (REP), daily reference slides, and routine quality control checks). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. Quality control samples are to be treated in the exact same manner as the associated field samples being tested. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

24.2 Controls

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps vary per method and may include homogenization, drying, acid digestion filter concentration, heat treatment, acid treatment, dilution, centrifugation, etc.. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches, where applicable. 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.

Quality Control Requirements include, but are not limited to, duplicate analysis, replicate analysis, daily reference analysis, round robin and proficiency testing as applicable to the method being performed. Quality control requirements, acceptance criteria, frequency and required trending practices are outlined in Document EM-QA-S-1994, Quality Control for Sample Analysis, Document EM-QA-S-1259, Quality Control for Asbestos Analysis, or within method specific documents.

A Quality Control and Acceptance Criteria Summary is available as Document EM-QA-R-5730.

24.3 Negative Controls

Table 24-1. Example – Negative Controls

Control Type	Details
Negative Control (NC)	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 standard operating procedure for each analysis. Generally it is 1 per day of analysis.
	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 reporting limit 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.
Field Blanks [1]	are sometimes used for specific projects by the field samplers.

[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."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.3.1 Negative Controls for Microbiological Methods – Microbiological Methods utilize a variety of negative controls throughout the process to ensure that false positive results are not obtained. These controls are critical to the validity of the microbiological analyses. Details of required negative controls are located within in each method SOP.

Negative culture controls demonstrate that a media does not support the growth of non-target organisms and ensures that there is not an atypical positive reaction from the target organisms. Prior to the first use of the media, each lot of pre-prepared selective media or batch of laboratory prepared selective media is analyzed with at least one known negative culture control as appropriate to the method.

24.4 Positive Controls

Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch

Note that 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.

Cultures for quality control testing of media and for use as reference organisms are stored appropriately based on procedural requirements. Details can be found in EM-AD-S-5745.

24.4.1 Controls for Microbiological Methods

Laboratory produced media and reagents are checked against quality control organisms, where applicable, and for sterility according to media type recipes/instructions prior to use in analytical procedures. Documentation for the quality control of media and reagents are kept on file. Quality Control records for media produced by outside vendors are kept on file.

24.5 Acceptance Criteria (Control Limits)

As mandated by the test method and regulation, each individual QC sample (daily reference, duplicate, replicate, positive control, negative control, etc.) 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 biennial 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 ± 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

- 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 data quality objectives (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.

24.5.1 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.

24.5.2 A 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 reporting limit 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.

24.5.3 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 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. In cases where client generally receives notes related to QC, there must 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. Data results are predominantly made available to clients directly through electronic means. EMLab P&K, LLC additionally offers hard copy reporting by special client request only. At a minimum, the standard laboratory report shall contain the following information:

25.2.1.1 A report title (e.g. Analytical Report For Samples)

25.2.2 Each report cover page printed on company letterhead, which includes the laboratory name, address and telephone number.

25.2.3 A unique identification of the report (e.g. project 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.

25.2.4 A copy of the chain of custody (COC).

- Any COCs involved with Subcontracting are included.

25.2.5 The name and address of client and a project name/number, if applicable.

25.2.6 Description and unambiguous identification of the tested sample(s) including the client identification code.

25.2.7 Date of receipt of sample, date 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.

25.2.8 Date reported or date of revision, if applicable.

25.2.9 Method of analysis including method code (EPA, Standard Methods, etc.).

25.2.10 Reporting limits, where applicable.

25.2.11 Method detection limits (if requested)

25.2.12 Definition of Data qualifiers and reporting acronyms (e.g. ND).

25.2.13 Sample results.

25.2.14 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

25.2.15 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue.

25.2.16 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.

25.2.17 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.18 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., preliminary report). A complete report must be sent once all of the work has been completed.

25.2.19 Any non-EMLab P&K 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.

Note: Refer to EMLab P&K SOP EM-QA-2059 for details on internally applying electronic signatures of approval.

25.2.20 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica's services in addition to the test report as described in Section 25.2. When NELAP accreditation is required and both a test report and EDD are provided to the client, the official version of the test report will be the combined information of the report and the EDD. **EMLab P&K** offers a variety of EDD formats including Excel and custom files.

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 coding the EDD.

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.

25.3 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 report comment 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 Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the Laboratory Director, 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.

25.4 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 EMLab P&K SOP on Subcontracting (SOP No. EM-SM-S-1288).

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 EMLab P&K are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.5 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: 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.

25.5.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are to meet all requirements of this document, and must include a cover letter.

25.6 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.

25.7 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 in the LIMS/LabServe, under the "Deliverables" section of the project details page. , The original report is maintained in the LIMS/LabServe, under the "Reports" section of the project details page. The revised report will have the word "revised" or "amended" on the report cover page and a unique report ID in LabServe. The "Delivery" section of the project details page in the LIMS/LabServe provides a delivery record of reports and packages.

When the report is re-issued, a notation of "revised report "is placed on the cover/signature page of the report.

25.8 Policies on Client Requests for Amendments

25.8.1 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 reporting limits 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).

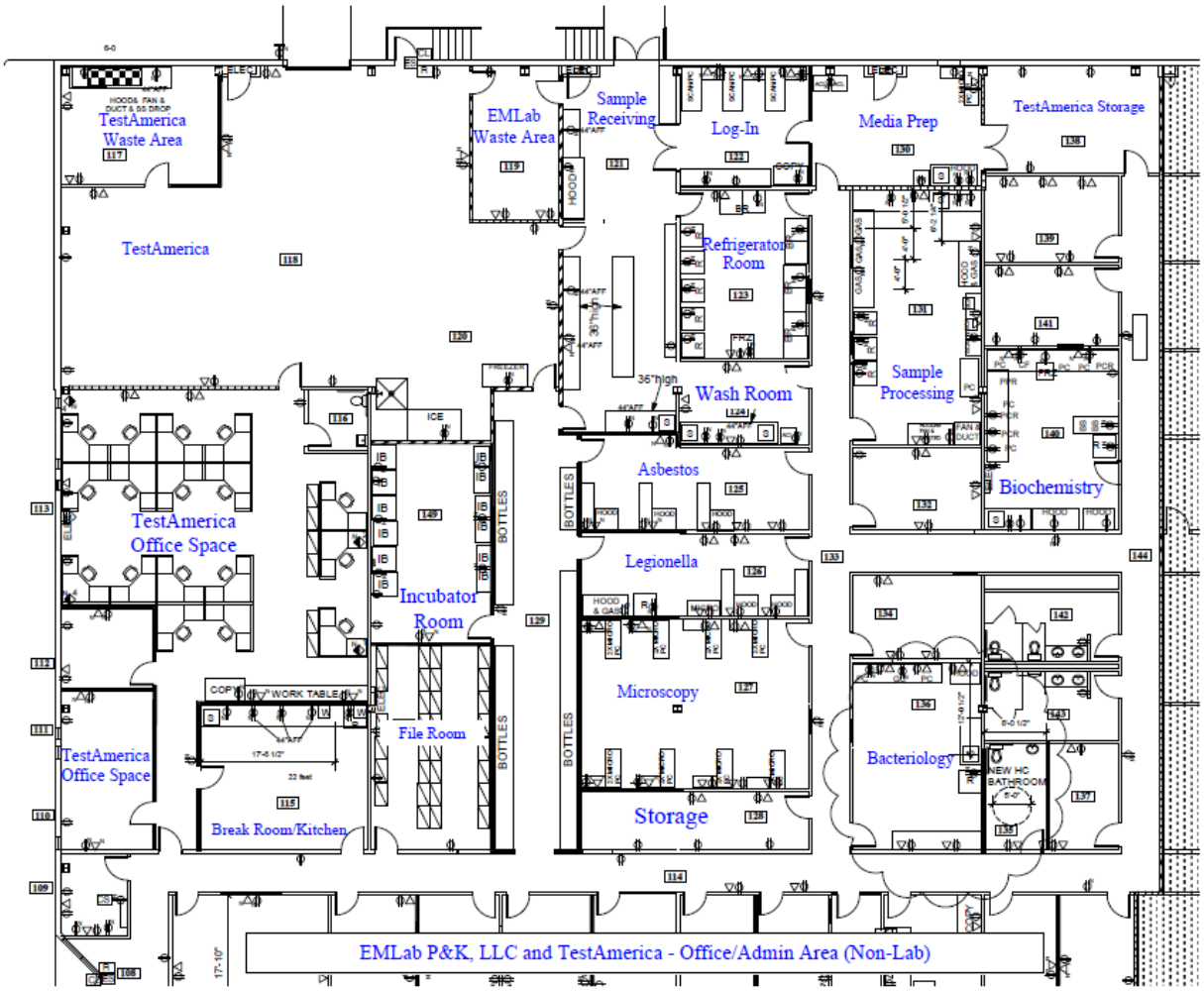
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely *no possible* impact on the interpretation of the analytical results and there is *no possibility* of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.8.2 Multiple Reports

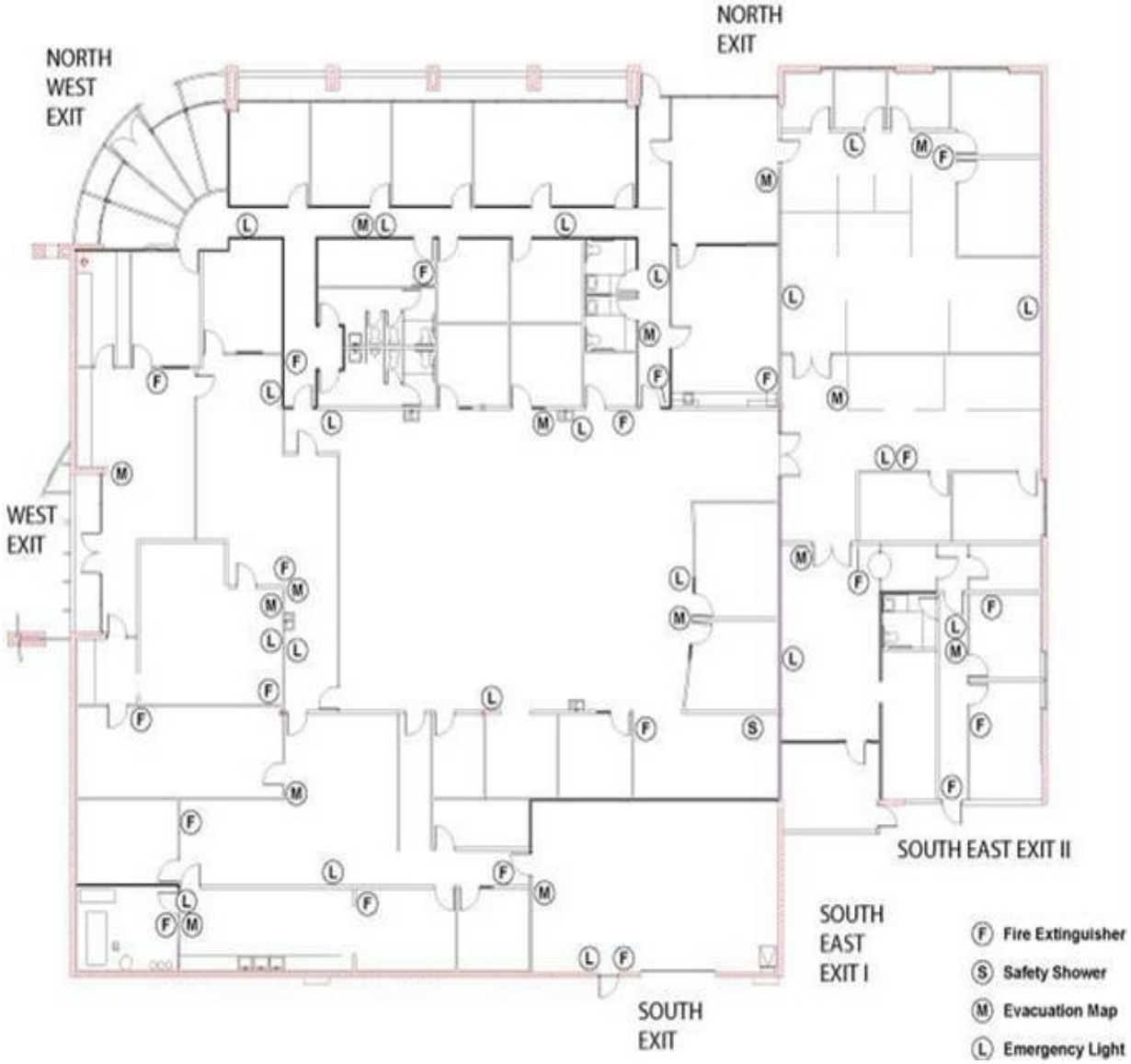
TestAmerica does not issue multiple reports for the same work order where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1. Laboratory Floor Plan

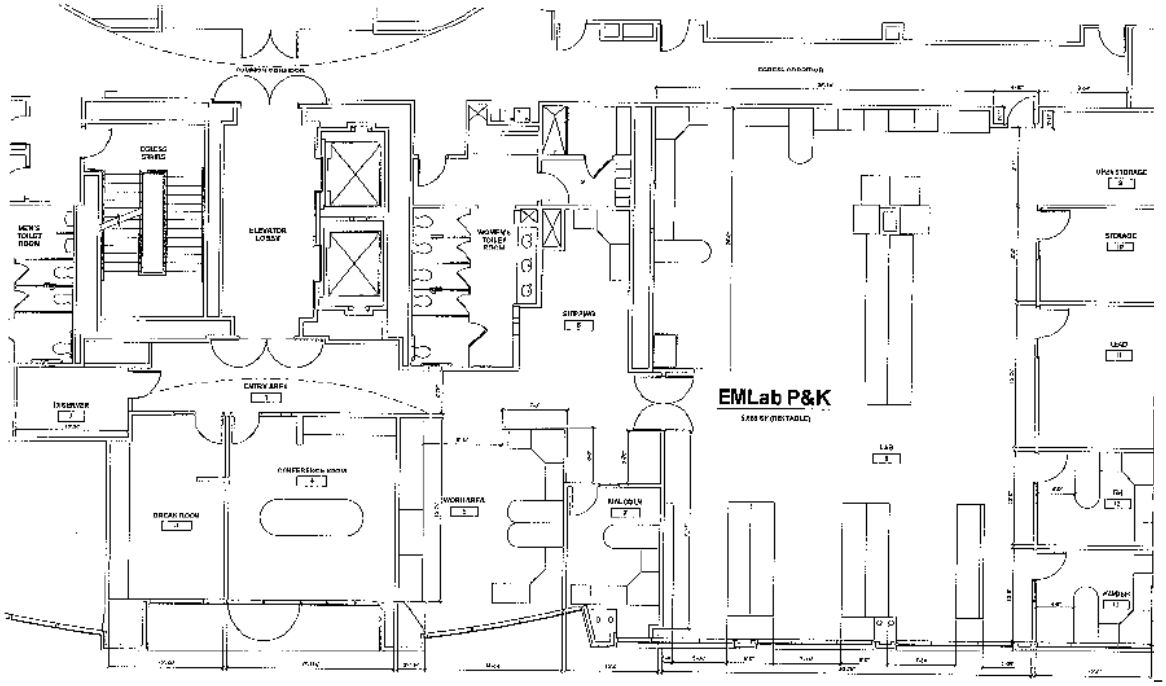
1.1 Floor Plan Marlton Main Laboratory



1.2 Floor Plan Phoenix Main Laboratory



1.3 Floor Plan South San Francisco Main Laboratory



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 quality 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)

Anomaly: A condition or event, other than a deficiency, that may affect the quality of the data, whether in the laboratory's control or not.

Asbestos Definitions

a. Limit of Quantitation: The Limit of Quantitation is 1%.

b. Less than One Percent (<1%): When the Laboratory reports a value of <1% using Calibrated Visual Area Estimation, this indicates that asbestos is present in an amount between trace and 0.99%, but cannot be accurately quantified at that level unless a 400 Point Count is performed.

c. Non-Detected (ND): The Laboratory reports "Non-Detected" when the laboratory homogenizes the sample in some way or analyzes a sufficient number of sub-samples to obtain a representative analysis whereby no asbestos fibers have been detected in any sub-sample preparations

d. Trace: When reporting the results of asbestos analyses using Calibrated Visual Area Estimation that are below the Laboratory's Limit of Quantitation, the Laboratory does not refer to or use the term "Trace"; the Laboratory reports the results as <1%. However, on occasion, samples can contain a "Trace" amount of asbestos. The term "Trace" means that asbestos was found to be present in the sample, but at a level below the minimum concentration needed to quantify at the reporting limit of 0.25% via a 400 Point Count (performed only by client request).

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 (chain of custody 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)

Daily Reference: A reference sample with a known or accepted quantity of analyte(s) of interest used as a daily calibration standard to verify accuracy.

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), whether in the laboratory's control or not.

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.

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.

Holding Times: The maximum time that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

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 ± 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)

(QS) 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 sorbant tube, impinger solution, filter, or other device. (TNI)

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, 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. 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.

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.

Observation: A record of phenomena that (1) may assist in evaluation of the sample data; (2) may be of importance to the project manager and/or the client, and yet not at the time of the observation have any known effect on quality.

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 (QAPP): A formal document describing the detailed quality control 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)

Replicate: One or more additional analyses for the same constituent of interest in a single aliquot of sample used to assist in the evaluation of method variance. To be performed on-site by a second qualified analyst.

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 quality control 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 organizations procedures and policies. (TNI)

Standard Operating Procedures (SOPs): 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.

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.

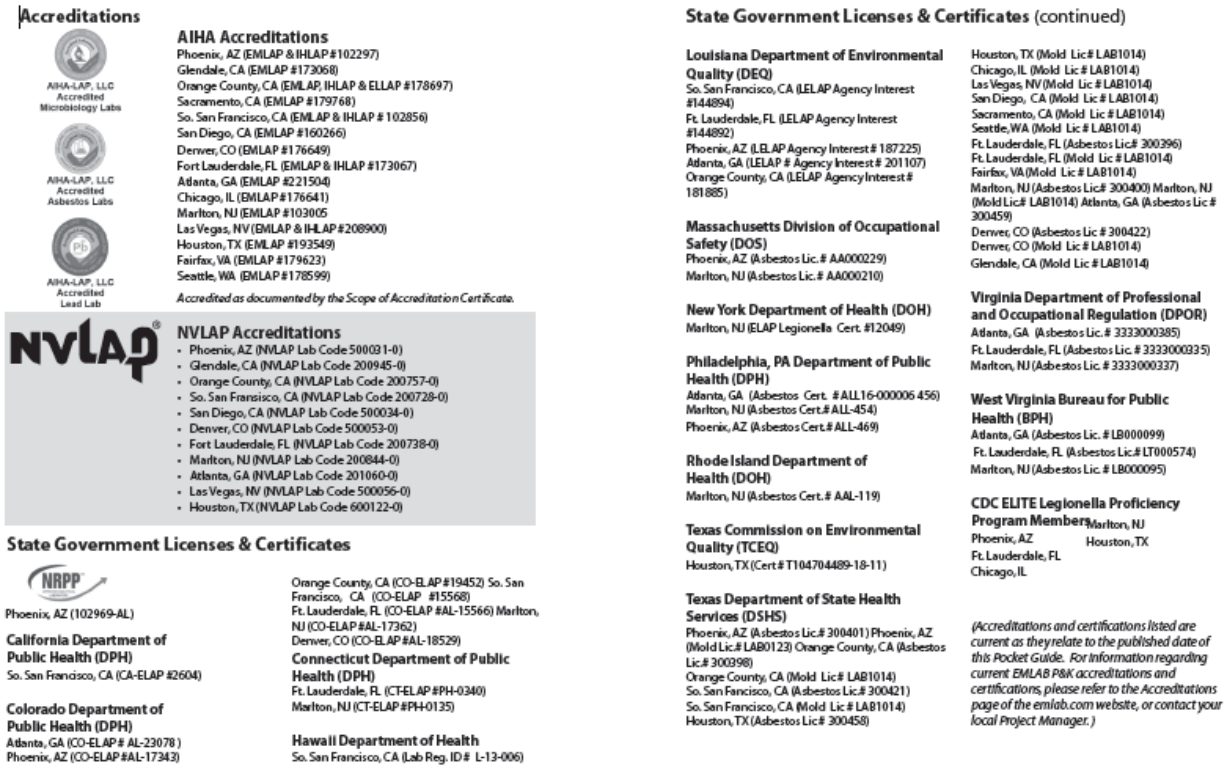
Uncertainty: A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

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
EHS – Environment, 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
SDS - 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
SD – Standard Deviation
SOP – Standard Operating Procedure
TAT – Turn-Around-Time
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3. Laboratory Certifications, Accreditations, Validations

EMLab P&K maintains accreditations, certifications, and approvals with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/ certification/licensing with the following organizations:



Accreditations

AIHA-LAP, LLC Accredited Microbiology Labs

AIHA-LAP, LLC Accredited Asbestos Labs

AIHA-LAP, LLC Accredited Lead Lab

AIHA Accreditations

Phoenix, AZ (EMLAP & IHLAP #102297)
Glendale, CA (EMLAP #173068)
Orange County, CA (EMLAP, IHLAP & ELLAP #178697)
Sacramento, CA (EMLAP #179768)
So. San Francisco, CA (EMLAP & IHLAP # 102856)
San Diego, CA (EMLAP #160266)
Denver, CO (EMLAP #176649)
Fort Lauderdale, FL (EMLAP & IHLAP #173067)
Atlanta, GA (EMLAP #221504)
Chicago, IL (EMLAP #176641)
Marlton, NJ (EMLAP #103005
Las Vegas, NV (EMLAP & IHLAP #208900)
Houston, TX (EMLAP #193549)
Fairfax, VA (EMLAP #179623)
Seattle, WA (EMLAP #178599)

Accredited as documented by the Scope of Accreditation Certificate.

NVLAP Accreditations

- Phoenix, AZ (NVLAP Lab Code 500031-0)
- Glendale, CA (NVLAP Lab Code 200945-0)
- Orange County, CA (NVLAP Lab Code 200757-0)
- So. San Fransisco, CA (NVLAP Lab Code 200728-0)
- San Diego, CA (NVLAP Lab Code 500034-0)
- Denver, CO (NVLAP Lab Code 500053-0)
- Fort Lauderdale, FL (NVLAP Lab Code 200738-0)
- Marlton, NJ (NVLAP Lab Code 200844-0)
- Atlanta, GA (NVLAP Lab Code 201060-0)
- Las Vegas, NV (NVLAP Lab Code 500056-0)
- Houston, TX (NVLAP Lab Code 600122-0)

State Government Licenses & Certificates

NRPP

Phoenix, AZ (102969-AL)

California Department of Public Health (DPH)
So. San Francisco, CA (CA-ELAP #2604)

Colorado Department of Public Health (DPH)
Atlanta, GA (CO-ELAP # AL-23078)
Phoenix, AZ (CO-ELAP #AL-17343)
Orange County, CA (CO-ELAP #19452) So. San Francisco, CA (CO-ELAP #15568)
Ft. Lauderdale, FL (CO-ELAP #AL-15566) Marlton, NJ (CO-ELAP #AL-17362)
Denver, CO (CO-ELAP #AL-18529)

Connecticut Department of Public Health (DPH)
Ft. Lauderdale, FL (CT-ELAP #PH-0340)
Marlton, NJ (CT-ELAP #PH-0135)

Hawaii Department of Health
So. San Francisco, CA (Lab Reg. ID # L-13-006)

State Government Licenses & Certificates (continued)

Louisiana Department of Environmental Quality (DEQ)
So. San Francisco, CA (LELAP Agency Interest #144894)
Ft. Lauderdale, FL (LELAP Agency Interest #144892)
Phoenix, AZ (LELAP Agency Interest # 187225)
Atlanta, GA (LELAP # Agency Interest # 201107)
Orange County, CA (LELAP Agency Interest # 181885)

Massachusetts Division of Occupational Safety (DOS)
Phoenix, AZ (Asbestos Lic.# AA000229)
Marlton, NJ (Asbestos Lic.# AA000210)

New York Department of Health (DOH)
Marlton, NJ (ELAP Legionella Cert. #12049)

Philadelphia, PA Department of Public Health (DPH)
Atlanta, GA (Asbestos Cert. # ALL16-000006 456)
Marlton, NJ (Asbestos Cert.# ALL-454)
Phoenix, AZ (Asbestos Cert.# ALL-469)

Rhode Island Department of Health (DOH)
Marlton, NJ (Asbestos Cert.# AAL-119)

Texas Commission on Environmental Quality (TCEQ)
Houston, TX (Cert.# T104704489-18-11)

Texas Department of State Health Services (DSHS)
Phoenix, AZ (Asbestos Lic.# 300401) Phoenix, AZ (Mold Lic.# LAB0123) Orange County, CA (Asbestos Lic.# 300398)
Orange County, CA (Mold Lic# LAB1014)
So. San Fancisco, CA (Asbestos Lic.# 300421)
So. San Fancisco, CA (Mold Lic # LAB1014)
Houston, TX (Asbestos Lic# 300458)
Houston, TX (Mold Lic# LAB1014)
Chicago, IL (Mold Lic # LAB1014)
Las Vegas, NV (Mold Lic # LAB1014)
San Diego, CA (Mold Lic # LAB1014)
Sacramento, CA (Mold Lic # LAB1014)
Seattle, WA (Mold Lic # LAB1014)
Ft. Lauderdale, FL (Asbestos Lic# 300396)
Ft. Lauderdale, FL (Mold Lic # LAB1014)
Fairfax, VA (Mold Lic # LAB1014)
Marlton, NJ (Asbestos Lic# 300400) Marlton, NJ (Mold Lic# LAB1014) Atlanta, GA (Asbestos Lic # 300459)
Denver, CO (Asbestos Lic # 300422)
Denver, CO (Mold Lic # LAB1014)
Glendale, CA (Mold Lic # LAB1014)

Virginia Department of Professional and Occupational Regulation (DPOR)
Atlanta, GA (Asbestos Lic.# 3333000385)
Ft. Lauderdale, FL (Asbestos Lic. # 3333000335)
Marlton, NJ (Asbestos Lic. # 3333000337)

West Virginia Bureau for Public Health (BPH)
Atlanta, GA (Asbestos Lic. # LB000099)
Ft. Lauderdale, FL (Asbestos Lic.# LT000574)
Marlton, NJ (Asbestos Lic.# LB000095)

CDC ELITE Legionella Proficiency Program Members
Marlton, NJ
Phoenix, AZ
Houston, TX
Ft. Lauderdale, FL
Chicago, IL

(Accreditations and certifications listed are current as they relate to the published date of this Pocket Guide. For information regarding current EMLAB P&K accreditations and certifications, please refer to the Accreditations page of the emlab.com website, or contact your local Project Manager.)

The certificates and accredited parameter lists are available for each State/Program at www.emlab.com under ”Accreditations”.

AIHA Laboratory Accreditation Programs, LLC

acknowledges that

Eurofins EMLab P&K

17461 Derian Ave. Suite 100, Irvine, CA 92614

Laboratory ID: 178697

along with all premises from which key activities are performed, as listed above, has fulfilled the requirements of the AIHA Laboratory Accreditation Programs (AIHA-LAP), LLC accreditation to the ISO/IEC 17025:2017 international standard, *General Requirements for the Competence of Testing and Calibration Laboratories* in the following:

LABORATORY ACCREDITATION PROGRAMS

✓	**INDUSTRIAL HYGIENE**	Accreditation Expires: September 01, 2021
✓	**ENVIRONMENTAL LEAD**	Accreditation Expires: September 01, 2021
✓	**ENVIRONMENTAL MICROBIOLOGY**	Accreditation Expires: September 01, 2021
☐	**FOOD**	Accreditation Expires:
☐	**UNIQUE SCOPES**	Accreditation Expires:

Specific Field(s) of Testing (FoT)/Method(s) within each Accreditation Program for which the above named laboratory maintains accreditation is outlined on the attached **Scope of Accreditation**. Continued accreditation is contingent upon successful on-going compliance with ISO/IEC 17025:2017 and AIHA-LAP, LLC requirements. This certificate is not valid without the attached **Scope of Accreditation**. Please review the AIHA-LAP, LLC website (www.aihaaccreditedlabs.org) for the most current Scope.

Beth Bair

Elizabeth Bair
Chairperson, Analytical Accreditation Board

Cheryl O. Morton

Cheryl O. Morton
Managing Director, AIHA Laboratory Accreditation Programs, LLC

Revision 17 – 09/11/2018

Date Issued: 08/21/2019

AIHA Laboratory Accreditation Programs, LLC
SCOPE OF ACCREDITATION

Eurofins EMLab P&K
17461 Derian Ave. Suite 100, Irvine, CA 92614

Laboratory ID: **178697**
Issue Date: 08/21/2019

The laboratory is approved for those specific field(s) of testing/methods listed in the table below. Clients are urged to verify the laboratory's current accreditation status for the particular field(s) of testing/Methods, since these can change due to proficiency status, suspension and/or withdrawal of accreditation.

Industrial Hygiene Laboratory Accreditation Program (IHLAP)

Initial Accreditation Date: 06/01/2011

IHLAP Scope Category	**Field of Testing (FoT)** (FoTs cover all relevant IH matrices)	**Technology sub-type/ Detector**	**Published Reference Method/Title of In-house Method**	**Method Description or Analyte** (*for internal methods only*)
Asbestos/Fiber Microscopy Core	Phase Contrast Microscopy (PCM)		NIOSH 7400	

A complete listing of currently accredited Industrial Hygiene laboratories is available on the AIHA-LAP, LLC website at: http://www.aihaaccreditedlabs.org

AIHA Laboratory Accreditation Programs, LLC
SCOPE OF ACCREDITATION

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17461 Derian Ave. Suite 100, Irvine, CA 92614

Laboratory ID: **178697**
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The laboratory is approved for those specific field(s) of testing/methods listed in the table below. Clients are urged to verify the laboratory's current accreditation status for the particular field(s) of testing/Methods, since these can change due to proficiency status, suspension and/or withdrawal of accreditation.

Environmental Microbiology Laboratory Accreditation Program (EMLAP)

Initial Accreditation Date: 07/01/2005

EMLAP Category	Field of Testing (FoT)	Method	Method Description (*for internal methods only*)
Fungal	Air - Direct Examination	EM-MY-S-1038	Preparation and Analysis of Spore Trap (Air) Samples for Fungal Spores, Other Biological and Non-Biological Particles
	Bulk - Direct Examination	EM-MY-S-1039	Preparation and Analysis of Tape, Swab, Wipe, Bulk and Dust - Soil Samples for Qualitative Direct Microscopic Examination
	Surface - Direct Examination	EM-MY-S-1041	Preparation and Analysis of Tape, Swab, Wipe, Bulk, and Dust - Soil Samples for Quantitative Direct Microscopic Examination
Bacterial	Legionella	EM-BT-S-1045	Enumeration of Legionella. International Standard ISO 11731:2017
		EM-BT-S-1687	CDC Laboratory protocol 2016

A complete listing of currently accredited Environmental Microbiology laboratories is available on the AIHA-LAP, LLC website at: http://www.aihaaccreditedlabs.org

AIHA Laboratory Accreditation Programs, LLC
SCOPE OF ACCREDITATION

Eurofins EMLab P&K
17461 Derian Ave. Suite 100, Irvine, CA 92614

Laboratory ID: **178697**
Issue Date: 08/21/2019

The laboratory is approved for those specific field(s) of testing/methods listed in the table below. Clients are urged to verify the laboratory's current accreditation status for the particular field(s) of testing/Methods, since these can change due to proficiency status, suspension and/or withdrawal of accreditation.

The EPA recognizes the AIHA-LAP, LLC ELLAP program as meeting the requirements of the National Lead Laboratory Accreditation Program (NLLAP) established under Title X of the Residential Lead-Based Paint Hazard Reduction Act of 1992 and includes paint, soil and dust wipe analysis. Air and composited wipes analyses are not included as part of the NLLAP.

Environmental Lead Laboratory Accreditation Program (ELLAP)

Initial Accreditation Date: 03/01/2017

Field of Testing (FoT)	Technology sub-type/ Detector	Method	Method Description (*for internal methods only*)
Paint		EPA SW-846 7000B Modified	
		NIOSH 7082	
Settled Dust by Wipe		EPA SW-846 7000B Modified	
		NIOSH 7082	

A complete listing of currently accredited Environmental Lead laboratories is available on the AIHA-LAP, LLC website at: http://www.aihaaccreditedlabs.org

Weck Laboratories, Inc.
Analytical Laboratory Service - Since 1964

Quality Assurance Manual

Rev 20.5 – Effective Date 04/26/2019
Updated 04/25/2019

Weck Laboratories, Inc.

Analytical Laboratory Services - Since 1964

QUALITY ASSURANCE MANUAL

For
Weck Laboratories, Inc.

14859 Clark Avenue
City of Industry, CA 91745
Telephone 626-336-2139 Fax 626-336-2634
www.wecklabs.com

Name	Function	Phone	Signatures	Date
Alfredo E. Pierri	President/CEO	626-336-2139 Ext. 111		04/26/2019
Alan Ching	Quality Assurance Director	626-336-2139 Ext. 116		04/26/2019
Joe Chau	Lab General Manager	626-336-2139 Ext. 110		04/26/2019
Agustin Pierri	Technical Director	626-336-2139 Ext. 128		04/26/2019

Revision Number:	20.5	Effective Date:	04/26/2019

Table of Contents

APPENDICES

Section	Title	Page	Effective Date

Table of Tables

Table of Figures

State of Nevada

Department of Conservation and Natural Resources
Division of Environmental Protection

Certifies that

Weck Laboratories, Inc.

14859 E. Clark Ave. Industry, CA 91745-

Having met the requirements of the
Nevada Administrative Code: NAC 445A

is hereby approved to perform the analyses as indicated on the most recently issued parameter list which must accompany this certificate to be valid. It is the certified laboratory's responsibility to provide their client the most current certified parameter list. Contact LCP to verify certification status.

Expiration Date: 7/31/2020

Donald E. LaFara
Program Manager
Laboratory Certification Program

Digitally signed by Don LaFara
Date: 2019.08.01 14:43:51 -07'00'

Certificate Number: CA002112020-1

Donald LaFara, Program Manager, 08/01/2019

State of Nevada Department of Conservation and Natural Resources
Division of Environmental Protection
Laboratory Scope of Accreditation

EPA Number: ***CA00211*** **Attachment to Certificate Number:** **CA002112020-1** **Expiration Date:** **7/31/2020**

Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***CWA (Non Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
Discipline: Chemistry				
EPA 1631E	Mercury	8/1/2019	7/31/2020	Certified
EPA 200.7	Aluminum	8/1/2019	7/31/2020	Certified
EPA 200.7	Antimony	8/1/2019	7/31/2020	Certified
EPA 200.7	Arsenic	8/1/2019	7/31/2020	Certified
EPA 200.7	Barium	8/1/2019	7/31/2020	Certified
EPA 200.7	Beryllium	8/1/2019	7/31/2020	Certified
EPA 200.7	Boron	8/1/2019	7/31/2020	Certified
EPA 200.7	Cadmium	8/1/2019	7/31/2020	Certified
EPA 200.7	Calcium	8/1/2019	7/31/2020	Certified
EPA 200.7	Calcium hardness as CaCO3	8/1/2019	7/31/2020	Certified
EPA 200.7	Chromium	8/1/2019	7/31/2020	Certified
EPA 200.7	Cobalt	8/1/2019	7/31/2020	Certified
EPA 200.7	Copper	8/1/2019	7/31/2020	Certified
EPA 200.7	Hardness by calculation	8/1/2019	7/31/2020	Certified
EPA 200.7	Iron	8/1/2019	7/31/2020	Certified
EPA 200.7	Lead	8/1/2019	7/31/2020	Certified
EPA 200.7	Magnesium	8/1/2019	7/31/2020	Certified
EPA 200.7	Manganese	8/1/2019	7/31/2020	Certified
EPA 200.7	Molybdenum	8/1/2019	7/31/2020	Certified
EPA 200.7	Nickel	8/1/2019	7/31/2020	Certified
EPA 200.7	Potassium	8/1/2019	7/31/2020	Certified
EPA 200.7	Selenium	8/1/2019	7/31/2020	Certified
EPA 200.7	Silica as SiO2	8/1/2019	7/31/2020	Certified
EPA 200.7	Silver	8/1/2019	7/31/2020	Certified
EPA 200.7	Sodium	8/1/2019	7/31/2020	Certified
EPA 200.7	Strontium	8/1/2019	7/31/2020	Certified
EPA 200.7	Thallium	8/1/2019	7/31/2020	Certified
EPA 200.7	Tin	8/1/2019	7/31/2020	Certified
EPA 200.7	Titanium	8/1/2019	7/31/2020	Certified

State of Nevada Department of Conservation and Natural Resources
Division of Environmental Protection
Laboratory Scope of Accreditation

EPA Number: ***CA00211*** **Attachment to Certificate Number:** **CA002112020-1** **Expiration Date:** **7/31/2020**

Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***CWA (Non Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
EPA 200.7	Vanadium	8/1/2019	7/31/2020	Certified
EPA 200.7	Zinc	8/1/2019	7/31/2020	Certified
EPA 200.8	Aluminum	8/1/2019	7/31/2020	Certified
EPA 200.8	Antimony	8/1/2019	7/31/2020	Certified
EPA 200.8	Arsenic	8/1/2019	7/31/2020	Certified
EPA 200.8	Barium	8/1/2019	7/31/2020	Certified
EPA 200.8	Beryllium	8/1/2019	7/31/2020	Certified
EPA 200.8	Boron	8/1/2019	7/31/2020	Certified
EPA 200.8	Cadmium	8/1/2019	7/31/2020	Certified
EPA 200.8	Calcium	8/1/2019	7/31/2020	Certified
EPA 200.8	Chromium	8/1/2019	7/31/2020	Certified
EPA 200.8	Cobalt	8/1/2019	7/31/2020	Certified
EPA 200.8	Copper	8/1/2019	7/31/2020	Certified
EPA 200.8	Iron	8/1/2019	7/31/2020	Certified
EPA 200.8	Lead	8/1/2019	7/31/2020	Certified
EPA 200.8	Magnesium	8/1/2019	7/31/2020	Certified
EPA 200.8	Manganese	8/1/2019	7/31/2020	Certified
EPA 200.8	Molybdenum	8/1/2019	7/31/2020	Certified
EPA 200.8	Nickel	8/1/2019	7/31/2020	Certified
EPA 200.8	Potassium	8/1/2019	7/31/2020	Certified
EPA 200.8	Selenium	8/1/2019	7/31/2020	Certified
EPA 200.8	Silver	8/1/2019	7/31/2020	Certified
EPA 200.8	Sodium	8/1/2019	7/31/2020	Certified
EPA 200.8	Strontium	8/1/2019	7/31/2020	Certified
EPA 200.8	Thallium	8/1/2019	7/31/2020	Certified
EPA 200.8	Tin	8/1/2019	7/31/2020	Certified
EPA 200.8	Titanium	8/1/2019	7/31/2020	Certified
EPA 200.8	Vanadium	8/1/2019	7/31/2020	Certified
EPA 200.8	Zinc	8/1/2019	7/31/2020	Certified
EPA 218.6	Chromium VI	8/1/2019	7/31/2020	Certified

State of Nevada Department of Conservation and Natural Resources
Division of Environmental Protection
Laboratory Scope of Accreditation

EPA Number: ***CA00211*** **Attachment to Certificate Number:** **CA002112020-1** **Expiration Date:** **7/31/2020**

Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***CWA (Non Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
EPA 245.1	Mercury	8/1/2019	7/31/2020	Certified
EPA 335.4	Cyanide, Total	8/1/2019	7/31/2020	Certified
EPA 350.1	Ammonia as N	8/1/2019	7/31/2020	Certified
EPA 351.2	Kjeldahl nitrogen - total	8/1/2019	7/31/2020	Certified
EPA 353.2	Nitrate as N	8/1/2019	7/31/2020	Certified
EPA 353.2	Nitrate-nitrite	8/1/2019	7/31/2020	Certified
EPA 353.2	Nitrite as N	8/1/2019	7/31/2020	Certified
EPA 365.1	Orthophosphate as P	8/1/2019	7/31/2020	Certified
EPA 365.1	Phosphorus, total	8/1/2019	7/31/2020	Certified
EPA 365.3	Orthophosphate as P	8/1/2019	7/31/2020	Certified
EPA 365.3	Phosphorus, total	8/1/2019	7/31/2020	Certified
EPA 410.4	Chemical oxygen demand	8/1/2019	7/31/2020	Certified
EPA 608.3	4,4'-DDD	8/1/2019	7/31/2020	Certified
EPA 608.3	4,4'-DDE	8/1/2019	7/31/2020	Certified
EPA 608.3	4,4'-DDT	8/1/2019	7/31/2020	Certified
EPA 608.3	Aldrin	8/1/2019	7/31/2020	Certified
EPA 608.3	alpha-BHC (alpha-Hexachlorocyclohexane)	8/1/2019	7/31/2020	Certified
EPA 608.3	alpha-Chlordane (cis-Chlordane)	8/1/2019	7/31/2020	Certified
EPA 608.3	Aroclor-1016 (PCB-1016)	8/1/2019	7/31/2020	Certified
EPA 608.3	Aroclor-1221 (PCB-1221)	8/1/2019	7/31/2020	Certified
EPA 608.3	Aroclor-1232 (PCB-1232)	8/1/2019	7/31/2020	Certified
EPA 608.3	Aroclor-1242 (PCB-1242)	8/1/2019	7/31/2020	Certified
EPA 608.3	Aroclor-1248 (PCB-1248)	8/1/2019	7/31/2020	Certified
EPA 608.3	Aroclor-1254 (PCB-1254)	8/1/2019	7/31/2020	Certified
EPA 608.3	Aroclor-1260 (PCB-1260)	8/1/2019	7/31/2020	Certified
EPA 608.3	beta-BHC (beta-Hexachlorocyclohexane)	8/1/2019	7/31/2020	Certified
EPA 608.3	Chlordane (tech.)	8/1/2019	7/31/2020	Certified
EPA 608.3	delta-BHC	8/1/2019	7/31/2020	Certified
EPA 608.3	Dieldrin	8/1/2019	7/31/2020	Certified
EPA 608.3	Endosulfan I	8/1/2019	7/31/2020	Certified

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Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***CWA (Non Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
EPA 608.3	Endosulfan II	8/1/2019	7/31/2020	Certified
EPA 608.3	Endosulfan sulfate	8/1/2019	7/31/2020	Certified
EPA 608.3	Endrin	8/1/2019	7/31/2020	Certified
EPA 608.3	Endrin aldehyde	8/1/2019	7/31/2020	Certified
EPA 608.3	gamma-BHC (Lindane)	8/1/2019	7/31/2020	Certified
EPA 608.3	Heptachlor	8/1/2019	7/31/2020	Certified
EPA 608.3	Heptachlor epoxide	8/1/2019	7/31/2020	Certified
EPA 608.3	Methoxychlor	8/1/2019	7/31/2020	Certified
EPA 608.3	Toxaphene (Chlorinated camphene)	8/1/2019	7/31/2020	Certified
EPA 624.1	1,1,1,2-Tetrachloroethane	8/1/2019	7/31/2020	Certified
EPA 624.1	1,1,1-Trichloroethane	8/1/2019	7/31/2020	Certified
EPA 624.1	1,1,2,2-Tetrachloroethane	8/1/2019	7/31/2020	Certified
EPA 624.1	1,1,2-Trichloroethane	8/1/2019	7/31/2020	Certified
EPA 624.1	1,1-Dichloroethane	8/1/2019	7/31/2020	Certified
EPA 624.1	1,1-Dichloroethylene	8/1/2019	7/31/2020	Certified
EPA 624.1	1,2,3-Trichloropropane	8/1/2019	7/31/2020	Certified
EPA 624.1	1,2,4-Trichlorobenzene	8/1/2019	7/31/2020	Certified
EPA 624.1	1,2,4-Trimethylbenzene	8/1/2019	7/31/2020	Certified
EPA 624.1	1,2-Dichlorobenzene	8/1/2019	7/31/2020	Certified
EPA 624.1	1,2-Dichloroethane	8/1/2019	7/31/2020	Certified
EPA 624.1	1,2-Dichloropropane	8/1/2019	7/31/2020	Certified
EPA 624.1	1,3,5-Trimethylbenzene	8/1/2019	7/31/2020	Certified
EPA 624.1	1,3-Dichlorobenzene	8/1/2019	7/31/2020	Certified
EPA 624.1	1,4-Dichlorobenzene	8/1/2019	7/31/2020	Certified
EPA 624.1	2-Butanone (Methyl ethyl ketone, MEK)	8/1/2019	7/31/2020	Certified
EPA 624.1	2-Chloroethyl vinyl ether	8/1/2019	7/31/2020	Certified
EPA 624.1	2-Hexanone	8/1/2019	7/31/2020	Certified
EPA 624.1	4-Methyl-2-pentanone (MIBK)	8/1/2019	7/31/2020	Certified
EPA 624.1	Acetone	8/1/2019	7/31/2020	Certified
EPA 624.1	Acrolein (Propenal)	8/1/2019	7/31/2020	Certified

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Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***CWA (Non Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
EPA 624.1	Acrylonitrile	8/1/2019	7/31/2020	Certified
EPA 624.1	Benzene	8/1/2019	7/31/2020	Certified
EPA 624.1	Bromodichloromethane	8/1/2019	7/31/2020	Certified
EPA 624.1	Bromoform	8/1/2019	7/31/2020	Certified
EPA 624.1	Carbon disulfide	8/1/2019	7/31/2020	Certified
EPA 624.1	Carbon tetrachloride	8/1/2019	7/31/2020	Certified
EPA 624.1	Chlorobenzene	8/1/2019	7/31/2020	Certified
EPA 624.1	Chlorodibromomethane (Dibromochloromethane)	8/1/2019	7/31/2020	Certified
EPA 624.1	Chloroethane (Ethyl chloride)	8/1/2019	7/31/2020	Certified
EPA 624.1	Chloroform	8/1/2019	7/31/2020	Certified
EPA 624.1	cis-1,2-Dichloroethylene	8/1/2019	7/31/2020	Certified
EPA 624.1	cis-1,3-Dichloropropene (cis-1,3-Dichloropropylene)	8/1/2019	7/31/2020	Certified
EPA 624.1	Dibromomethane (Methylene bromide)	8/1/2019	7/31/2020	Certified
EPA 624.1	Dichlorodifluoromethane (Freon-12)	8/1/2019	7/31/2020	Certified
EPA 624.1	Ethylbenzene	8/1/2019	7/31/2020	Certified
EPA 624.1	m+p-xylene	8/1/2019	7/31/2020	Certified
EPA 624.1	Methyl bromide (Bromomethane)	8/1/2019	7/31/2020	Certified
EPA 624.1	Methyl chloride (Chloromethane)	8/1/2019	7/31/2020	Certified
EPA 624.1	Methyl tert-butyl ether (MTBE)	8/1/2019	7/31/2020	Certified
EPA 624.1	Methylene chloride (Dichloromethane)	8/1/2019	7/31/2020	Certified
EPA 624.1	Naphthalene	8/1/2019	7/31/2020	Certified
EPA 624.1	o-Xylene	8/1/2019	7/31/2020	Certified
EPA 624.1	Styrene	8/1/2019	7/31/2020	Certified
EPA 624.1	Tetrachloroethylene (Perchloroethylene)	8/1/2019	7/31/2020	Certified
EPA 624.1	Toluene	8/1/2019	7/31/2020	Certified
EPA 624.1	trans-1,2-Dichloroethylene	8/1/2019	7/31/2020	Certified
EPA 624.1	trans-1,3-Dichloropropene (trans-1,3-Dichloropropylene)	8/1/2019	7/31/2020	Certified
EPA 624.1	Trichloroethene (Trichloroethylene)	8/1/2019	7/31/2020	Certified
EPA 624.1	Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	8/1/2019	7/31/2020	Certified
EPA 624.1	Vinyl chloride	8/1/2019	7/31/2020	Certified

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Weck Laboratories, Inc.
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Matrix: ***CWA (Non Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
EPA 624.1	Xylene (total)	8/1/2019	7/31/2020	Certified
EPA 625.1	1,2,4-Trichlorobenzene	8/1/2019	7/31/2020	Certified
EPA 625.1	2,3,4,6-Tetrachlorophenol	8/1/2019	7/31/2020	Certified
EPA 625.1	2,4,5-Trichlorophenol	8/1/2019	7/31/2020	Certified
EPA 625.1	2,4,6-Trichlorophenol	8/1/2019	7/31/2020	Certified
EPA 625.1	2,4-Dichlorophenol	8/1/2019	7/31/2020	Certified
EPA 625.1	2,4-Dimethylphenol	8/1/2019	7/31/2020	Certified
EPA 625.1	2,4-Dinitrophenol	8/1/2019	7/31/2020	Certified
EPA 625.1	2,4-Dinitrotoluene (2,4-DNT)	8/1/2019	7/31/2020	Certified
EPA 625.1	2,6-Dinitrotoluene (2,6-DNT)	8/1/2019	7/31/2020	Certified
EPA 625.1	2-Chloronaphthalene	8/1/2019	7/31/2020	Certified
EPA 625.1	2-Chlorophenol	8/1/2019	7/31/2020	Certified
EPA 625.1	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	8/1/2019	7/31/2020	Certified
EPA 625.1	2-Methylnaphthalene	8/1/2019	7/31/2020	Certified
EPA 625.1	2-Methylphenol (o-Cresol)	8/1/2019	7/31/2020	Certified
EPA 625.1	2-Nitroaniline	8/1/2019	7/31/2020	Certified
EPA 625.1	2-Nitrophenol	8/1/2019	7/31/2020	Certified
EPA 625.1	3 & 4-Methylphenol (m & p-Cresol)	8/1/2019	7/31/2020	Certified
EPA 625.1	3,3'-Dichlorobenzidine	8/1/2019	7/31/2020	Certified
EPA 625.1	3-Nitroaniline	8/1/2019	7/31/2020	Certified
EPA 625.1	4,4'-DDD	8/1/2019	7/31/2020	Certified
EPA 625.1	4,4'-DDE	8/1/2019	7/31/2020	Certified
EPA 625.1	4,4'-DDT	8/1/2019	7/31/2020	Certified
EPA 625.1	4-Bromophenyl phenyl ether	8/1/2019	7/31/2020	Certified
EPA 625.1	4-Chloro-3-methylphenol	8/1/2019	7/31/2020	Certified
EPA 625.1	4-Chloroaniline	8/1/2019	7/31/2020	Certified
EPA 625.1	4-Chlorophenyl phenylether	8/1/2019	7/31/2020	Certified
EPA 625.1	4-Methylphenol (p-Cresol)	8/1/2019	7/31/2020	Certified
EPA 625.1	4-Nitroaniline	8/1/2019	7/31/2020	Certified
EPA 625.1	4-Nitrophenol	8/1/2019	7/31/2020	Certified

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Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***CWA (Non Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
EPA 625.1	Acenaphthene	8/1/2019	7/31/2020	Certified
EPA 625.1	Acenaphthylene	8/1/2019	7/31/2020	Certified
EPA 625.1	Aldrin	8/1/2019	7/31/2020	Certified
EPA 625.1	alpha-BHC (alpha-Hexachlorocyclohexane)	8/1/2019	7/31/2020	Certified
EPA 625.1	Aniline	8/1/2019	7/31/2020	Certified
EPA 625.1	Anthracene	8/1/2019	7/31/2020	Certified
EPA 625.1	Benzidine	8/1/2019	7/31/2020	Certified
EPA 625.1	Benzo(a)anthracene	8/1/2019	7/31/2020	Certified
EPA 625.1	Benzo(a)pyrene	8/1/2019	7/31/2020	Certified
EPA 625.1	Benzo(b)fluoranthene	8/1/2019	7/31/2020	Certified
EPA 625.1	Benzo(g,h,i)perylene	8/1/2019	7/31/2020	Certified
EPA 625.1	Benzo(k)fluoranthene	8/1/2019	7/31/2020	Certified
EPA 625.1	Benzoic acid	8/1/2019	7/31/2020	Certified
EPA 625.1	Benzyl alcohol	8/1/2019	7/31/2020	Certified
EPA 625.1	beta-BHC (beta-Hexachlorocyclohexane)	8/1/2019	7/31/2020	Certified
EPA 625.1	bis(2-Chloroethoxy)methane	8/1/2019	7/31/2020	Certified
EPA 625.1	bis(2-Chloroethyl) ether	8/1/2019	7/31/2020	Certified
EPA 625.1	bis(2-Chloroisopropyl) ether, (2,2'-Oxybis(1-chloropropane))	8/1/2019	7/31/2020	Certified
EPA 625.1	bis(2-Ethylhexyl)phthalate,(DEHP, Di(2-ethylhexyl) phthalate)	8/1/2019	7/31/2020	Certified
EPA 625.1	Butyl benzyl phthalate	8/1/2019	7/31/2020	Certified
EPA 625.1	Carbazole	8/1/2019	7/31/2020	Certified
EPA 625.1	Chrysene	8/1/2019	7/31/2020	Certified
EPA 625.1	delta-BHC	8/1/2019	7/31/2020	Certified
EPA 625.1	Dibenz(a,h) anthracene	8/1/2019	7/31/2020	Certified
EPA 625.1	Dibenzofuran	8/1/2019	7/31/2020	Certified
EPA 625.1	Dieldrin	8/1/2019	7/31/2020	Certified
EPA 625.1	Diethyl phthalate	8/1/2019	7/31/2020	Certified
EPA 625.1	Dimethyl phthalate	8/1/2019	7/31/2020	Certified
EPA 625.1	Di-n-butyl phthalate	8/1/2019	7/31/2020	Certified
EPA 625.1	Di-n-octyl phthalate	8/1/2019	7/31/2020	Certified

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Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***CWA (Non Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
EPA 625.1	Endosulfan I	8/1/2019	7/31/2020	Certified
EPA 625.1	Endosulfan II	8/1/2019	7/31/2020	Certified
EPA 625.1	Endosulfan sulfate	8/1/2019	7/31/2020	Certified
EPA 625.1	Endrin	8/1/2019	7/31/2020	Certified
EPA 625.1	Endrin aldehyde	8/1/2019	7/31/2020	Certified
EPA 625.1	Fluoranthene	8/1/2019	7/31/2020	Certified
EPA 625.1	Fluorene	8/1/2019	7/31/2020	Certified
EPA 625.1	gamma-BHC (Lindane)	8/1/2019	7/31/2020	Certified
EPA 625.1	Heptachlor	8/1/2019	7/31/2020	Certified
EPA 625.1	Heptachlor epoxide	8/1/2019	7/31/2020	Certified
EPA 625.1	Hexachlorobenzene	8/1/2019	7/31/2020	Certified
EPA 625.1	Hexachlorobutadiene	8/1/2019	7/31/2020	Certified
EPA 625.1	Hexachlorocyclopentadiene	8/1/2019	7/31/2020	Certified
EPA 625.1	Hexachloroethane	8/1/2019	7/31/2020	Certified
EPA 625.1	Indeno(1,2,3-cd) pyrene	8/1/2019	7/31/2020	Certified
EPA 625.1	Isophorone	8/1/2019	7/31/2020	Certified
EPA 625.1	Naphthalene	8/1/2019	7/31/2020	Certified
EPA 625.1	Nitrobenzene	8/1/2019	7/31/2020	Certified
EPA 625.1	n-Nitrosodimethylamine	8/1/2019	7/31/2020	Certified
EPA 625.1	n-Nitrosodi-n-propylamine	8/1/2019	7/31/2020	Certified
EPA 625.1	n-Nitrosodiphenylamine	8/1/2019	7/31/2020	Certified
EPA 625.1	Pentachlorophenol	8/1/2019	7/31/2020	Certified
EPA 625.1	Phenanthrene	8/1/2019	7/31/2020	Certified
EPA 625.1	Phenol	8/1/2019	7/31/2020	Certified
EPA 625.1	Pyrene	8/1/2019	7/31/2020	Certified
EPA 625.1	Pyridine	8/1/2019	7/31/2020	Certified
Nitrate Calculation	Nitrate-N (by calculation)	8/1/2019	7/31/2020	Certified
Organic Nitrogen by Calculation (TKN - NH3)	Organic nitrogen	8/1/2019	7/31/2020	Certified
SM 2540 C	Residue-filterable (TDS)	8/1/2019	7/31/2020	Certified
SM 2540 D	Residue-nonfilterable (TSS)	8/1/2019	7/31/2020	Certified

Disclaimer: A laboratory that is certified or approved has established that they have the ability to implement a quality control program in accordance with the appropriate Federal or State regulations or statutes. It is the certified laboratory's responsibility to provide their client the most current certified parameter list. Contact LCP to verify certification status.

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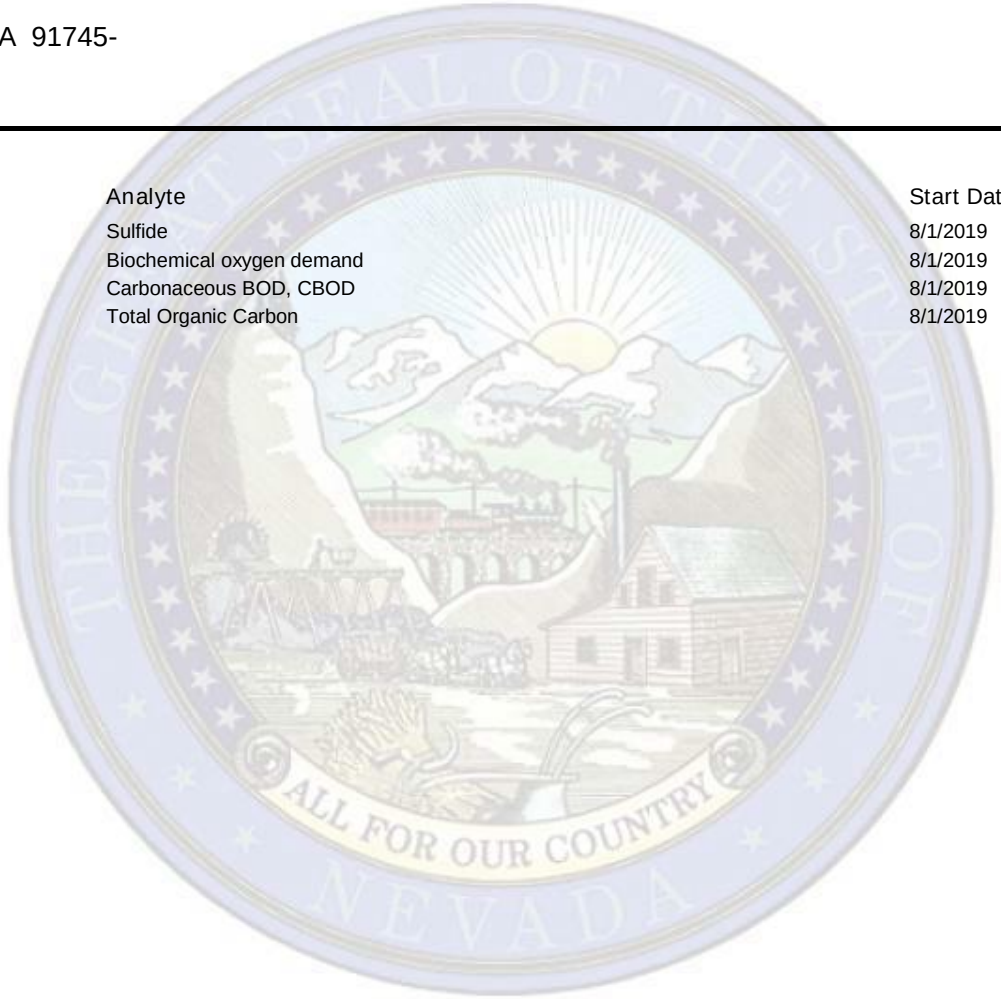
Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***CWA (Non Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
SM 4500-$S2^{-}$ D	Sulfide	8/1/2019	7/31/2020	Certified
SM 5210 B	Biochemical oxygen demand	8/1/2019	7/31/2020	Certified
SM 5210 B	Carbonaceous BOD, CBOD	8/1/2019	7/31/2020	Certified
SM 5310 B	Total Organic Carbon	8/1/2019	7/31/2020	Certified



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Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***SDWA (Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
Discipline: Chemistry				
EPA 1613B	2,3,7,8-Tetrachlorodibenzo- p-dioxin (TCDD)	8/1/2019	7/31/2020	Certified
EPA 200.7	Aluminum	8/1/2019	7/31/2020	Certified
EPA 200.7	Barium	8/1/2019	7/31/2020	Certified
EPA 200.7	Beryllium	8/1/2019	7/31/2020	Certified
EPA 200.7	Boron	8/1/2019	7/31/2020	Certified
EPA 200.7	Cadmium	8/1/2019	7/31/2020	Certified
EPA 200.7	Calcium	8/1/2019	7/31/2020	Certified
EPA 200.7	Calcium hardness as CaCO3	8/1/2019	7/31/2020	Certified
EPA 200.7	Chromium	8/1/2019	7/31/2020	Certified
EPA 200.7	Copper	8/1/2019	7/31/2020	Certified
EPA 200.7	Hardness by calculation	8/1/2019	7/31/2020	Certified
EPA 200.7	Iron	8/1/2019	7/31/2020	Certified
EPA 200.7	Magnesium	8/1/2019	7/31/2020	Certified
EPA 200.7	Manganese	8/1/2019	7/31/2020	Certified
EPA 200.7	Nickel	8/1/2019	7/31/2020	Certified
EPA 200.7	Potassium	8/1/2019	7/31/2020	Certified
EPA 200.7	Silica as SiO2	8/1/2019	7/31/2020	Certified
EPA 200.7	Silver	8/1/2019	7/31/2020	Certified
EPA 200.7	Sodium	8/1/2019	7/31/2020	Certified
EPA 200.7	Zinc	8/1/2019	7/31/2020	Certified
EPA 200.8	Aluminum	8/1/2019	7/31/2020	Certified
EPA 200.8	Antimony	8/1/2019	7/31/2020	Certified
EPA 200.8	Arsenic	8/1/2019	7/31/2020	Certified
EPA 200.8	Barium	8/1/2019	7/31/2020	Certified
EPA 200.8	Beryllium	8/1/2019	7/31/2020	Certified
EPA 200.8	Boron	8/1/2019	7/31/2020	Certified
EPA 200.8	Cadmium	8/1/2019	7/31/2020	Certified
EPA 200.8	Chromium	8/1/2019	7/31/2020	Certified
EPA 200.8	Copper	8/1/2019	7/31/2020	Certified

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Weck Laboratories, Inc.
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Matrix: ***SDWA (Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
EPA 200.8	Lead	8/1/2019	7/31/2020	Certified
EPA 200.8	Manganese	8/1/2019	7/31/2020	Certified
EPA 200.8	Mercury	8/1/2019	7/31/2020	Certified
EPA 200.8	Molybdenum	8/1/2019	7/31/2020	Certified
EPA 200.8	Nickel	8/1/2019	7/31/2020	Certified
EPA 200.8	Selenium	8/1/2019	7/31/2020	Certified
EPA 200.8	Silver	8/1/2019	7/31/2020	Certified
EPA 200.8	Thallium	8/1/2019	7/31/2020	Certified
EPA 200.8	Vanadium	8/1/2019	7/31/2020	Certified
EPA 200.8	Zinc	8/1/2019	7/31/2020	Certified
EPA 245.1	Mercury	8/1/2019	7/31/2020	Certified
EPA 300.0	Chloride	8/1/2019	7/31/2020	Certified
EPA 300.0	Fluoride	8/1/2019	7/31/2020	Certified
EPA 300.0	Nitrate as N	8/1/2019	7/31/2020	Certified
EPA 300.0	Nitrite as N	8/1/2019	7/31/2020	Certified
EPA 300.0	Sulfate	8/1/2019	7/31/2020	Certified
EPA 300.1	Bromate	8/1/2019	7/31/2020	Certified
EPA 300.1	Bromide	8/1/2019	7/31/2020	Certified
EPA 300.1	Chlorate	8/1/2019	7/31/2020	Certified
EPA 300.1	Chlorite	8/1/2019	7/31/2020	Certified
EPA 314.0	Perchlorate	8/1/2019	7/31/2020	Certified
EPA 331.0	Perchlorate	8/1/2019	7/31/2020	Certified
EPA 335.4	Cyanide	8/1/2019	7/31/2020	Certified
EPA 353.2	Nitrate as N	8/1/2019	7/31/2020	Certified
EPA 353.2	Nitrate-nitrite	8/1/2019	7/31/2020	Certified
EPA 353.2	Nitrite as N	8/1/2019	7/31/2020	Certified
EPA 365.1	Orthophosphate as P	8/1/2019	7/31/2020	Certified
EPA 504.1	1,2-Dibromo-3-chloropropane (DBCP, Dibromochloropropane)	8/1/2019	7/31/2020	Certified
EPA 504.1	1,2-Dibromoethane (EDB, Ethylene dibromide)	8/1/2019	7/31/2020	Certified
EPA 508	Aroclor-1016 (PCB-1016)	8/1/2019	7/31/2020	Certified

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Division of Environmental Protection
Laboratory Scope of Accreditation

EPA Number: ***CA00211*** **Attachment to Certificate Number:** **CA002112020-1** **Expiration Date:** **7/31/2020**

Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***SDWA (Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
EPA 508	Aroclor-1221 (PCB-1221)	8/1/2019	7/31/2020	Certified
EPA 508	Aroclor-1232 (PCB-1232)	8/1/2019	7/31/2020	Certified
EPA 508	Aroclor-1242 (PCB-1242)	8/1/2019	7/31/2020	Certified
EPA 508	Aroclor-1248 (PCB-1248)	8/1/2019	7/31/2020	Certified
EPA 508	Aroclor-1254 (PCB-1254)	8/1/2019	7/31/2020	Certified
EPA 508	Aroclor-1260 (PCB-1260)	8/1/2019	7/31/2020	Certified
EPA 508	Chlordane (tech.)	8/1/2019	7/31/2020	Certified
EPA 508	Endrin	8/1/2019	7/31/2020	Certified
EPA 508	gamma-BHC (Lindane)	8/1/2019	7/31/2020	Certified
EPA 508	Heptachlor	8/1/2019	7/31/2020	Certified
EPA 508	Heptachlor epoxide	8/1/2019	7/31/2020	Certified
EPA 508	Hexachlorobenzene	8/1/2019	7/31/2020	Certified
EPA 508	Hexachlorocyclopentadiene	8/1/2019	7/31/2020	Certified
EPA 508	Methoxychlor	8/1/2019	7/31/2020	Certified
EPA 508	PCB Aroclor Identification (PCBs as Aroclors)	8/1/2019	7/31/2020	Certified
EPA 508	Toxaphene (Chlorinated camphene)	8/1/2019	7/31/2020	Certified
EPA 515.4	2,4-D	8/1/2019	7/31/2020	Certified
EPA 515.4	Dalapon	8/1/2019	7/31/2020	Certified
EPA 515.4	Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	8/1/2019	7/31/2020	Certified
EPA 515.4	Pentachlorophenol	8/1/2019	7/31/2020	Certified
EPA 515.4	Picloram	8/1/2019	7/31/2020	Certified
EPA 515.4	Silvex (2,4,5-TP)	8/1/2019	7/31/2020	Certified
EPA 524.2	1,1,1-Trichloroethane	8/1/2019	7/31/2020	Certified
EPA 524.2	1,1,2-Trichloroethane	8/1/2019	7/31/2020	Certified
EPA 524.2	1,1-Dichloroethylene	8/1/2019	7/31/2020	Certified
EPA 524.2	1,2,4-Trichlorobenzene	8/1/2019	7/31/2020	Certified
EPA 524.2	1,2-Dichlorobenzene	8/1/2019	7/31/2020	Certified
EPA 524.2	1,2-Dichloroethane	8/1/2019	7/31/2020	Certified
EPA 524.2	1,2-Dichloropropane	8/1/2019	7/31/2020	Certified
EPA 524.2	1,4-Dichlorobenzene	8/1/2019	7/31/2020	Certified

State of Nevada Department of Conservation and Natural Resources
Division of Environmental Protection
Laboratory Scope of Accreditation

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Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***SDWA (Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
EPA 524.2	Benzene	8/1/2019	7/31/2020	Certified
EPA 524.2	Bromodichloromethane	8/1/2019	7/31/2020	Certified
EPA 524.2	Bromoform	8/1/2019	7/31/2020	Certified
EPA 524.2	Carbon tetrachloride	8/1/2019	7/31/2020	Certified
EPA 524.2	Chlorobenzene	8/1/2019	7/31/2020	Certified
EPA 524.2	Chlorodibromomethane (Dibromochloromethane)	8/1/2019	7/31/2020	Certified
EPA 524.2	Chloroform	8/1/2019	7/31/2020	Certified
EPA 524.2	cis-1,2-Dichloroethylene	8/1/2019	7/31/2020	Certified
EPA 524.2	Ethylbenzene	8/1/2019	7/31/2020	Certified
EPA 524.2	Methylene chloride (Dichloromethane)	8/1/2019	7/31/2020	Certified
EPA 524.2	Styrene	8/1/2019	7/31/2020	Certified
EPA 524.2	Tetrachloroethylene (Perchloroethylene)	8/1/2019	7/31/2020	Certified
EPA 524.2	Toluene	8/1/2019	7/31/2020	Certified
EPA 524.2	Total trihalomethanes	8/1/2019	7/31/2020	Certified
EPA 524.2	trans-1,2-Dichloroethylene	8/1/2019	7/31/2020	Certified
EPA 524.2	Trichloroethene (Trichloroethylene)	8/1/2019	7/31/2020	Certified
EPA 524.2	Vinyl chloride	8/1/2019	7/31/2020	Certified
EPA 524.2	Xylene (total)	8/1/2019	7/31/2020	Certified
EPA 525.2	Alachlor	8/1/2019	7/31/2020	Certified
EPA 525.2	Atrazine	8/1/2019	7/31/2020	Certified
EPA 525.2	Benzo(a)pyrene	8/1/2019	7/31/2020	Certified
EPA 525.2	bis(2-Ethylhexyl)adipate	8/1/2019	7/31/2020	Certified
EPA 525.2	bis(2-Ethylhexyl)phthalate,(DEHP, Di(2-ethylhexyl) phthalate)	8/1/2019	7/31/2020	Certified
EPA 525.2	Endrin	8/1/2019	7/31/2020	Certified
EPA 525.2	gamma-BHC (Lindane)	8/1/2019	7/31/2020	Certified
EPA 525.2	Heptachlor	8/1/2019	7/31/2020	Certified
EPA 525.2	Heptachlor epoxide	8/1/2019	7/31/2020	Certified
EPA 525.2	Hexachlorobenzene	8/1/2019	7/31/2020	Certified
EPA 525.2	Hexachlorocyclopentadiene	8/1/2019	7/31/2020	Certified
EPA 525.2	Metolachlor	8/1/2019	7/31/2020	Certified

State of Nevada Department of Conservation and Natural Resources
Division of Environmental Protection
Laboratory Scope of Accreditation

EPA Number: ***CA00211*** **Attachment to Certificate Number:** **CA002112020-1** **Expiration Date:** **7/31/2020**

Weck Laboratories, Inc.
14859 E. Clark Ave. Industry, CA 91745-

Matrix: ***SDWA (Potable Water)***

Method	Analyte	Start Date	Date Expires	Status
EPA 525.2	Simazine	8/1/2019	7/31/2020	Certified
EPA 531.2	Carbofuran (Furaden)	8/1/2019	7/31/2020	Certified
EPA 531.2	Oxamyl	8/1/2019	7/31/2020	Certified
EPA 547	Glyphosate	8/1/2019	7/31/2020	Certified
EPA 548.1	Endothall	8/1/2019	7/31/2020	Certified
EPA 549.2	Diquat	8/1/2019	7/31/2020	Certified
EPA 552.3	Bromoacetic acid (Monobromoacetic acid, MBAA)	8/1/2019	7/31/2020	Certified
EPA 552.3	Bromochloroacetic acid (BCAA)	8/1/2019	7/31/2020	Certified
EPA 552.3	Chloroacetic acid (Monochloroacetic acid, MCAA)	8/1/2019	7/31/2020	Certified
EPA 552.3	Dibromoacetic acid (DBAA)	8/1/2019	7/31/2020	Certified
EPA 552.3	Dichloroacetic acid (DCAA)	8/1/2019	7/31/2020	Certified
EPA 552.3	Haloacetic acids (HAA5)	8/1/2019	7/31/2020	Certified
EPA 552.3	Trichloroacetic acid (TCAA)	8/1/2019	7/31/2020	Certified
OIA 1677	Cyanide	8/1/2019	7/31/2020	Certified
SM 2320 B	Alkalinity as CaCO3	8/1/2019	7/31/2020	Certified
SM 2330 B	Corrosivity (langlier index)	8/1/2019	7/31/2020	Certified
SM 2510 B	Conductivity	8/1/2019	7/31/2020	Certified
SM 2540 C	Residue-filterable (TDS)	8/1/2019	7/31/2020	Certified
SM 4500-Cl G	Combined Chlorine (residual)	8/1/2019	7/31/2020	Certified
SM 4500-H+ B	pH	8/1/2019	7/31/2020	Certified
SM 5540 C	Surfactants - MBAS	8/1/2019	7/31/2020	Certified
Discipline: Radiochemistry				
EPA 900.0	Gross-alpha	8/1/2019	7/31/2020	Certified
EPA 900.0	Gross-beta	8/1/2019	7/31/2020	Certified
SM 7110 C (GPC)	Gross-alpha	8/1/2019	7/31/2020	Certified

Disclaimer: A laboratory that is certified or approved has established that they have the ability to implement a quality control program in accordance with the appropriate Federal or State regulations or statutes. It is the certified laboratory's responsibility to provide their client the most current certified parameter list. Contact LCP to verify certification status.

ATTACHMENT 7

Field Forms

bec environmental, inc.
Environmental Services

Groundwater Sample Log

Project:_____

Sample ID:	Inner well casing diameter: *(from well log, if available)*	
Location:	Well location elevation and source of information: *(from northernmost point of well casing)*	
Date:	Recorded total well depth: *(from well log, if available)*	
Field Crew:	Recorded depth to water: *(Taken immediately prior to purging, if possible. Or from well log, if available)*	
Well ID: *(NV Well or USGS#, if available)*	Well Casing Material: *(PVC, Steel, HDPE, etc.)*	

Casing volume calculations:

$$V = \frac{\pi d^2 h}{77.01}$$

V = volume of one well casing of water (in gallons);
d = inner diameter of the well casing (in inches);
h = length of water in the well (in feet), which is the total well depth minus depth to water.

Purge timing calculations:

Purge Start Time (24hr): _____ Amount of time to fill a 5 gal bucket: _____seconds

$$\textbf{Minutes to Purge 3 Casing Volumes} = \frac{\_\_\_\_\_\ \textbf{seconds}}{5\ \textbf{gallons}} \times \frac{\textbf{minute}}{60\ \textbf{seconds}} \times 3(V)$$

Estimated Purge End Time (24hr): _____ Actual Purge End Time (24hr): _____

Type of pump and tubing used for sample collection: _____

Notes & Physical observations:
(Free product, turbidity, odor, etc.)

(Low-Stress Approach vs Casing Volume Approach for stabilization measurements)

Sample Collection Time (24hr): _____

Analysis (*circle*): VOCs SVOCs PAHs PCBs Pesticides

Metals (list): _____

(see reverse side for water quality measurements)

bec environmental, inc.
Environmental Services

Groundwater Sample Log

Project:______________________________

Water Quality Measurements:

Time (*24hr*)	Purge Rate (gal/min)	Estimated purge volume (*gallons*)	pH	Temperature (*°C*)	Specific Electrical Conductivity (*µS/cm*)	Dissolved Oxygen (*mg/L*)

Project:_____
Date:_____
Inspector: _____

Lead Paint Chip Sample Log		
Sample Number	Paint Color / Substrate	Location

ATTACHMENT 8

Chains of Custody

CHAIN OF CUSTODY

eurofins | EMLab P&K

www.EMLabPK.com

Marlton, NJ: 3000 Lincoln Dr E, Ste. A, Marlton, NJ 08053 *** (866) 871-1984**
Phoenix, AZ: 1501 West Knudsen Drive, Phoenix, AZ 85027 *** (800) 651-4802**
SSF, CA: 6000 Shoreline Ct, Ste. 205, S. San Francisco, CA 94080 *** (866) 888-6653**

WEATHER		Fog	Rain	Snow	Wind	Clear
LEVEL	None					
	Light					
	Moderate					
	Heavy					

CONTACT INFORMATION

Company:		Address:	
Contact:		Special Instructions:	
Phone:			

PROJECT INFORMATION

Project ID:			
Project Description:			
Project Zip Code:		Sampling Date/Time:	
PO Number:		Sampled By:	

TURN AROUND TIME CODES - (TAT)

STD - Standard (Default)

ND - Next Business Day

SD - Same Business Day

WH - Weekend/Holiday/ASAP

Rushes received after 2pm or on weekends, will be considered received the next business day. Please alert us in advance of weekend analysis needs.

REQUESTED SERVICES

SAMPLE ID	DESCRIPTION	Sample Type (Below)	TAT (Above)	Total Volume/Area (as applicable)	NOTES (Time of day, Temp, RH, etc.)	Non-Culturable: Spore Trap: Spore Trap Analysis	Non-Culturable: Tape, Swab, Bulk: Other biological particles - supplement	Non-Culturable: Tape, Swab, Bulk: Direct Microscopic Exam (Qualitative)	Non-Culturable: Tape, Swab, Bulk: Quantitative spore count direct exam	Non-Culturable: Tape, Swab, Bulk: Dust Characterization	Culturable: BioCassette™, Andersen, SAS, Swab, Water, Bulk, Dust, Soil, Contact Plate: 1-Media Surface Fungi (Genus ID + *Asp.* spp.)	Culturable: BioCassette™, Andersen, SAS, Swab, Water, Bulk, Dust, Soil, Contact Plate: Culturable Air Fungi (Genus ID + *Asp.* spp.)	Culturable: BioCassette™, Andersen, SAS, Swab, Water, Bulk, Dust, Soil, Contact Plate: Gram Stain and Counts (Culturable Air and Surface Bacteria)	Culturable: BioCassette™, Andersen, SAS, Swab, Water, Bulk, Dust, Soil, Contact Plate: *Legionella* culture	Culturable: BioCassette™, Andersen, SAS, Swab, Water, Bulk, Dust, Soil, Contact Plate: Total Coliform, *E.coli* (Presence/Absence)	Culturable: BioCassette™, Andersen, SAS, Swab, Water, Bulk, Dust, Soil, Contact Plate: QuantiTray-Sewage Screen	Culturable: BioCassette™, Andersen, SAS, Swab, Water, Bulk, Dust, Soil, Contact Plate: OTHER: (please specify test)	Other Requests: Asbestos in Air - PCM Airborne Fiber Count (NIOSH 7400)	Other Requests: Asbestos Bulk - PLM	Other Requests: Lead (Pb) - Flame AA	Other Requests: PCR (please specify test)	Other Requests: Allergens (please specifiy test)

SAMPLE TYPE CODES

BC - BioCassette™	**CP** - Contact Plate	**T** - Tape	**O** - Other:
A1S - Andersen	**ST** - Spore Trap	**SW** - Swab	
SAS - Surface Air Sampler	**B** - Bulk	**SO** - Soil	
NP - Non-potable Water	**P** - Potable Water	**D** - Dust	

RELINQUISHED BY	DATE & TIME

RECEIVED BY	DATE & TIME

WECK LABORATORIES, INC.
Analytical Laboratory Service - Since 1964
14859 Clark Avenue : Industry : CA 91745
Tel 626-336-2139 ♦ Fax 626-336-2634 ♦ www.wecklabs.com

CHAIN OF CUSTODY RECORD

DRINKING WATER

CLIENT NAME:

PROJECT:
PWS ID:
PWS Name:

ADDRESS:

PHONE:
FAX:
EMAIL:

PROJECT MANAGER

SAMPLER

SPECIAL HANDLING

- ☐ Same Day Rush 150%
- ☐ 24 Hour Rush 100%
- ☐ 48-72 Hour Rush 75%
- ☐ 4 - 5 Day Rush 30%
- ☐ Rush Extractions 50%
- ☐ 10 - 15 Business Days
- ☐ QA/QC Data Package

Charges will apply for weekends/holidays

Method of Shipment:

COMMENTS

LAB ID# (For lab Use Only)	DATE SAMPLED	TIME SAMPLED	SMPL TYPE	SAMPLE POINT I.D. / NAME	# OF CONT.	ANALYSES REQUESTED: Coliform: ☐ P/A ☐ Quantitray ☐ MTF	☐ General Physical ☐ General Mineral	Inorganic Chemicals	VOCs: ☐ Regulated ☐ Unregulated	SOCs: ☐ 504 ☐ 508 ☐ 507 ☐ 515	SOCs: ☐ 525 ☐ 531 ☐ 547 ☐ 548 ☐ 549	Radiochem: ☐ Alpha ☐ Beta ☐ Uranium	DBPs: ☐ THM 524.2 ☐ HAA 552.2		

RELINOUISHED BY	DATE / TIME	RECEIVED BY
RELINQUISHED BY	DATE / TIME	RECEIVED BY
RELINQUISHED BY	DATE / TIME	RECEIVED BY

SAMPLE CONDITION:

Actual Temperature:

Received On Ice	Y / N
Preserved	Y / N
Evidence Seals Present	Y / N
Container Attacked	Y / N
Preserved at Lab	Y / N

SAMPLE TYPE CODE:

DW - Drinking Water
SW - Surface Water
RW - Raw Water
GW - Groundwater
RW - Recreational Water
TW - Treated Water

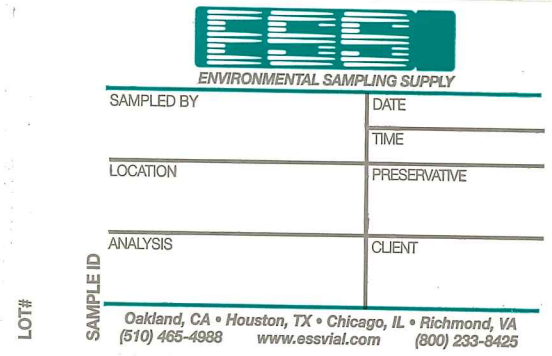
PRESCHEDULED RUSH ANALYSES WILL TAKE PRIORITY
OVER UNSCHEDULED RUSH REQUESTS
Client agrees to Terms & Conditions at: www.wecklabs.com

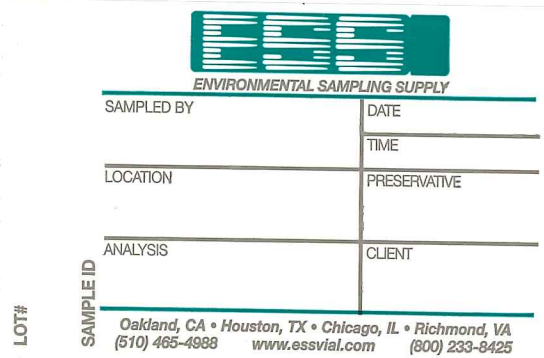
SPECIAL REQUIREMENTS / BILLING INFORMATION

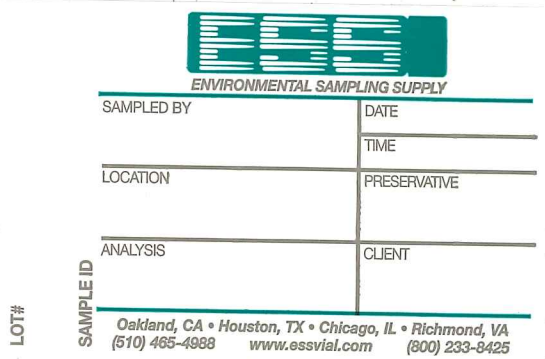
☐ check box if EDT is required

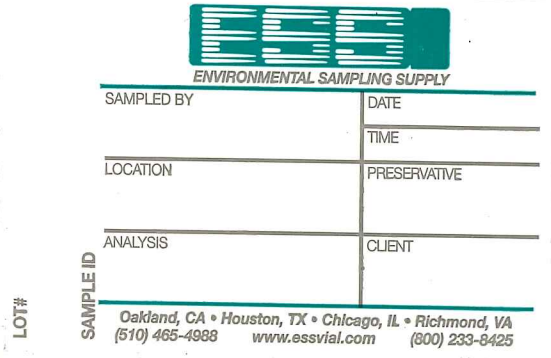
ATTACHMENT 9

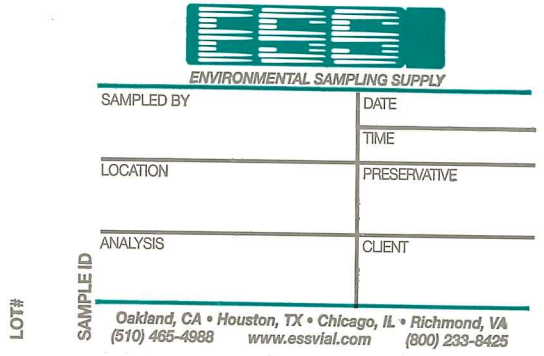
Sample Labels

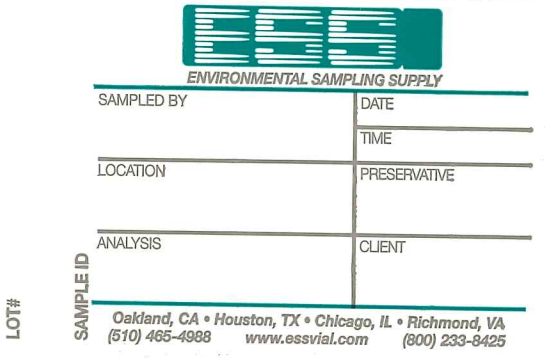












ENVIRONMENTAL SAMPLING SUPPLY

SAMPLED BY	DATE
	TIME
LOCATION	PRESERVATIVE
ANALYSIS	CLIENT

LOT#

SAMPLE ID

Oakland, CA • Houston, TX • Chicago, IL • Richmond, VA
(510) 465-4988 www.essvial.com (800) 233-8425

ENVIRONMENTAL SAMPLING SUPPLY

SAMPLED BY	DATE
	TIME
LOCATION	PRESERVATIVE
ANALYSIS	CLIENT

LOT#

SAMPLE ID

Oakland, CA • Houston, TX • Chicago, IL • Richmond, VA
(510) 465-4988 www.essvial.com (800) 233-8425

ENVIRONMENTAL SAMPLING SUPPLY

SAMPLED BY	DATE
	TIME
LOCATION	PRESERVATIVE
ANALYSIS	CLIENT

LOT#

SAMPLE ID

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ENVIRONMENTAL SAMPLING SUPPLY

SAMPLED BY	DATE
	TIME
LOCATION	PRESERVATIVE
ANALYSIS	CLIENT

LOT#

SAMPLE ID

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ENVIRONMENTAL SAMPLING SUPPLY

SAMPLED BY	DATE
	TIME
LOCATION	PRESERVATIVE
ANALYSIS	CLIENT

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ENVIRONMENTAL SAMPLING SUPPLY

SAMPLED BY	DATE
	TIME
LOCATION	PRESERVATIVE
ANALYSIS	CLIENT

LOT#

SAMPLE ID

Oakland, CA • Houston, TX • Chicago, IL • Richmond, VA
(510) 465-4988 www.essvial.com (800) 233-8425

ATTACHMENT 10

Health and Safety Plan

bec environmental, inc.
Environmental Services

Lathrop Wells Parcels -06 and -08
Limited Phase II Environmental Site Assessment

Site-Specific
Health and Safety Plan

1 PROJECT INFORMATION

Project Name:	Lathrop Wells -06 and -08 Phase II Environmental Site Assessment (ESA)		
Site Location (see Figure 1 – Site Map):	5240 East U.S. Highway 95 and 5700 Easy U.S. Highway 95, Amargosa Valley, Nevada 89020		
Site Description:	Vacant, mostly undeveloped sites in rural location near heavily trafficked U.S. Highway 95		
Project Objective(s):	Groundwater sampling from an onsite domestic well, and paint chip sample collection.		
Project Start Date:	Summer 2020	***Anticipated Completion Date:***	1 day of sampling activities

2 PERSONNEL

Field Safety Supervisor:	Rachel Kistler		Phone:	(540) 553-4311
BEC Office Contact:	Elizabeth Nelson		Phone (24 hour):	(702) 596-4896
Site Worker:	Rachel Schlick		Phone:	(760) 793-7171
Site Worker:			Phone:	
Site Worker:			Phone:	

3 HAZARD ANALYSIS (CHECK ALL THAT APPLY):

Task/Operation (Check all Applicable):

☐ Air Sampling/Monitoring
☐ Asbestos Survey
☐ Biological Sampling
☐ Biological Monitoring/Evaluation
☐ Ecological Study
☐ Erosion Control
☒ Groundwater Sampling
☐ Inspections: _____
☒ Lead Inspection
☐ Perimeter Monitoring
☐ Other (Describe):_____
☐ Radon Measurement Survey
☐ Site Survey
☐ Sample Collection/Transportation
☐ Soil Excavation
☐ Soil Sampling
☐ Staging Supplies
☐ Subsurface Soil Sampling – Drilling
☐ Subsurface Soil Sampling – Hand Auger
☐ Surface Soil Sampling
☐ Traffic Controls
☐ Water Sampling

4 CHEMICAL HAZARDS (INCLUDE ALL THAT APPLY):

Chemical Name	*Source*	*Concentration*	*Exposure Limits**
--	--	--	--

**Exposure limits are those established by OSHA as the Permissible Exposure Limits (PEL) as of the date of the Site Specific HASP.*

At the time of this investigation, specific chemicals at the site are unknown, and therefore, exposure limits cannot be tested or confirmed in real time. Groundwater sampling will be to analyze volatile organic compounds and heavy metals. Paint on billboards will be sampled and analyzed for lead content.

5 BIOLOGICAL HAZARDS (CHECK ALL THAT APPLY):

☐ No Biological Hazards
☒ Small Mammals/Droppings
☒ Insect Bites and Stings
☐ Mold
☐ Other (Describe): _____
☒ Snakes
☒ Poisonous Plants
☐ Rabies – Bats/Other Animals

6 PHYSICAL HAZARDS (CHECK ALL THAT APPLY):

- ☐ Abandoned Mine Access
- ☐ Cold Weather Operations
- ☐ Compressed Gas – Storage & Use
- ☐ Demolition Operations/Oversight
- ☒ Dust/Inhalation Hazards
- ☐ Drilling Rig Operations/Oversight
- ☒ Electrical Hazards
- ☒ Ergonomics: Heavy Lifting/Moving, Repetitive Motion, etc.
- ☒ Hand Tool Use
- ☒ Hazardous Chemicals/Materials
- ☐ Heavy Equipment Operation/Oversight
- ☐ Helicopter Operations
- ☐ High Pressure Water Use
- ☒ Hot Weather Operations
- ☐ Housekeeping Hazards (Slips, Trips, Falls, Sharp Objects, etc.)
- ☐ Inadequate Illumination
- ☒ Inclement Weather
- ☒ Ladder Use
- ☐ Noise
- ☒ Remote Site Location
- ☐ Rough Terrain
- ☒ Traffic On or Near Site
- ☐ Trenching and Excavation Operations
- ☐ Welding/Cutting/Brazing Operations

For each item checked, see the associated Slip Sheet following this Plan.

7 WORK PRACTICE CONTROLS

Personal Protective Equipment:

- ☐ Steel-toed Boots
- ☒ Gloves
- ☐ Hard Hat
- ☒ Long Pants
- ☐ Hearing Protection
- ☐ Other (Describe): _____
- ☒ Sunscreen
- ☒ Safety Glasses/Sunglasses
- ☐ Respirators
- ☐ Layers of Clothing

Describe work practice controls as appropriate:

_____
_____
_____

8 FIELD WORK ITEMS CHECKLIST

- ☐ Vehicle Safety Kit
- ☐ 2-way Radios (extra batteries)
- ☐ Digital Camera (extra batteries)
- ☐ Cell Phone with Car Charger
- ☐ GPS Units (extra batteries)
- ☐ Binoculars
- ☐ Topographic Map
- ☐ First Aid Kit
- ☐ Fire Extinguisher
- ☐ Portable Eye-Wash Kit
- ☐ Copy of the HASP
- ☐ Mileage Clipboard
- ☐ SPOT GPS Device

Other Items:

_____

_____

_____

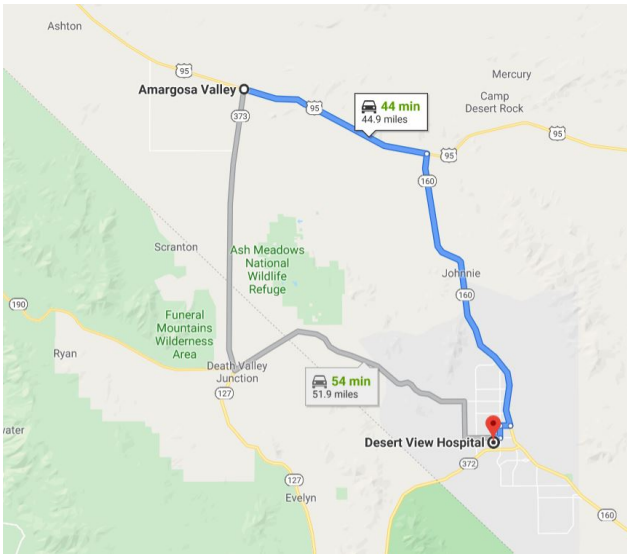
9 ACKNOWLEDGEMENT

I have read and understand the Lathrop Wells -06 and -08 Phase II ESA Site Specific Health and Safety Plan.

Printed Name and Signature	**Date**

Figure 1 – Site Map

Figure 2 – Emergency Action Map



Desert View Hospital
360 Lola Lane, Pahrump, NV 89048

From US- 95 North, Amargosa Valley, NV

1. Head southeast on US-95 North toward US-95 N
2. Turn right onto NV-160 E
3. Turn right onto East Irene Street
4. Turn left onto North Blagg Road
5. Turn right onto West Basin Avenue
6. Turn Left onto Lola Lane

Destination on the right

Figure 3– Site Sampling Map (if applicable)

Parcel -06 Parcel Sampling Locations

Parcel -08 Sampling Locations

bec environmental, inc.
Environmental Services

Adverse Site Condition Procedures Checklist and Safety Slip Sheets

ADVERSE SITE CONDITIONS PROCEDURES CHECKLIST

☐ Unable to locate site
- Consult the topographic map (other maps if available)
  - Find current location (elevation)
  - Verify location of survey site (and elevation)
- Verify the GPS has the correct coordinates entered.
  - UTM vs. Lat. Long.
  - UTM Zone 11 (Nevada)
  - NAD27, NAD83, WGS
- Call point of contact with BEC and/or the governing agency

☐ Site inaccessible
- Use steps above to verify the correct area
- Research other possible access routes
- If feasible, return to site at a later date
- Notify BEC and governing agency of difficulty
- Do not attempt to access if conditions do not allow it to be done safely

☐ Unknown individuals at or around site
- Try to determine professional association either at a distance, or during conversation through the vehicle window
- Determine current activities of individual(s)
- If uncomfortable about the individual(s) activity, return at a later time or date
- Notify BEC of the presence of individuals in the area and of determinations made of whether or not to proceed with work at the site

☐ Vehicle problems
- Troubleshoot mechanical problems
  - Verify battery cables are secure
  - Verify the vehicle is in park
  - Check fuel level
  - Contact BEC office personnel and/or the truck rental company
- If vehicle is stuck, determine action necessary to free the vehicle
  - If possible, use the shovel to dig the tires out
  - If unable to free the vehicle, call the BEC contact for assistance and direction
- If there is an accident with another vehicle, get all of the pertinent information from the other driver, take photos, write down a description of the events that happened and contact BEC and the appropriate legal authority with jurisdiction over the area

☐ Injury
- Attend to the injured individual immediately
- Call for an ambulance if necessary
- Notify BEC contact
- Take notes on incident that led to the injury and the action taken to assist the individual
- Upon return to the BEC office, restock any supplies used in the field

☐ Submit Emergency Event Report Form to Supervisor, as appropriate

Dust and Inhalation Hazards

Hazards associated with dust inhalation include occupational asthma and silicosis. Exposure to respirable crystalline silica can cause silicosis, lung cancer, other respiratory diseases, and kidney disease.

Symptoms of Asthma:

- Chest tightness
- Cough
- Shortness of breath
- Wheezing

Symptoms of Silicosis:

- Difficulty in breathing
- Increased coughing
- Infectious complications may cause fever, weight loss, and night sweats
- Initially there may be no symptoms

Mitigative Actions:

- Use wet methods for cutting
- Provide adequate ventilation
- Limit access to areas where anyone could be exposed to silica above the Action Level (25 µg/m^3) or Permissible Exposure Limit (50 µg/m^3)
- Restrict housekeeping practices that expose workers to silica where feasible alternatives are available.

Recommendations for Personal Protective Equipment:

- Safety Glasses
- Dust Mask
- Respirators

Electrical Hazards

Hazards associated with electricity include electric shock, electrocution, fires and explosions. Contact with electricity may be direct, such as working on overhead lines, cable harnesses, and circuit assemblies. Indirect exposure to electrical hazards may also occur in the course of day to day operations.

Mitigative Actions:

- Only approved conductors and equipment may be utilized.
- Equipment shall be inspected on a regular basis.
- Equipment shall be used/installed in accordance with any instructions provided by the manufacturer/installer.
- Parts of electric equipment which in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.
- Electrical equipment may not be used unless the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified is placed on the equipment. Other markings shall be provided giving voltage, current, wattage, or other ratings as necessary. The marking shall be of sufficient durability to withstand the environment involved.
- Each disconnecting means shall be legibly marked to indicate its purpose.
- Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

Minimum travel distance for travel under power lines (feet)	*Powerline Voltage (kV)*
10	0 – 50
15	50 – 200
20	200 – 350
25	350 – 500
35	500 – 750

- Electrical equipment work areas shall be adequately illuminated.
- Live parts exceeding 50 volts shall be appropriately guarded to prevent accidental shocks.
- Electrical installations exceeding 600 volts shall be installed, maintained and accessed by qualified individuals only.
- All applicable lockout/tagout (LOTO) protocols will be followed.

Recommendations for Personal Protective Equipment

- Gloves
- Long Pants
- Safety Glasses

Ergonomic Hazards

Ergonomics seeks to decrease fatigue and injuries, along with increasing comfort, productivity, job satisfaction and safety. If your body is stressed by an awkward posture, extreme temperature, or repeated movement, your musculoskeletal system is affected. Musculoskeletal disorders (MSDs) are cumulative and chronic injuries of the soft tissue-muscles, tendons, ligaments, nerves, joints, and blood vessels. MSDs are caused or aggravated by our actions and/or environment that does not follow safe and healthy work practices.

Symptoms of a musculoskeletal disorder include fatigue, discomfort, pain, weakness, sensitivity, swelling, burning or tingling sensation, difficulty moving, and clumsiness.

Heavy Manual Lifting/Moving

The hazards associated with improper material handling include being struck by a load, losing control of a load, physically overexerting oneself, and exceeding equipment capacities. Such accidents can lead to injuries (e.g., abrasions, bruises, and broken bones) and even loss of life.

Repetitive Motion

The hazards associated with repetitive motion are that the same joints and muscle groups are used over and over when motions happen to often, too quickly, and for too long. Common symptoms include cramping, muscle weakness, pain, numbness, decreased range of motion.

Vibration

Vibration affects tendons, muscles, joints and nerves. It can be experienced over the whole body (from heavy machinery or vehicle operation) or in a localized area of the body (from using power tools). Common symptoms are numbness of the fingers, hands, or arms; loss of touch and grip; and pain. In addition, the worker may use more force and awkward body positions because vibration hand tools are harder to control.

Mitigative Actions:

- Loads should be handled no more than 18 cm (7 in.) in front of the body as measured from the ankles. The heavier a load, the more closely to the body the load should be held.
- Whenever possible, push rather than pull loads: Pushing uses the strong leg muscles, whereas pulling uses the easily strained back muscles.
- Good handholds shall be provided on an object to be carried.
- Carts and handling aids shall be used where possible.
- Manual movement of objects shall be minimized wherever possible.
- Employees shall not twist or bend while lifting or handling a heavy load.
- Loads shall be inspected for sharp edges, slivers, and wet or greasy spots prior to movement.
- The route objects are to be moved along shall be free of obstructions or spills that may cause tripping, slipping, or impair ability to maneuver objects.
- Take breaks at regular intervals.
- Use correct tools made for the designated task.

Recommendations for Personal Protective Equipment:

- Gloves
- Comfortable, proper footwear for the job being done
- Back support belts (limit range of motion to encourage proper body positioning)
- Knee pads / Elbow pads

Hand and Portable Power Tools

Hand and portable power tools are a common part of the workplace. However, these simple tools can be hazardous and have the potential for causing severe injuries when used or maintained improperly. The hazards associated with these tools comes primarily from damaged or worn tools, improperly guarded tools, and tools with rotating/moving parts which may send debris toward workers.

Mitigative Actions:

- Tools and equipment (both company and employee owned) used by employees at their workplace shall be kept in good condition.
- Hand tools such as chisels and punches, which develop mushroomed heads during use, shall be reconditioned or replaced as necessary.
- Broken or fractured handles on hammers, axes and similar equipment shall be replaced promptly.
- Worn or bent wrenches shall be replaced regularly.
- Employees shall be made aware of the hazards caused by faulty or improperly used hand tools.
- Appropriate handles shall be used on files and similar tools.
- Appropriate safety glasses, face shields, etc. shall be used while using hand tools or equipment which might produce flying materials or be subject to breakage.
- Jacks shall be checked periodically to ensure they are in good operating condition.
- Tool handles shall be wedged tightly in the head of all tools.
- Tool cutting edges shall be kept sharp so the tool will move smoothly without binding or skipping.
- Tools shall be stored in dry, secure locations where they won't be tampered with.
- Eye and face protection shall be used when driving hardened or tempered spuds or nails.
- Grinders, saws and similar equipment shall be provided with appropriate safety guards.
- Power tools shall be used with the correct shield, guard, or attachment, recommended by the manufacturer.
- Rotating or moving parts of equipment shall be guarded to prevent physical contact.
- All cord-connected, electrically operated tools and equipment shall be effectively grounded or of the approved double insulated type.
- Portable fans shall be provided with full guards or screens having openings ½ inch or less.

Recommendations for Personal Protective Equipment:

- Hard hat
- Steel-toed Boots
- Gloves
- Long Pants
- Hearing Protection
- Safety Glasses

Hazardous Chemicals

Under the Hazard Communication Standard, any chemical that presents a physical hazard or a health hazards is considered a hazardous chemical. A ***physical hazard*** means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive. A ***health hazard*** means a chemical for which there is statistically significant evidence that acute or chronic health effects may occur in exposed individuals. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.

Physical Hazards

Fire Hazards: Combustible liquids, flammable liquids, flammable aerosols, flammable gases, flammable solids, oxidizers, and pyrophoric chemicals.

Reactive Hazards: Organic peroxides, unstable (reactive) materials such as corrosives, and water-reactive chemicals.

Explosion Hazards: Compressed gases and explosive materials.

Health Hazards

Systemic Effects: Carcinogens, highly toxic and toxic agents, corrosives, irritants, and sensitizers

Target Organ Effects: Hepatotoxins, nephrotoxins, neurotoxins, blood/hematopoietic toxins, respiratory toxins, reproductive toxins, cutaneous hazard, eye hazard.

Mitigative Actions:

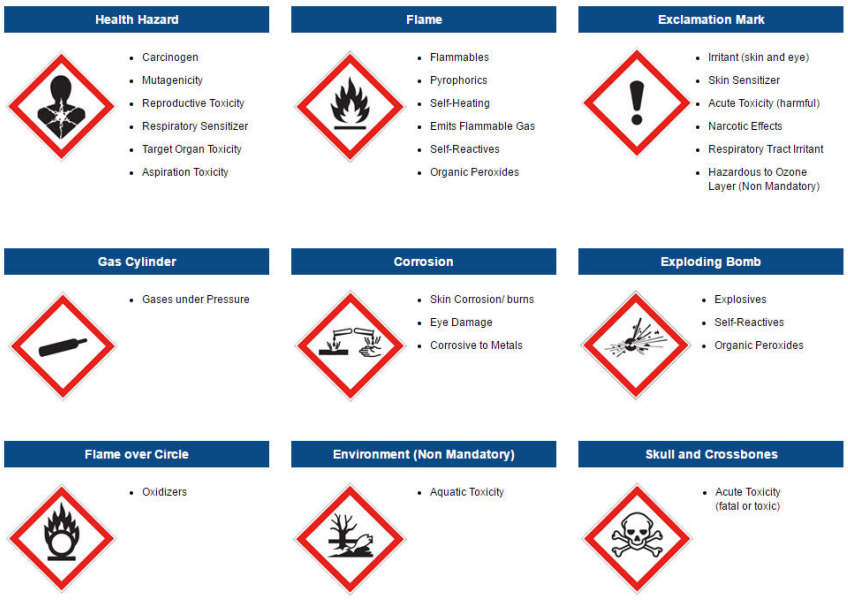
- Adequate ventilation should be maintained, and no open flames, sparks, or smoking should be permitted near flammable liquids.
- Personnel will be alert to the potential dangers and will wear the appropriate protective equipment.
- Personnel shall exercise caution at all time to prevent accidents.

Recommendations for Personal Protective Equipment:

- Gloves
- Closed-Toed Shoes
- Full Coverage Clothing
- Safety Glasses/Goggles/Face Shield

Hazard Communication

Chemical hazards will be communicated with the following pictograms:



Hot Weather Operations

Heat stress is any external environmental heat stimulus that causes your body to react outside its normal range of activities. Heat stress is the cumulative environmental condition (hot outside temperatures, high humidity, winds, etc.) that causes your body to react. Each individual may react differently to heat stress, depending on individual susceptibility to heat, age, physical condition, alcoholic intake, etc. Heat stress does not necessarily result in adverse health effects.

Heat Rash

Heat rash is a temporary but painful condition caused by clogged skin pores, which can impair sweating and result in diminished heat tolerance.

Symptoms: Tiny red bumps on skin.

First Aid: Treatment consists of washing the affected part and using body powder to help absorb moisture.

Heat Cramps

Heat cramps are caused by a loss of electrolytes – mainly sodium and/or potassium – causing fluids to collect in muscle tissue, resulting in spasms.

Symptoms: painful intermittent muscle spasms following hard physical work in a hot environment.

First Aid: Rest. Find a cool place. Drink plenty of water and eat regular meals.

Heat Exhaustion

Heat exhaustion is the most common form of serious heat illness encountered during work activities.

Symptoms: Profuse sweating, weakness, low blood pressure, rapid pulse, dizziness, nausea and/or headache may be present, cool clammy pale skin, body core temperature may be normal or depressed, fainting or vomiting may occur

First Aid: Rest. Find a cool place. Place ice packs or cool wet towels on the neck, armpits and groin. Call 911 for further instruction.

A victim of heat exhaustion must not be exposed to a hot working environment for at least 24 hours after onset of heat exhaustion. If fainting has occurred, they should not return to work until authorized by a physician.

Heat Stroke

Heat stroke is the most serious heat disorder and is life-threatening. It results when the body's heat dissipating system is overwhelmed and shuts down. Heat stroke results in a continual rise in the victim's deep core body temperature, and is fatal if not checked.

Symptoms: Hot, dry, flushed skin; Elevated body temperature; Convulsions; Delirium; Unconsciousness and possible death.

First Aid: Call 911. Find a cool, shaded place for the victim to rest. Sponge with cool water. Fan while misting with cool water. Place ice packs or cool wet towels on the neck, armpits and groin.

A heat stroke victim must be seen by a physician and cannot return to work without physician approval.

Hot Weather Mitigative Actions:

- Monitor your physical condition and that of your coworkers.
- Wear appropriate clothing for all weather conditions.
- Recommendations for working in environments with temperatures above 100.4 °F:
    - Move to a cool location/shade
    - Rest regularly
    - Drink cool, non-caffeinated and non-alcoholic drinks
- Drink at least one quart of water every hour (or one cup per hour) for the entire work shift.
- Each work vehicle should carry at least 5 gallons of drinking water.

Recommendations for Personal Protective Equipment

- Loose-fitting, moisture wicking clothing
- Personal water container
- Chemical cooling towels

Inclement Weather

Hazards associated with inclement weather include Cold Stress and Heat Stress, which are further discussed in their own Slip Sheets. Extreme heat or cold can result in serious injuries (i.e. frostbite or heat stroke) or death. Other extreme weather conditions, such as flooding, snowstorms, and natural disasters may also be encountered in the field.

- **Cold Stress**
  Cold exposure may occur either at low temperatures or at more moderate temperatures when there is a high the wind-chill factor, and may cause hypothermia, frostbite; and the impaired ability to work. Their physical condition should be closely monitored by themselves, their co-workers, and the Safety Officer. The work schedule should be carefully planned and include rest periods.

- **Heat Stress**
  Operations involving high air temperatures, radiant heat sources, high humidity, direct sun or heat, limited air movement, or strenuous physical activities have a high potential for inducing heat stress in employees engaged in such operations. Heat stress can cause heat exhaustion and heat stroke. Employees should be trained to recognize the symptoms and take actions to relieve heat stress.

- **Flash Flooding/Monsoons**
  Flash flooding occurs quickly and is dangerous due to the combination of the destructive power of a flood and incredible speed and unpredictability. In the desert, effects on access roads will probably be of short duration unless road repairs are necessary. Do not walk or drive in areas that remain flooded. Seek higher ground. Be aware of downed electrical lines in water.

- **High Winds**
  High winds also occur frequently in the region and appropriate measures for dust control and personnel protection should be exercised. Damaging winds are classified as those exceeding 50-60 miles per hour.

- **Thunderstorms**
  Thunderstorms are common during the winter and late summer months and lightning is a threat to all workers. The Safety Officer has the authority to suspend field activities if needed to prevent injury due to lightning strikes. Flash flooding and high winds are common during thunderstorms.

- **Snowstorms**
  Snowstorms can occur in the region, especially at higher elevations in the winter. Hazards of winter weather include icy roads, hypothermia, low visibility, high winds, and dehydration. Always be prepared for winter weather by bringing extra clothes, handwarmers, snow chains for the vehicle, a shovel, and plenty of water.

- **Earthquakes**
  Earthquakes are unpredictable natural disasters that may occur in this region. If an earthquake generates a large enough shaking intensity, structures like buildings, bridges and dams can be severely damaged, and cliffs and sloping ground destabilized. The ground may become displaced especially near fault lines. Expect aftershocks.
  - If you are in a vehicle, pull over and stop. Set your parking brake.
  - If you are outdoors, stay outdoors away from buildings.
  - If you are inside a building, do not get in a doorway. Drop to the ground and cover your head and neck with your arms.

Ladder Hazards

Employers must train each worker to recognize and minimize ladder-related hazards. Using ladders safely reduces the risk of serious injury or death. Do not use ladders for a purpose other than that for which they were designed.

Stepladders

This is a portable, self-supporting, A-frame ladder. It has two front side rails and two rear side rails. Generally, there are steps mounted between the front side rails and bracing between the rear side rails. Do not use a folded stepladder as a single ladder, always use the ladder with the spreaders unlocked.

Extension Ladders

Also known as "portable ladders," extension ladders usually have two sections that operate in brackets or guides allowing for adjustable lengths. Because extension ladders are not self-supporting, they require a stable structure that can withstand the intended load.
Set the ladder at the proper angle. When a ladder is leaned against a wall, the bottom of the ladder should be one-quarter of the ladder's working length away from the wall. For access to an elevated work surface, extend the top of the ladder three feet above that surface or secure the ladder at its top. Set the base of the ladder so that the bottom sits securely and so both side rails are evenly supported. The ladder rails should be square to the structure against which it is leaning with both footpads placed securely on a stable and level surface.

Mitigative Actions:

- Use a ladder that can sustain at least four times the maximum intended load, except extra-heavy duty type 1A metal or plastic ladders shall sustain at least 3.3 times the maximum intended load.
- Do not exceed the load rating and always include the weight of all tools, materials and equipment.
- A competent person must visually inspect ladders before use for any defects such as: missing rungs, bolts, cleats, screws and loose components; grease, dirt or other contaminants that could cause slips or falls; paint or stickers (except warning or safety labels) that could hide possible defects
    - Where a ladder has these or other defects, it must be immediately marked as defective or tagged with "Do Not Use" or similar language.
- Allow sufficient room to step off the ladder safely.
- Keep the area around the bottom and the top of the ladder clear of equipment, materials and tools.
- Before starting work, survey the area for potential hazards, such as energized overhead power lines. Ladders shall have nonconductive side rails if they are used where the worker or the ladder could contact exposed energized electrical equipment.
- Keep all ladders and other tools at least 10 feet away from any power lines.
- When using a ladder in a high-activity area, secure it to prevent movement and use a barrier to redirect workers and equipment. If the ladder is placed in front of a door, always block off the door.
- Maintain a 3-point contact (two hands and a foot, or two feet and a hand) when climbing/descending a ladder.
- Stay near the middle of the ladder and face the ladder while climbing up/down.
- Only put ladders on a stable and level surface that is not slippery.

Remote Site Location

Remote work is defined as work that is isolated from the assistance of other people because of the location, time, or nature of the work being done. It may involve work activities undertaken at a location removed from an office environment where there are few people, and where communications and travel are difficult. Remote workers also have a duty to take reasonable care for their own health and safety, and the health and safety of other persons, as well as to comply with reasonable safety instructions given by their employers. Remote workers should work with their employers to identify and control the risks associated with remote work, as well as assist with putting in place appropriate health and safety measures.

Mitigative Actions:

- Determine if control measures in place are adequate.
- Establish an appropriate system for reporting and investigating injuries, illnesses, and dangerous incidents that may occur because of remote work activities.
- Proactively identify any health and safety issues in the field, and report in a timely manner, as well as the necessary precautions to be taken.
- Managers and supervisors should make periodic site visits and address health and safety issues that arise.
- Consult with emergency services about possible recuse scenarios in remote locations.
- Be sure you are well-rested to avoid fatigued or drowsy driving to/from remote locations.

Recommendations for Personal Protective Equipment:

- SPOT GPS device
- Two-Way Radios
- First Aid Kit

Traffic On or Near Work Site

Workers in areas where there are moving vehicles and traffic are exposed to struck-by hazards. Work zones are used to move traffic in an approved direction and are typically identified by signs, cones, barrels, and barriers.

Mitigative Actions:

- Traffic control plans must be in place for the movement of vehicles in areas where there are also workers conducting other tasks.
- Limiting motorist intrusions into the work zone can be concrete, water, sand, or collapsible barriers, crash cushions, and truck-mounted attenuators.
- Flagger stations should be illuminated. Lighting for workers on foot and equipment operators is to be at least 5 foot-candles or greater.
- Where lighting is not sufficient, flares or chemical lighting should be used.
- Operators and workers on foot need to know the visibility limits and the "blind spots" for each vehicle on site.

Recommendations for Personal Protective Equipment:

- High Visibility Clothing

BEC COVID-19 Field Safety Plan

COVID-19 Specific Safety Precautions while Conducting Fieldwork

Prepared By:
BEC Environmental, Inc.
7241 West Sahara Avenue, Suite 120
Las Vegas, Nevada 89117
(702)304-9830
www.becnv.com

Date *March 2020*

bec environmental, inc.
Environmental Services

Table of Contents

BACKGROUND

COVID-19 (Novel Coronavirus Disease 2019) is a respiratory illness that can spread from person to person. The virus that causes COVID-19 is a novel coronavirus (coronavirus, like the flu, has been around for a very long time). Coronavirus disease (old and new strains) spreads primarily through contact with an infected person when they cough or sneeze. It also spreads when a person touches a surface or object that has the virus on it, then touches their eyes, nose, or mouth. The disease causes respiratory illness (like the flu) with symptoms such as a cough, fever, and in more severe cases, difficulty breathing.

Due to heightened concerns of COVID-19 transmission, it is important we all take extra precautions to keep ourselves, our coworkers, and our community safe and healthy. BEC is committed to conducting business activities in a manner to protect employees, clients/teaming partners/vendors, and the organization, relying on guidance from the Centers for Disease Control (CDC) and state and local governments. Based on the current evaluation, BEC's 2020 field efforts should be modified or delayed whenever possible. As we move into the field season, it is critical that team members in hotels, rental vehicles, or airplanes follow recommended health and safety measures to prevent the infection and spread of COVID-19, and ensure they have access to the tools they need to be safe and successful. This document is intended to provide guidance on communication expectations, prepping for communal living (i.e., hotel stays), pre-cleaning and maintaining clean field trucks and equipment, personal hygiene, mobilization and demobilization expectations, and how to respond if one of our team members displays symptoms. In the context of this document, mobilization and demobilization refer to any activities which involve travel away from the office (Las Vegas) for purposes of work.

Please note, all directives in this document are fluid and will be adjusted based on updated guidance from BEC's Officers, the CDC, or state and local governments. Email communications will be utilized to provide the most current information on COVID-19 should conditions or recommended precautions change. For immediate questions or concerns, please communicate with supervisors, project manager, or a BEC Officer.

1 PRE-FIELDWORK

1.1 Personal Preparedness

Team members are discouraged from any air travel until state and federal guidelines lift travel restrictions and consider air travel safe.

Team members should avoid attending any conferences, trainings, workshops, parties, or other large public gatherings during the month of March and early April 2020, and possibly longer.

Team members with pending fieldwork should prepare their home and an overnight bag prior to the scheduled fieldwork. A state-wide or nation-wide quarantine may be put into effect, requiring a stay at the field location longer than scheduled.

The CDC recommends everyone get the flu shot, when available, to ensure flu symptoms are not mistaken with COVID-19 symptoms. All team members are strongly encouraged to get the current season's flu shot as soon as possible and stay current on all other CDC recommended vaccines.

1.2 Communication

All Project Managers are to communicate daily with Team members regarding field staff health conditions. If any of the scheduled field staff begin to feel ill within the two weeks prior to any scheduled fieldwork, a potential alternate for the fieldwork should be identified.

Any travel planned or conducted within the two weeks prior to scheduled fieldwork, or any large events attended during this period, should be discussed with a supervisor and the project manager.

Team Members feeling ill, and especially those with COVID-19-like symptoms, WILL NOT report for fieldwork. They must communicate directly with their supervisor and project manager about their health concerns. The Project is not more important than anyone's health and safety. If any field staff display illness symptoms, they will not be approved for fieldwork and will be encouraged to use sick leave. An alternate team member will participate in the fieldwork if the type of project allows for the substitution. Any field employee displaying COVID-19-like symptoms will be encouraged to seek medical attention immediately (see Symptoms on page 3).

Team members who have been a caretaker for someone who is or was ill, should communicate directly with their supervisor or project manager to discuss alternatives or potential issues.

1.3 Approval

Approval for a team member to participate in fieldwork will require approval from the member's supervisor and the project manager. This approval will be based on:

- Field staff current health condition
- Potential past risk of exposure to someone else who has tested positive for COVID-19, or has displayed COVID-19-like symptoms
- CDC definitions for high-risk individuals
- The locations of identified COVID-19 hotspots and local regulations regarding public movements

2 PREPPING FOR FIELDWORK AND MOBILIZATION

It is of the utmost importance to practice good hygiene during travel and in the field. Health and hygiene items to bring to the field include hand sanitizer, disinfecting wipes, antimicrobial soap, antimicrobial cleaning spray, paper towels, and latex or nitrile gloves.

2.1 Rental Vehicle Preparation and Cleaning

Practice caution when traveling in trucks, with equipment, or personal goods potentially touched by other people. Wipe down all steering wheels, door handles, common contact areas on the sides of doors, center consoles, display knobs, field equipment, gasoline pumps, and food product packaging to avoid potentially transporting germs to a different community. Wear latex or nitrile gloves when cleaning or handling these surfaces is also recommended. Follow the same vehicle cleaning standards with utility-task vehicles and all-terrain vehicles.

2.2 Safety Meetings

Any safety (tailgate) meeting forms should detail appropriate personal protective equipment relevant for safe project work.

All tailgate meetings will be used to check each team member's physical health. These meetings will include discussions on personal hygiene, communication requirements, and emergency response action plans relevant to COVID-19 spread or quarantines.

2.3 Hotel Stays

Each team member will have their own hotel room, with their own bathroom, should a hotel stay be necessary during fieldwork. Guests will not be permitted. Any work-related discussions or meetings will be conducted either in the field or electronically.

Immediately upon arrival to the hotel room, wash your hands with antimicrobial soap to help ensure any microbes from travel or fieldwork activities will not be transferred to room surfaces. After washing your hands, it is recommended that all surfaces be wiped or cleaned with an antimicrobial-rated cleaner. Do not forget counters; interior and exterior door handles; cabinet handles; medicine cabinet handles; appliance handles, buttons, and knobs such as on the refrigerator or microwave; toilets; faucet handles; shower knobs; tv remotes; light switches, and other frequently touched surfaces, such as shoulder-height on doors where we push them closed.

2.4 Personal Hygiene

Avoid close contact with others; it is recommended individuals keep at least a minimum of six feet apart. Do not shake hands, hug, or touch people unnecessarily. An elbow bump, foot tap, or a nod are good alternatives for handshakes.

Avoid touching your face. Sneeze or cough into a tissue and then throw it away, or into your elbow. If you accidentally sneeze or cough into your hands, wash them immediately.

Regularly wash your hands for at least 20 seconds with antimicrobial soap or hand sanitizer throughout the day, especially before and after eating or touching common surfaces.

2.4.1 In the Field

Follow the standard CDC recommendations above for personal hygiene even when in the field. This is especially important when handling shared equipment.

Use hand sanitizer regularly, especially before eating, after eating, or if you sneeze or cough into your hands. Look out for fellow fieldworkers and encourage them to do the same.

Wipe down field equipment daily with antimicrobial spray or wipes. Wipe down field truck steering wheels, door handles, display knobs and center consoles daily or if there is a switch in user.

2.4.2 In the Community

When stopping anywhere to or from the field, such as a restaurant or gas station, wash your hands with antimicrobial soap prior to leaving the establishment. Use a paper towel or an elbow to exit the bathroom/building. This helps to reduces the risk of picking up microbes from fellow travelers.

Upon returning to the hotel room, avoid touching surfaces until after washing your hands.

3 ACTION PLAN FOR POTENTIAL INFECTION

If you or a co-worker becomes ill, contact the appropriate supervisor or project manager immediately.

Anyone showing signs of COVID-19 will be required to cease fieldwork activities and encouraged to seek immediate medical attention (COVID-19 symptoms are listed below). The sick team member/field staff may be quarantined in their hotel room.

Sick and caretaking team members should wash their hands frequently and immediately before and after touching communal surfaces (food dishes, shared spaces, etc.). If possible, supervisory staff may consider evacuating all team members not displaying symptoms to other housing. Please consider potential spread to the community when making this decision.

4 COVID-19 SYMPTOMS

COVID-19 symptoms may not appear for two days to two weeks after exposure. Symptoms may be slight or severe and may not necessarily all occur at the same time.

- Fever
- Dry cough
- Tiredness
- And in severe cases:
    - Shortness of breath or difficulty breathing
    - Persistent pain or pressure in the chest
    - Confusion or inability to arouse
    - Bluish lips or face

5 DEMOBILIZATION

5.1 Communication

Project managers and/or supervisors are to communicate daily with field staff. Additionally, extra care should be taken as field staff demobilize, paying special attention to:

- where team members are coming from and going to relative to COVID-19 hotspots;
- team member current health conditions;
- whether or not there are nation-wide or state-wide quarantines in place restricting travel; and
- whether team members have been exposed to people showing symptoms.

5.2 Preparation

Practice personal hygiene methods described above during demobilization. Clean all field equipment thoroughly before returning it to the office or its usual storage location. Prior to returning the field vehicle, clean the interior and exterior surfaces to the same standards as when the vehicle was received.

5.3 Post-Demobilization

Please continue to evaluate your health daily and communicate directly with your supervisor if you start to feel ill after demobilization.

For Team members scheduled to re-mobilize for another field effort soon after returning, continue to practice the personal hygiene standards described above, avoid large gatherings, and get enough rest. Sleep deprivation lowers immune system responses, making potential illnesses much worse. Communicate directly with supervisors about health needs and if illness symptoms appear after demobilization, or if other potential contacts (friends, nearby family, coworkers, etc.) have become ill.

APPENDIX D

Site-Specific Health & Safety
Plan Documentation

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Lathrop Wells Parcels -06 and -08
Limited Phase II Environmental Site Assessment

Site-Specific
Health and Safety Plan

1 PROJECT INFORMATION

Project Name:	Lathrop Wells -06 and -08 Phase II Environmental Site Assessment (ESA)		
Site Location (see Figure 1 – Site Map):	5240 East U.S. Highway 95 and 5700 Easy U.S. Highway 95, Amargosa Valley, Nevada 89020		
Site Description:	Vacant, mostly undeveloped sites in rural location near heavily trafficked U.S. Highway 95		
Project Objective(s):	Groundwater sampling from an onsite domestic well, and paint chip sample collection.		
Project Start Date:	November 19, 2020	***Anticipated Completion Date:***	1 day of sampling activities

2 PERSONNEL

Field Safety Supervisor:	Rachel Kistler		Phone:	(540) 553-4311
BEC Office Contact:	Elizabeth Nelson		Phone (24 hour):	(702) 596-4896
Site Worker:	Alana Holt-Hall		Phone:	(702) 773-3364
Site Worker:			Phone:	
Site Worker:			Phone:	

3 HAZARD ANALYSIS (CHECK ALL THAT APPLY):

Task/Operation (Check all Applicable):

- ☐ Air Sampling/Monitoring
- ☐ Asbestos Survey
- ☐ Biological Sampling
- ☐ Biological Monitoring/Evaluation
- ☐ Ecological Study
- ☐ Erosion Control
- ☒ Groundwater Sampling
- ☐ Inspections: _____
- ☒ Lead Inspection
- ☐ Perimeter Monitoring
- ☐ Radon Measurement Survey
- ☐ Site Survey
- ☐ Sample Collection/Transportation
- ☐ Soil Excavation
- ☐ Soil Sampling
- ☐ Staging Supplies
- ☐ Subsurface Soil Sampling – Drilling
- ☐ Subsurface Soil Sampling – Hand Auger
- ☐ Surface Soil Sampling
- ☐ Traffic Controls
- ☐ Water Sampling
- ☐ Other (Describe):_____

4 CHEMICAL HAZARDS (INCLUDE ALL THAT APPLY):

Chemical Name	*Source*	*Concentration*	*Exposure Limits**
--	--	--	--

**Exposure limits are those established by OSHA as the Permissible Exposure Limits (PEL) as of the date of the Site Specific HASP.*

At the time of this investigation, specific chemicals at the site are unknown, and therefore, exposure limits cannot be tested or confirmed in real time. Groundwater sampling will be to analyze volatile organic compounds and heavy metals. Paint on billboards will be sampled and analyzed for lead content.

5 BIOLOGICAL HAZARDS (CHECK ALL THAT APPLY):

- ☐ No Biological Hazards
- ☒ Small Mammals/Droppings
- ☒ Insect Bites and Stings
- ☐ Mold
- ☒ Snakes
- ☒ Poisonous Plants
- ☐ Rabies – Bats/Other Animals
- ☐ Other (Describe): _____

6 PHYSICAL HAZARDS (CHECK ALL THAT APPLY):

- ☐ Abandoned Mine Access
- ☐ Cold Weather Operations
- ☐ Compressed Gas – Storage & Use
- ☐ Demolition Operations/Oversight
- ☒ Dust/Inhalation Hazards
- ☐ Drilling Rig Operations/Oversight
- ☒ Electrical Hazards
- ☒ Ergonomics: Heavy Lifting/Moving, Repetitive Motion, etc.
- ☒ Hand Tool Use
- ☒ Hazardous Chemicals/Materials
- ☐ Heavy Equipment Operation/Oversight
- ☐ Helicopter Operations
- ☐ High Pressure Water Use
- ☒ Hot Weather Operations
- ☐ Housekeeping Hazards (Slips, Trips, Falls, Sharp Objects, etc.)
- ☐ Inadequate Illumination
- ☒ Inclement Weather
- ☒ Ladder Use
- ☐ Noise
- ☒ Remote Site Location
- ☐ Rough Terrain
- ☒ Traffic On or Near Site
- ☐ Trenching and Excavation Operations
- ☐ Welding/Cutting/Brazing Operations

For each item checked, see the associated Slip Sheet following this Plan.

7 WORK PRACTICE CONTROLS

Personal Protective Equipment:

- ☐ Steel-toed Boots
- ☒ Gloves
- ☐ Hard Hat
- ☒ Long Pants
- ☐ Hearing Protection
- ☐ Other (Describe): _____
- ☒ Sunscreen
- ☒ Safety Glasses/Sunglasses
- ☐ Respirators
- ☐ Layers of Clothing

Describe work practice controls as appropriate:

_____
_____
_____

8 FIELD WORK ITEMS CHECKLIST

- ☐ Vehicle Safety Kit
- ☐ 2-way Radios (extra batteries)
- ☐ Digital Camera (extra batteries)
- ☐ Cell Phone with Car Charger
- ☐ GPS Units (extra batteries)
- ☐ Binoculars
- ☐ Topographic Map
- ☐ First Aid Kit
- ☐ Fire Extinguisher
- ☐ Portable Eye-Wash Kit
- ☐ Copy of the HASP
- ☐ Mileage Clipboard
- ☐ SPOT GPS Device

Other Items:

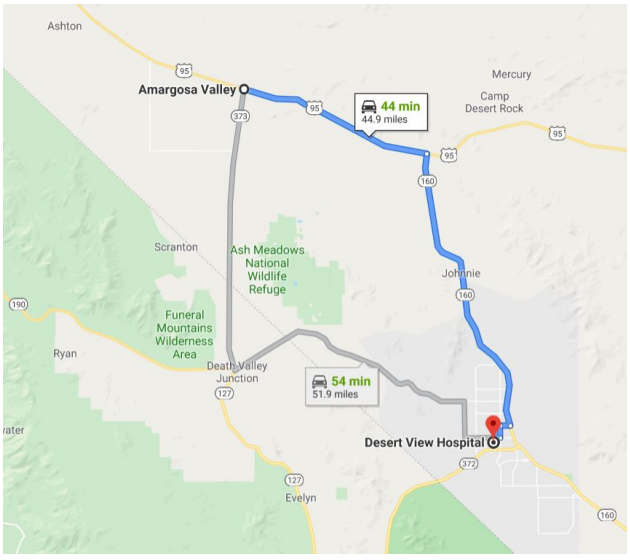
9 ACKNOWLEDGEMENT

I have read and understand the Lathrop Wells -06 and -08 Phase II ESA Site Specific Health and Safety Plan.

Printed Name and Signature	**Date**
Rachel Kistler	11/19/2020
Alana Holt-Hall	11/19/2020

Figure 1 – Site Map

Figure 2 – Emergency Action Map



Desert View Hospital
360 Lola Lane, Pahrump, NV 89048

From US- 95 North, Amargosa Valley, NV

1. Head southeast on US-95 North toward US-95 N
2. Turn right onto NV-160 E
3. Turn right onto East Irene Street
4. Turn left onto North Blagg Road
5. Turn right onto West Basin Avenue
6. Turn Left onto Lola Lane

Destination on the right

Figure 3– Site Sampling Map (if applicable)

Parcel -06 Parcel Sampling Locations

Parcel -08 Sampling Locations

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Adverse Site Condition Procedures Checklist and Safety Slip Sheets

ADVERSE SITE CONDITIONS PROCEDURES CHECKLIST

☐ Unable to locate site
- Consult the topographic map (other maps if available)
  - Find current location (elevation)
  - Verify location of survey site (and elevation)
- Verify the GPS has the correct coordinates entered.
  - UTM vs. Lat. Long.
  - UTM Zone 11 (Nevada)
  - NAD27, NAD83, WGS
- Call point of contact with BEC and/or the governing agency

☐ Site inaccessible
- Use steps above to verify the correct area
- Research other possible access routes
- If feasible, return to site at a later date
- Notify BEC and governing agency of difficulty
- Do not attempt to access if conditions do not allow it to be done safely

☐ Unknown individuals at or around site
- Try to determine professional association either at a distance, or during conversation through the vehicle window
- Determine current activities of individual(s)
- If uncomfortable about the individual(s) activity, return at a later time or date
- Notify BEC of the presence of individuals in the area and of determinations made of whether or not to proceed with work at the site

☐ Vehicle problems
- Troubleshoot mechanical problems
  - Verify battery cables are secure
  - Verify the vehicle is in park
  - Check fuel level
  - Contact BEC office personnel and/or the truck rental company
- If vehicle is stuck, determine action necessary to free the vehicle
  - If possible, use the shovel to dig the tires out
  - If unable to free the vehicle, call the BEC contact for assistance and direction
- If there is an accident with another vehicle, get all of the pertinent information from the other driver, take photos, write down a description of the events that happened and contact BEC and the appropriate legal authority with jurisdiction over the area

☐ Injury
- Attend to the injured individual immediately
- Call for an ambulance if necessary
- Notify BEC contact
- Take notes on incident that led to the injury and the action taken to assist the individual
- Upon return to the BEC office, restock any supplies used in the field

☐ Submit Emergency Event Report Form to Supervisor, as appropriate

Dust and Inhalation Hazards

Hazards associated with dust inhalation include occupational asthma and silicosis. Exposure to respirable crystalline silica can cause silicosis, lung cancer, other respiratory diseases, and kidney disease.

Symptoms of Asthma:

- Chest tightness
- Cough
- Shortness of breath
- Wheezing

Symptoms of Silicosis:

- Difficulty in breathing
- Increased coughing
- Infectious complications may cause fever, weight loss, and night sweats
- Initially there may be no symptoms

Mitigative Actions:

- Use wet methods for cutting
- Provide adequate ventilation
- Limit access to areas where anyone could be exposed to silica above the Action Level (25 µg/m^3) or Permissible Exposure Limit (50 µg/m^3)
- Restrict housekeeping practices that expose workers to silica where feasible alternatives are available.

Recommendations for Personal Protective Equipment:

- Safety Glasses
- Dust Mask
- Respirators

Electrical Hazards

Hazards associated with electricity include electric shock, electrocution, fires and explosions. Contact with electricity may be direct, such as working on overhead lines, cable harnesses, and circuit assemblies. Indirect exposure to electrical hazards may also occur in the course of day to day operations.

Mitigative Actions:

- Only approved conductors and equipment may be utilized.
- Equipment shall be inspected on a regular basis.
- Equipment shall be used/installed in accordance with any instructions provided by the manufacturer/installer.
- Parts of electric equipment which in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.
- Electrical equipment may not be used unless the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified is placed on the equipment. Other markings shall be provided giving voltage, current, wattage, or other ratings as necessary. The marking shall be of sufficient durability to withstand the environment involved.
- Each disconnecting means shall be legibly marked to indicate its purpose.
- Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

Minimum travel distance for travel under power lines (feet)	*Powerline Voltage (kV)*
10	0 – 50
15	50 – 200
20	200 – 350
25	350 – 500
35	500 – 750

- Electrical equipment work areas shall be adequately illuminated.
- Live parts exceeding 50 volts shall be appropriately guarded to prevent accidental shocks.
- Electrical installations exceeding 600 volts shall be installed, maintained and accessed by qualified individuals only.
- All applicable lockout/tagout (LOTO) protocols will be followed.

Recommendations for Personal Protective Equipment

- Gloves
- Long Pants
- Safety Glasses

Ergonomic Hazards

Ergonomics seeks to decrease fatigue and injuries, along with increasing comfort, productivity, job satisfaction and safety. If your body is stressed by an awkward posture, extreme temperature, or repeated movement, your musculoskeletal system is affected. Musculoskeletal disorders (MSDs) are cumulative and chronic injuries of the soft tissue-muscles, tendons, ligaments, nerves, joints, and blood vessels. MSDs are caused or aggravated by our actions and/or environment that does not follow safe and healthy work practices.

Symptoms of a musculoskeletal disorder include fatigue, discomfort, pain, weakness, sensitivity, swelling, burning or tingling sensation, difficulty moving, and clumsiness.

Heavy Manual Lifting/Moving

The hazards associated with improper material handling include being struck by a load, losing control of a load, physically overexerting oneself, and exceeding equipment capacities. Such accidents can lead to injuries (e.g., abrasions, bruises, and broken bones) and even loss of life.

Repetitive Motion

The hazards associated with repetitive motion are that the same joints and muscle groups are used over and over when motions happen to often, too quickly, and for too long. Common symptoms include cramping, muscle weakness, pain, numbness, decreased range of motion.

Vibration

Vibration affects tendons, muscles, joints and nerves. It can be experienced over the whole body (from heavy machinery or vehicle operation) or in a localized area of the body (from using power tools). Common symptoms are numbness of the fingers, hands, or arms; loss of touch and grip; and pain. In addition, the worker may use more force and awkward body positions because vibration hand tools are harder to control.

Mitigative Actions:

- Loads should be handled no more than 18 cm (7 in.) in front of the body as measured from the ankles. The heavier a load, the more closely to the body the load should be held.
- Whenever possible, push rather than pull loads: Pushing uses the strong leg muscles, whereas pulling uses the easily strained back muscles.
- Good handholds shall be provided on an object to be carried.
- Carts and handling aids shall be used where possible.
- Manual movement of objects shall be minimized wherever possible.
- Employees shall not twist or bend while lifting or handling a heavy load.
- Loads shall be inspected for sharp edges, slivers, and wet or greasy spots prior to movement.
- The route objects are to be moved along shall be free of obstructions or spills that may cause tripping, slipping, or impair ability to maneuver objects.
- Take breaks at regular intervals.
- Use correct tools made for the designated task.

Recommendations for Personal Protective Equipment:

- Gloves
- Comfortable, proper footwear for the job being done
- Back support belts (limit range of motion to encourage proper body positioning)
- Knee pads / Elbow pads

Hand and Portable Power Tools

Hand and portable power tools are a common part of the workplace. However, these simple tools can be hazardous and have the potential for causing severe injuries when used or maintained improperly. The hazards associated with these tools comes primarily from damaged or worn tools, improperly guarded tools, and tools with rotating/moving parts which may send debris toward workers.

Mitigative Actions:

- Tools and equipment (both company and employee owned) used by employees at their workplace shall be kept in good condition.
- Hand tools such as chisels and punches, which develop mushroomed heads during use, shall be reconditioned or replaced as necessary.
- Broken or fractured handles on hammers, axes and similar equipment shall be replaced promptly.
- Worn or bent wrenches shall be replaced regularly.
- Employees shall be made aware of the hazards caused by faulty or improperly used hand tools.
- Appropriate handles shall be used on files and similar tools.
- Appropriate safety glasses, face shields, etc. shall be used while using hand tools or equipment which might produce flying materials or be subject to breakage.
- Jacks shall be checked periodically to ensure they are in good operating condition.
- Tool handles shall be wedged tightly in the head of all tools.
- Tool cutting edges shall be kept sharp so the tool will move smoothly without binding or skipping.
- Tools shall be stored in dry, secure locations where they won't be tampered with.
- Eye and face protection shall be used when driving hardened or tempered spuds or nails.
- Grinders, saws and similar equipment shall be provided with appropriate safety guards.
- Power tools shall be used with the correct shield, guard, or attachment, recommended by the manufacturer.
- Rotating or moving parts of equipment shall be guarded to prevent physical contact.
- All cord-connected, electrically operated tools and equipment shall be effectively grounded or of the approved double insulated type.
- Portable fans shall be provided with full guards or screens having openings ½ inch or less.

Recommendations for Personal Protective Equipment:

- Hard hat
- Steel-toed Boots
- Gloves
- Long Pants
- Hearing Protection
- Safety Glasses

Hazardous Chemicals

Under the Hazard Communication Standard, any chemical that presents a physical hazard or a health hazards is considered a hazardous chemical. A ***physical hazard*** means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive. A ***health hazard*** means a chemical for which there is statistically significant evidence that acute or chronic health effects may occur in exposed individuals. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.

Physical Hazards

Fire Hazards: Combustible liquids, flammable liquids, flammable aerosols, flammable gases, flammable solids, oxidizers, and pyrophoric chemicals.

Reactive Hazards: Organic peroxides, unstable (reactive) materials such as corrosives, and water-reactive chemicals.

Explosion Hazards: Compressed gases and explosive materials.

Health Hazards

Systemic Effects: Carcinogens, highly toxic and toxic agents, corrosives, irritants, and sensitizers

Target Organ Effects: Hepatotoxins, nephrotoxins, neurotoxins, blood/hematopoietic toxins, respiratory toxins, reproductive toxins, cutaneous hazard, eye hazard.

Mitigative Actions:

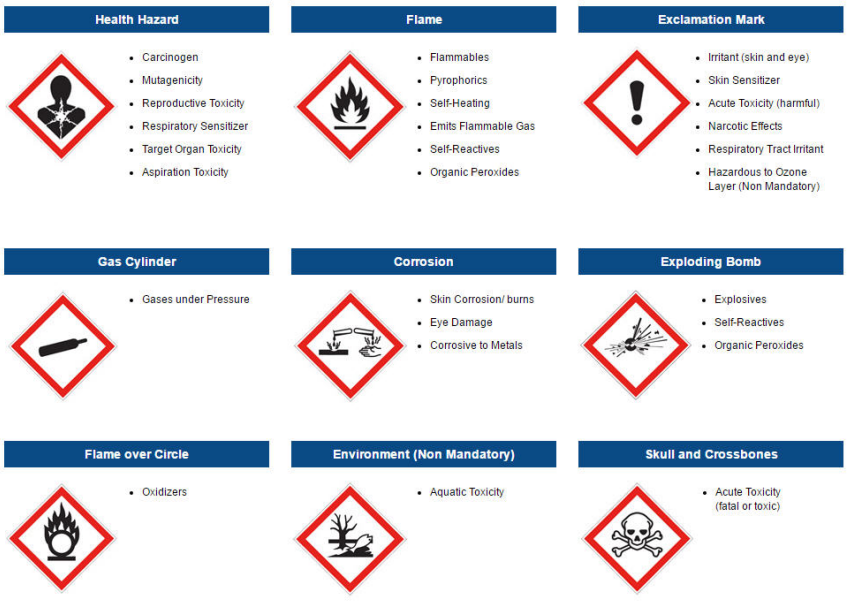
- Adequate ventilation should be maintained, and no open flames, sparks, or smoking should be permitted near flammable liquids.
- Personnel will be alert to the potential dangers and will wear the appropriate protective equipment.
- Personnel shall exercise caution at all time to prevent accidents.

Recommendations for Personal Protective Equipment:

- Gloves
- Closed-Toed Shoes
- Full Coverage Clothing
- Safety Glasses/Goggles/Face Shield

Hazard Communication

Chemical hazards will be communicated with the following pictograms:



Hot Weather Operations

Heat stress is any external environmental heat stimulus that causes your body to react outside its normal range of activities. Heat stress is the cumulative environmental condition (hot outside temperatures, high humidity, winds, etc.) that causes your body to react. Each individual may react differently to heat stress, depending on individual susceptibility to heat, age, physical condition, alcoholic intake, etc. Heat stress does not necessarily result in adverse health effects.

Heat Rash

Heat rash is a temporary but painful condition caused by clogged skin pores, which can impair sweating and result in diminished heat tolerance.

Symptoms: Tiny red bumps on skin.

First Aid: Treatment consists of washing the affected part and using body powder to help absorb moisture.

Heat Cramps

Heat cramps are caused by a loss of electrolytes – mainly sodium and/or potassium – causing fluids to collect in muscle tissue, resulting in spasms.

Symptoms: painful intermittent muscle spasms following hard physical work in a hot environment.

First Aid: Rest. Find a cool place. Drink plenty of water and eat regular meals.

Heat Exhaustion

Heat exhaustion is the most common form of serious heat illness encountered during work activities.

Symptoms: Profuse sweating, weakness, low blood pressure, rapid pulse, dizziness, nausea and/or headache may be present, cool clammy pale skin, body core temperature may be normal or depressed, fainting or vomiting may occur

First Aid: Rest. Find a cool place. Place ice packs or cool wet towels on the neck, armpits and groin. Call 911 for further instruction.

A victim of heat exhaustion must not be exposed to a hot working environment for at least 24 hours after onset of heat exhaustion. If fainting has occurred, they should not return to work until authorized by a physician.

Heat Stroke

Heat stroke is the most serious heat disorder and is life-threatening. It results when the body's heat dissipating system is overwhelmed and shuts down. Heat stroke results in a continual rise in the victim's deep core body temperature, and is fatal if not checked.

Symptoms: Hot, dry, flushed skin; Elevated body temperature; Convulsions; Delirium; Unconsciousness and possible death.

First Aid: Call 911. Find a cool, shaded place for the victim to rest. Sponge with cool water. Fan while misting with cool water. Place ice packs or cool wet towels on the neck, armpits and groin.

A heat stroke victim must be seen by a physician and cannot return to work without physician approval.

Hot Weather Mitigative Actions:

- Monitor your physical condition and that of your coworkers.
- Wear appropriate clothing for all weather conditions.
- Recommendations for working in environments with temperatures above 100.4 °F:
    - Move to a cool location/shade
    - Rest regularly
    - Drink cool, non-caffeinated and non-alcoholic drinks
- Drink at least one quart of water every hour (or one cup per hour) for the entire work shift.
- Each work vehicle should carry at least 5 gallons of drinking water.

Recommendations for Personal Protective Equipment

- Loose-fitting, moisture wicking clothing
- Personal water container
- Chemical cooling towels

Inclement Weather

Hazards associated with inclement weather include Cold Stress and Heat Stress, which are further discussed in their own Slip Sheets. Extreme heat or cold can result in serious injuries (i.e. frostbite or heat stroke) or death. Other extreme weather conditions, such as flooding, snowstorms, and natural disasters may also be encountered in the field.

- **Cold Stress**
  Cold exposure may occur either at low temperatures or at more moderate temperatures when there is a high the wind-chill factor, and may cause hypothermia, frostbite; and the impaired ability to work. Their physical condition should be closely monitored by themselves, their co-workers, and the Safety Officer. The work schedule should be carefully planned and include rest periods.

- **Heat Stress**
  Operations involving high air temperatures, radiant heat sources, high humidity, direct sun or heat, limited air movement, or strenuous physical activities have a high potential for inducing heat stress in employees engaged in such operations. Heat stress can cause heat exhaustion and heat stroke. Employees should be trained to recognize the symptoms and take actions to relieve heat stress.

- **Flash Flooding/Monsoons**
  Flash flooding occurs quickly and is dangerous due to the combination of the destructive power of a flood and incredible speed and unpredictability. In the desert, effects on access roads will probably be of short duration unless road repairs are necessary. Do not walk or drive in areas that remain flooded. Seek higher ground. Be aware of downed electrical lines in water.

- **High Winds**
  High winds also occur frequently in the region and appropriate measures for dust control and personnel protection should be exercised. Damaging winds are classified as those exceeding 50-60 miles per hour.

- **Thunderstorms**
  Thunderstorms are common during the winter and late summer months and lightning is a threat to all workers. The Safety Officer has the authority to suspend field activities if needed to prevent injury due to lightning strikes. Flash flooding and high winds are common during thunderstorms.

- **Snowstorms**
  Snowstorms can occur in the region, especially at higher elevations in the winter. Hazards of winter weather include icy roads, hypothermia, low visibility, high winds, and dehydration. Always be prepared for winter weather by bringing extra clothes, handwarmers, snow chains for the vehicle, a shovel, and plenty of water.

- **Earthquakes**
  Earthquakes are unpredictable natural disasters that may occur in this region. If an earthquake generates a large enough shaking intensity, structures like buildings, bridges and dams can be severely damaged, and cliffs and sloping ground destabilized. The ground may become displaced especially near fault lines. Expect aftershocks.
  - If you are in a vehicle, pull over and stop. Set your parking brake.
  - If you are outdoors, stay outdoors away from buildings.
  - If you are inside a building, do not get in a doorway. Drop to the ground and cover your head and neck with your arms.

Ladder Hazards

Employers must train each worker to recognize and minimize ladder-related hazards. Using ladders safely reduces the risk of serious injury or death. Do not use ladders for a purpose other than that for which they were designed.

Stepladders

This is a portable, self-supporting, A-frame ladder. It has two front side rails and two rear side rails. Generally, there are steps mounted between the front side rails and bracing between the rear side rails. Do not use a folded stepladder as a single ladder, always use the ladder with the spreaders unlocked.

Extension Ladders

Also known as "portable ladders," extension ladders usually have two sections that operate in brackets or guides allowing for adjustable lengths. Because extension ladders are not self-supporting, they require a stable structure that can withstand the intended load.
Set the ladder at the proper angle. When a ladder is leaned against a wall, the bottom of the ladder should be one-quarter of the ladder's working length away from the wall. For access to an elevated work surface, extend the top of the ladder three feet above that surface or secure the ladder at its top. Set the base of the ladder so that the bottom sits securely and so both side rails are evenly supported. The ladder rails should be square to the structure against which it is leaning with both footpads placed securely on a stable and level surface.

Mitigative Actions:

- Use a ladder that can sustain at least four times the maximum intended load, except extra-heavy duty type 1A metal or plastic ladders shall sustain at least 3.3 times the maximum intended load.
- Do not exceed the load rating and always include the weight of all tools, materials and equipment.
- A competent person must visually inspect ladders before use for any defects such as: missing rungs, bolts, cleats, screws and loose components; grease, dirt or other contaminants that could cause slips or falls; paint or stickers (except warning or safety labels) that could hide possible defects
    - Where a ladder has these or other defects, it must be immediately marked as defective or tagged with "Do Not Use" or similar language.
- Allow sufficient room to step off the ladder safely.
- Keep the area around the bottom and the top of the ladder clear of equipment, materials and tools.
- Before starting work, survey the area for potential hazards, such as energized overhead power lines. Ladders shall have nonconductive side rails if they are used where the worker or the ladder could contact exposed energized electrical equipment.
- Keep all ladders and other tools at least 10 feet away from any power lines.
- When using a ladder in a high-activity area, secure it to prevent movement and use a barrier to redirect workers and equipment. If the ladder is placed in front of a door, always block off the door.
- Maintain a 3-point contact (two hands and a foot, or two feet and a hand) when climbing/descending a ladder.
- Stay near the middle of the ladder and face the ladder while climbing up/down.
- Only put ladders on a stable and level surface that is not slippery.

Remote Site Location

Remote work is defined as work that is isolated from the assistance of other people because of the location, time, or nature of the work being done. It may involve work activities undertaken at a location removed from an office environment where there are few people, and where communications and travel are difficult. Remote workers also have a duty to take reasonable care for their own health and safety, and the health and safety of other persons, as well as to comply with reasonable safety instructions given by their employers. Remote workers should work with their employers to identify and control the risks associated with remote work, as well as assist with putting in place appropriate health and safety measures.

Mitigative Actions:

- Determine if control measures in place are adequate.
- Establish an appropriate system for reporting and investigating injuries, illnesses, and dangerous incidents that may occur because of remote work activities.
- Proactively identify any health and safety issues in the field, and report in a timely manner, as well as the necessary precautions to be taken.
- Managers and supervisors should make periodic site visits and address health and safety issues that arise.
- Consult with emergency services about possible recuse scenarios in remote locations.
- Be sure you are well-rested to avoid fatigued or drowsy driving to/from remote locations.

Recommendations for Personal Protective Equipment:

- SPOT GPS device
- Two-Way Radios
- First Aid Kit

Traffic On or Near Work Site

Workers in areas where there are moving vehicles and traffic are exposed to struck-by hazards. Work zones are used to move traffic in an approved direction and are typically identified by signs, cones, barrels, and barriers.

Mitigative Actions:

- Traffic control plans must be in place for the movement of vehicles in areas where there are also workers conducting other tasks.
- Limiting motorist intrusions into the work zone can be concrete, water, sand, or collapsible barriers, crash cushions, and truck-mounted attenuators.
- Flagger stations should be illuminated. Lighting for workers on foot and equipment operators is to be at least 5 foot-candles or greater.
- Where lighting is not sufficient, flares or chemical lighting should be used.
- Operators and workers on foot need to know the visibility limits and the "blind spots" for each vehicle on site.

Recommendations for Personal Protective Equipment:

- High Visibility Clothing

BEC COVID-19 Field Safety Plan

COVID-19 Specific Safety Precautions while Conducting Fieldwork

Prepared By:
BEC Environmental, Inc.
7241 West Sahara Avenue, Suite 120
Las Vegas, Nevada 89117
(702) 304-9830
www.becnv.com

Date Created: *March 2020*
Updated: *October 2020*

bec environmental, inc.
Environmental Services

Table of Contents

BACKGROUND

COVID-19 (Novel Coronavirus Disease 2019) is a respiratory illness that can spread from person to person. The virus that causes COVID-19 is a novel coronavirus (coronavirus, like the flu, has been around for a very long time). Coronavirus disease (old and new strains) spreads primarily through contact with an infected person when they cough or sneeze. It also spreads when a person touches a surface or object that has the virus on it, then touches their eyes, nose, or mouth. The disease causes respiratory illness (like the flu) with symptoms such as a cough, fever, and in more severe cases, difficulty breathing.

Due to heightened concerns of COVID-19 transmission, it is important we all take extra precautions to keep ourselves, our coworkers, and our community safe and healthy. BEC is committed to conducting business activities in a manner to protect employees, clients/teaming partners/vendors, and the organization, relying on guidance from the Centers for Disease Control (CDC) and state and local governments. Based on the current evaluation, BEC's 2020 field efforts should be modified or delayed whenever possible. As we move into the field season, it is critical that team members in hotels, rental vehicles, or airplanes follow recommended health and safety measures to prevent the infection and spread of COVID-19, and ensure they have access to the tools they need to be safe and successful. This document is intended to provide guidance on communication expectations, prepping for communal living (i.e., hotel stays), pre-cleaning and maintaining clean field trucks and equipment, personal hygiene, mobilization and demobilization expectations, and how to respond if one of our team members displays symptoms. In the context of this document, mobilization and demobilization refer to any activities which involve travel away from the office (Las Vegas) for purposes of work.

Please note, all directives in this document are fluid and will be adjusted based on updated guidance from BEC's Officers, the CDC, or state and local governments. Email communications will be utilized to provide the most current information on COVID-19 should conditions or recommended precautions change. For immediate questions or concerns, please communicate with supervisors, project manager, or a BEC Officer.

1 PRE-FIELDWORK

1.1 Personal Preparedness

Team members should review current travel restrictions prior to scheduling fieldwork outside of Clark County, Nevada.

Team members should avoid physically attending any conferences, trainings, workshops, parties, or other large public gatherings until local, state, and/or federal public health officials declare it is safe to do so.

Team members with pending fieldwork should prepare their home and an overnight bag prior to the scheduled fieldwork. A state-wide or nation-wide quarantine may be put into effect, requiring a stay at the field location longer than scheduled.

The CDC recommends everyone get the flu shot, when available, to ensure flu symptoms are not mistaken with COVID-19 symptoms. All team members are strongly encouraged to get the current season's flu shot as soon as possible and stay current on all other CDC recommended vaccines.

1.2 Communication

All Project Managers are to communicate daily with Team members regarding field staff health conditions. If any of the scheduled field staff begin to feel ill within the two weeks prior to any scheduled fieldwork, a potential alternate for the fieldwork should be identified.

Any travel planned or conducted within the two weeks prior to scheduled fieldwork, or any large events attended during this period, should be discussed with a supervisor and the project manager.

Team Members feeling ill, and especially those with COVID-19-like symptoms, WILL NOT report for fieldwork. They must complete the Daily Wellness Questionnaire for each day of fieldwork and communicate directly with their supervisor and project manager about their health concerns. The health and safety of our team members if more important than any Project. If any field staff display illness symptoms, they will not be approved for fieldwork and will be encouraged to use sick leave. An alternate team member will participate in the fieldwork if the type of project allows for the substitution. Any field employee displaying COVID-19-like symptoms will be encouraged to seek medical attention immediately.

Team members who have been a caretaker for someone who is or was ill, who share a residence with someone who has exhibited symptoms of COVID-19, or who have come into close contact with someone who has a laboratory-confirmed COVID-19 diagnosis in the past 14 days should communicate directly with their supervisor or project manager to discuss alternatives or potential issues. According to the CDC's update on October 21, 2020, "close contact" means someone who was within 6 feet of an infected person for a cumulative total of 15 minutes or more over a 24-hour period* starting from 2 days before illness onset (or, for asymptomatic patients, 2 days prior to test specimen collection) until the time the patient is isolated.

**Individual exposures added together over a 24-hour period (e.g., three 5-minute exposures for a total of 15 minutes).*

1.3 Approval

Approval for a team member to participate in fieldwork will require approval from the member's supervisor and the project manager. This approval will be based on:

- Field staff current health condition
- Potential past risk of exposure to someone else who has tested positive for COVID-19, or has displayed COVID-19-like symptoms
- CDC definitions for high-risk individuals
- The locations of identified COVID-19 hotspots and local regulations regarding public movements

2 PREPPING FOR FIELDWORK AND MOBILIZATION

It is of the utmost importance to practice good hygiene during travel and in the field. Health and hygiene items to bring to the field include hand sanitizer, disinfecting wipes, and latex or nitrile gloves. If disinfecting wipes are not available, bring paper towels and disinfecting spray.

Travel itineraries and booking information must be submitted to the Team Member's supervisor for approval, and Site-Specific Health and Safety Plans must be reviewed by the BEC Safety Officer, with special attention being paid to COVID-19 field practices.

2.1 Vehicle Preparation and Cleaning

Practice caution when traveling in trucks, with equipment, or personal goods potentially touched by other people. Wipe down all steering wheels, door handles, common contact areas on the sides of doors, center consoles, display knobs, field equipment, gasoline pumps, and food product packaging to avoid potentially transporting germs to a different community. Wearing latex or nitrile gloves when cleaning or handling these surfaces is also recommended. Follow the same vehicle cleaning standards with utility-task vehicles and all-terrain vehicles.

Two people may share a field vehicle to and from the job site. It is strongly recommended each passenger wears a facemask while inside the vehicle. Alternatively, a physical barrier (i.e.: plastic sheeting) inside the vehicle may used between the passengers in place of facemasks to prevent the spread of airborne droplets. The physical barrier must not obstruct the driver's view of windows and mirrors, and must be either replaced or sanitized if driver and passenger switch. In addition, it is recommended that both passengers wear disposable gloves when sharing a vehicle. Commonly-touched surfaces (steering wheel, seatbelt, gear shifter, lock and window controls, radio and climate control knobs, etc.) should be disinfected if driver and passenger switch, and at the beginning and end of the workday.

2.2 Air Travel

At this time, air travel is permitted for project work, subject to authorization from a BEC Officer. Check the departing and arriving airports, airline, the CDC, and the FAA for information and safeguards pertaining to COVID-19 while traveling via air. BEC encourages Team Members traveling by air to wear a facemask during travel activities, exercise frequent hand hygiene, and practice social distancing in public areas. Be aware that some airlines may also require travelers to wear facemasks.

2.3 Hotel Stays

Each team member will have their own hotel room, with their own bathroom, should a hotel stay be necessary during fieldwork. Guests will not be permitted. Any work-related discussions or meetings will be conducted either in the field using social distancing precautions or electronically.

Immediately upon arrival to the hotel room, wash your hands with antimicrobial soap to help ensure any microbes from travel or fieldwork activities will not be transferred to room surfaces. After washing your hands, it is recommended that all surfaces be wiped or cleaned with an antimicrobial-rated cleaner. Do not forget counters; interior and exterior door handles; cabinet handles; medicine cabinet handles; appliance handles, buttons, and knobs such as on the refrigerator or microwave; toilets; faucet handles; shower knobs; tv remotes; light switches, and other frequently touched surfaces, such as shoulder-height on doors where we push them closed.

3 CONDUCTING FIELDWORK

3.1 Safety Meetings

Any safety (tailgate) meeting forms should detail appropriate personal protective equipment relevant for safe project work. All tailgate meetings will be used to check each team member's physical health, including reviewing the daily wellness check questions recommended by the Southern Nevada Health District:

- Do you have a new cough that you cannot attribute to another health condition?
- Do you have new shortness of breath that you cannot attribute to another health condition?
- Do you have any two of the following symptoms: Fever (100.4°F or higher), chills, repeated shaking with chills, muscle pain, headache, sore throat, or new loss of taste or smell?
- Have you come into close contact (CDC definition as of October 21, 2020) with someone who has a laboratory-confirmed COVID-19 diagnosis in the past 14 days?

Tailgate meetings will include discussions on personal hygiene, communication requirements, and emergency response action plans relevant to COVID-19 spread or quarantines.

3.2 Personal Hygiene

Avoid close contact with others; it is recommended individuals keep at least a minimum of six feet apart. Do not shake hands, hug, or touch people unnecessarily. An elbow bump, foot tap, or a nod are good alternatives for handshakes. Avoid touching your face. Sneeze or cough into a tissue and then throw it away, or into your elbow. If you accidentally sneeze or cough into your hands, wash them immediately. Regularly wash your hands for at least 20 seconds with antimicrobial soap or hand sanitizer throughout the day, especially before and after eating or touching common surfaces.

If at any point you feel unsafe working with others in the field who are not exercising COVID-19 precautions such as wearing a face mask or practicing social distancing, you are permitted to leave the work site. The health and safety of Team Members is more important than any project. Contact your project manager or Eileen Christensen for further guidance, recommendations, or field support.

3.2.1 In the Field

Follow the standard CDC recommendations above for personal hygiene even when in the field. This is especially important when handling shared equipment. Wipe down field equipment daily with antimicrobial spray or wipes. Wipe down field truck steering wheels, door handles, display knobs and center consoles daily or if there is a switch in user. Use hand sanitizer regularly, especially before eating, after eating, or if you sneeze or cough into your hands. Wear a cloth facemask, as recommended by the CDC. Look out for fellow fieldworkers and encourage them to do the same.

Exercise social/physical distancing when in the field with coworkers by maintaining at least a six-foot distance from others. In certain circumstances, social distancing may not be feasible based on the task at hand. In these instances, Team Members should wear face coverings in accordance with CDC

requirements and frequently practice good hand hygiene. Additionally, if social distancing measures are unable to be followed while conducting field work, a COVID-19 Job Hazard Analysis form must be filled out by the field workers and attached with this COVID-19 Fieldwork Safety Plan for Site Specific Health and Safety Plans.

3.2.2 In the Community

When stopping anywhere to or from the field, such as a restaurant or gas station, wash your hands with antimicrobial soap prior to leaving the establishment if available. Use a paper towel or an elbow to exit the bathroom/building. Consider using gloves to pump gas and practice safe donning-doffing techniques. This helps to reduces the risk of picking up microbes from fellow travelers. In cases where antibacterial soap is not available, use the hand sanitizer in your COVID field kit.

When entering public establishments, wearing a facemask is recommended, and is required in many places. Please note that as public restrictions are lifted, facemasks may be required by public directives or by individual business owners.

Upon returning to the hotel room or office, avoid touching surfaces until after washing your hands.

4 ACTION PLAN FOR POTENTIAL INFECTION

If you or a co-worker becomes ill, contact the appropriate supervisor or project manager immediately. Anyone showing signs of COVID-19 will be required to cease fieldwork activities and encouraged to seek immediate medical attention (COVID-19 symptoms are listed below). The sick team member/field staff may be quarantined in their hotel room.

Sick and caretaking team members should wash their hands frequently and immediately before and after touching communal surfaces (food dishes, shared spaces, etc.). If possible, supervisory staff may consider evacuating all team members not displaying symptoms to other housing. Please consider potential spread to the community when making this decision.

5 COVID-19 SYMPTOMS

COVID-19 symptoms may not appear for two days to two weeks after exposure. Symptoms may be slight or severe and may not necessarily all occur at the same time. People who have these symptoms may have COVID-19 (This list does not include all possible symptoms):

- Fever or chills
- Cough
- Shortness of breath or difficulty breathing
- Fatigue
- Muscle or body aches
- Headache
- New loss of taste or smell
- Sore throat
- Congestion or runny nose
- Nausea or vomiting
- Diarrhea

Look for emergency warning signs* for COVID-19. If someone is showing any of these signs, seek emergency medical care immediately:

- Trouble breathing
- Persistent pain or pressure in the chest
- New confusion
- Inability to wake or stay awake
- Bluish lips or face

**This list is not all possible symptoms. Please call your medical provider for any other symptoms that are severe or concerning to you.*

6 DEMOBILIZATION

6.1 Communication

Project managers and/or supervisors are to communicate daily with field staff. Additionally, extra care should be taken as field staff demobilize, paying special attention to:

- where team members are coming from and going to relative to COVID-19 hotspots.
- team member current health conditions.
- whether or not there are nation-wide or state-wide quarantines in place restricting travel.
- whether team members have been exposed to people showing symptoms.

6.2 Preparation

Practice personal hygiene methods described above during demobilization. Clean all field equipment thoroughly before returning it to the office or its usual storage location. Prior to returning the field vehicle, clean the interior and exterior surfaces to the same standards as when the vehicle was received.

6.3 Post-Demobilization

Please continue to evaluate your health daily and communicate directly with your supervisor if you start to feel ill after demobilization.

For Team members scheduled to re-mobilize for another field effort soon after returning, continue to practice the personal hygiene standards described above, avoid large gatherings, and get enough rest. Sleep deprivation lowers immune system responses, making potential illnesses much worse. Communicate directly with supervisors about health needs and if illness symptoms appear after demobilization, or if other potential contacts (friends, nearby family, coworkers, etc.) have become ill.

APPENDIX E

Analytical Reports and COCs

WECK LABORATORIES, INC.

Certificate of Analysis

FINAL REPORT

Work Orders:	0K24078	**Report Date:**	12/22/2020
		Received Date:	11/24/2020
Project:	Lathrop Wells	**Turnaround Time:**	Normal
		Phones:	(702) 304-9830
		Fax:	
Attn:	Rachel Kistler	**P.O. #:**	
Client:	BEC Environmental, Inc. 7241 West Sahara Ave., Ste. 120 Las Vegas, NV 89117	**Billing Code:**	

DoD-ISO ANAB # • ELAP-CA #1132 • EPA-UCMR #CA00211 • HW-DOH # • ISO17025 ANAB #L2457.01 • LACSD #10143 • NELAP-OR #4047 • NJ-DEP #CA015

This is a complete final report. The information in this report applies to the samples analyzed in accordance with the chain-of-custody document. Weck Laboratories certifies that the test results meet all requirements of TNI unless noted by qualifiers or written in the Case Narrative. This analytical report must be reproduced in its entirety.

Dear Rachel Kistler,

Enclosed are the results of analyses for samples received 11/24/20 with the Chain-of-Custody document. The samples were received in good condition, at 4.8 °C and on ice. All analyses met the method criteria except as noted in the case narrative or in the report with data qualifiers.

Reviewed by:

Kim G. Tu
Project Manager

14859 Clark Avenue,City of Industry CA, 91745 | Phone: (626) 336-2139 | Fax: (626) 336-2634

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BEC Environmental, Inc.
7241 West Sahara Ave., Ste. 120
Las Vegas, NV 89117

Project Number: Lathrop Wells

Project Manager: Rachel Kistler

Reported:
12/22/2020 14:55

Sample Summary

Sample Name	Sampled By	Lab ID	Matrix	Sampled	Qualifiers
GW-01	Rachel Kistler	0K24078-01	Water	11/19/20 14:55	
GW-02	Rachel Kistler	0K24078-02	Water	11/19/20 14:59	
GW-03	Rachel Kistler	0K24078-03	Water	11/19/20 14:45	
GW-01	Rachel Kistler	0K24078-04	Water	11/19/20 15:03	
GW-02	Rachel Kistler	0K24078-05	Water	11/19/20 15:04	
GW-03	Rachel Kistler	0K24078-06	Water	11/19/20 14:48	

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BEC Environmental, Inc.
7241 West Sahara Ave., Ste. 120
Las Vegas, NV 89117

Project Number: Lathrop Wells

Project Manager: Rachel Kistler

Reported: 12/22/2020 14:55

Sample Results

Sample: GW-01

0K24078-01 (Water)

Sampled: 11/19/20 14:55 by Rachel Kistler

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Volatile Organic Compounds by P&T and GC/MS						
Method: EPA 524.2		**Instr:** GCMS12				
Batch ID: W0K1456 **Preparation:** EPA 524.2 P&T		**Prepared:** 11/25/20 07:44				**Analyst:** cam
1,1,1,2-Tetrachloroethane	ND	0.50	ug/l	1	11/25/20	
1,1,1-Trichloroethane	ND	0.50	ug/l	1	11/25/20	
1,1,2,2-Tetrachloroethane	ND	0.50	ug/l	1	11/25/20	
1,1,2-Trichloroethane	ND	0.50	ug/l	1	11/25/20	
1,1-Dichloroethane	ND	0.50	ug/l	1	11/25/20	
1,1-Dichloroethene	ND	0.50	ug/l	1	11/25/20	
1,1-Dichloropropene	ND	0.50	ug/l	1	11/25/20	
1,2,3-Trichlorobenzene	ND	0.50	ug/l	1	11/25/20	
1,2,4-Trichlorobenzene	ND	0.50	ug/l	1	11/25/20	
1,2,4-Trimethylbenzene	ND	0.50	ug/l	1	11/25/20	
1,2-Dichloroethane	ND	0.50	ug/l	1	11/25/20	
1,2-Dichloropropane	ND	0.50	ug/l	1	11/25/20	
1,3,5-Trimethylbenzene	ND	0.50	ug/l	1	11/25/20	
1,3-Dichloropropane	ND	0.50	ug/l	1	11/25/20	
1,3-Dichloropropene, Total	ND	0.50	ug/l	1	11/25/20	
2,2-Dichloropropane	ND	0.50	ug/l	1	11/25/20	
2-Butanone	ND	5.0	ug/l	1	11/25/20	
2-Chlorotoluene	ND	0.50	ug/l	1	11/25/20	
2-Hexanone	ND	5.0	ug/l	1	11/25/20	
4-Chlorotoluene	ND	0.50	ug/l	1	11/25/20	
4-Methyl-2-pentanone	ND	5.0	ug/l	1	11/25/20	
Benzene	ND	0.50	ug/l	1	11/25/20	
Bromobenzene	ND	0.50	ug/l	1	11/25/20	
Bromochloromethane	ND	0.50	ug/l	1	11/25/20	
Bromodichloromethane	ND	0.50	ug/l	1	11/25/20	
Bromoform	ND	0.50	ug/l	1	11/25/20	
Bromomethane	ND	0.50	ug/l	1	11/25/20	
Carbon tetrachloride	ND	0.50	ug/l	1	11/25/20	
Chlorobenzene	ND	0.50	ug/l	1	11/25/20	
Chloroethane	ND	0.50	ug/l	1	11/25/20	
Chloroform	ND	0.50	ug/l	1	11/25/20	
Chloromethane	ND	0.50	ug/l	1	11/25/20	
cis-1,2-Dichloroethene	ND	0.50	ug/l	1	11/25/20	
cis-1,3-Dichloropropene	ND	0.50	ug/l	1	11/25/20	
Dibromochloromethane	ND	0.50	ug/l	1	11/25/20	

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Project Number: Lathrop Wells

Project Manager: Rachel Kistler

Reported: 12/22/2020 14:55

Sample Results

(Continued)

Sample: GW-01

Sampled: 11/19/20 14:55 by Rachel Kistler

0K24078-01 (Water)

(Continued)

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Volatile Organic Compounds by P&T and GC/MS (Continued)						
Method: EPA 524.2		**Instr:** GCMS12				
Batch ID: W0K1456 **Preparation:** EPA 524.2 P&T		**Prepared:** 11/25/20 07:44				**Analyst:** cam
Dibromomethane	ND	0.50	ug/l	1	11/25/20	
Dichlorodifluoromethane (Freon 12)	ND	0.50	ug/l	1	11/25/20	
Di-isopropyl ether	ND	2.0	ug/l	1	11/25/20	
Ethyl tert-butyl ether	ND	2.0	ug/l	1	11/25/20	
Ethylbenzene	ND	0.50	ug/l	1	11/25/20	
Freon 113	ND	5.0	ug/l	1	11/25/20	
Hexachlorobutadiene	ND	0.50	ug/l	1	11/25/20	
Isopropylbenzene	ND	0.50	ug/l	1	11/25/20	
m,p-Xylene	ND	0.50	ug/l	1	11/25/20	
m-Dichlorobenzene	ND	0.50	ug/l	1	11/25/20	
Methyl tert-butyl ether (MTBE)	ND	2.0	ug/l	1	11/25/20	
Methylene chloride	ND	0.50	ug/l	1	11/25/20	
Naphthalene	ND	0.50	ug/l	1	11/25/20	
n-Butylbenzene	ND	0.50	ug/l	1	11/25/20	
n-Propylbenzene	ND	0.50	ug/l	1	11/25/20	
o-Dichlorobenzene	ND	0.50	ug/l	1	11/25/20	
o-Xylene	ND	0.50	ug/l	1	11/25/20	
p-Dichlorobenzene	ND	0.50	ug/l	1	11/25/20	
p-Isopropyltoluene	ND	0.50	ug/l	1	11/25/20	
sec-Butylbenzene	ND	0.50	ug/l	1	11/25/20	
Styrene	ND	0.50	ug/l	1	11/25/20	
Tert-amyl methyl ether	ND	2.0	ug/l	1	11/25/20	
tert-Butylbenzene	ND	0.50	ug/l	1	11/25/20	
Tetrachloroethene	ND	0.50	ug/l	1	11/25/20	
THMs, Total	ND	0.50	ug/l	1	11/25/20	
Toluene	ND	0.50	ug/l	1	11/25/20	
trans-1,2-Dichloroethene	ND	0.50	ug/l	1	11/25/20	
trans-1,3-Dichloropropene	ND	0.50	ug/l	1	11/25/20	
Trichloroethene	ND	0.50	ug/l	1	11/25/20	
Trichlorofluoromethane	ND	0.50	ug/l	1	11/25/20	
Vinyl chloride	ND	0.50	ug/l	1	11/25/20	
Xylenes, Total	ND	0.50	ug/l	1	11/25/20	
Surrogate(s)						
1,2-Dichlorobenzene-d4	*93%*	*Conc: 9.31*	*70-130*		*11/25/20*	
4-Bromofluorobenzene	*103%*	*Conc: 10.3*	*70-130*		*11/25/20*	

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Project Number: Lathrop Wells

Project Manager: Rachel Kistler

Reported: 12/22/2020 14:55

Sample Results

(Continued)

Sample: GW-02

0K24078-02 (Water)

Sampled: 11/19/20 14:59 by Rachel Kistler

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Volatile Organic Compounds by P&T and GC/MS						
Method: EPA 524.2		**Instr:** GCMS12				
Batch ID: W0K1456 **Preparation:** EPA 524.2 P&T		**Prepared:** 11/25/20 07:44				**Analyst:** cam
1,1,1,2-Tetrachloroethane	ND	0.50	ug/l	1	11/25/20	
1,1,1-Trichloroethane	ND	0.50	ug/l	1	11/25/20	
1,1,2,2-Tetrachloroethane	ND	0.50	ug/l	1	11/25/20	
1,1,2-Trichloroethane	ND	0.50	ug/l	1	11/25/20	
1,1-Dichloroethane	ND	0.50	ug/l	1	11/25/20	
1,1-Dichloroethene	ND	0.50	ug/l	1	11/25/20	
1,1-Dichloropropene	ND	0.50	ug/l	1	11/25/20	
1,2,3-Trichlorobenzene	ND	0.50	ug/l	1	11/25/20	
1,2,4-Trichlorobenzene	ND	0.50	ug/l	1	11/25/20	
1,2,4-Trimethylbenzene	ND	0.50	ug/l	1	11/25/20	
1,2-Dichloroethane	ND	0.50	ug/l	1	11/25/20	
1,2-Dichloropropane	ND	0.50	ug/l	1	11/25/20	
1,3,5-Trimethylbenzene	ND	0.50	ug/l	1	11/25/20	
1,3-Dichloropropane	ND	0.50	ug/l	1	11/25/20	
1,3-Dichloropropene, Total	ND	0.50	ug/l	1	11/25/20	
2,2-Dichloropropane	ND	0.50	ug/l	1	11/25/20	
2-Butanone	ND	5.0	ug/l	1	11/25/20	
2-Chlorotoluene	ND	0.50	ug/l	1	11/25/20	
2-Hexanone	ND	5.0	ug/l	1	11/25/20	
4-Chlorotoluene	ND	0.50	ug/l	1	11/25/20	
4-Methyl-2-pentanone	ND	5.0	ug/l	1	11/25/20	
Benzene	ND	0.50	ug/l	1	11/25/20	
Bromobenzene	ND	0.50	ug/l	1	11/25/20	
Bromochloromethane	ND	0.50	ug/l	1	11/25/20	
Bromodichloromethane	ND	0.50	ug/l	1	11/25/20	
Bromoform	ND	0.50	ug/l	1	11/25/20	
Bromomethane	ND	0.50	ug/l	1	11/25/20	
Carbon tetrachloride	ND	0.50	ug/l	1	11/25/20	
Chlorobenzene	ND	0.50	ug/l	1	11/25/20	
Chloroethane	ND	0.50	ug/l	1	11/25/20	
Chloroform	ND	0.50	ug/l	1	11/25/20	
Chloromethane	ND	0.50	ug/l	1	11/25/20	
cis-1,2-Dichloroethene	ND	0.50	ug/l	1	11/25/20	
cis-1,3-Dichloropropene	ND	0.50	ug/l	1	11/25/20	
Dibromochloromethane	ND	0.50	ug/l	1	11/25/20	

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Project Number: Lathrop Wells

Project Manager: Rachel Kistler

Reported: 12/22/2020 14:55

Sample Results

(Continued)

Sample: GW-02

Sampled: 11/19/20 14:59 by Rachel Kistler

0K24078-02 (Water)

(Continued)

Volatile Organic Compounds by P&T and GC/MS (Continued)

Method: EPA 524.2 **Instr:** GCMS12

Batch ID: W0K1456 **Preparation:** EPA 524.2 P&T **Prepared:** 11/25/20 07:44 **Analyst:** cam

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Dibromomethane	ND	0.50	ug/l	1	11/25/20	
Dichlorodifluoromethane (Freon 12)	ND	0.50	ug/l	1	11/25/20	
Di-isopropyl ether	ND	2.0	ug/l	1	11/25/20	
Ethyl tert-butyl ether	ND	2.0	ug/l	1	11/25/20	
Ethylbenzene	ND	0.50	ug/l	1	11/25/20	
Freon 113	ND	5.0	ug/l	1	11/25/20	
Hexachlorobutadiene	ND	0.50	ug/l	1	11/25/20	
Isopropylbenzene	ND	0.50	ug/l	1	11/25/20	
m,p-Xylene	ND	0.50	ug/l	1	11/25/20	
m-Dichlorobenzene	ND	0.50	ug/l	1	11/25/20	
Methyl tert-butyl ether (MTBE)	ND	2.0	ug/l	1	11/25/20	
Methylene chloride	ND	0.50	ug/l	1	11/25/20	
Naphthalene	ND	0.50	ug/l	1	11/25/20	
n-Butylbenzene	ND	0.50	ug/l	1	11/25/20	
n-Propylbenzene	ND	0.50	ug/l	1	11/25/20	
o-Dichlorobenzene	ND	0.50	ug/l	1	11/25/20	
o-Xylene	ND	0.50	ug/l	1	11/25/20	
p-Dichlorobenzene	ND	0.50	ug/l	1	11/25/20	
p-Isopropyltoluene	ND	0.50	ug/l	1	11/25/20	
sec-Butylbenzene	ND	0.50	ug/l	1	11/25/20	
Styrene	ND	0.50	ug/l	1	11/25/20	
Tert-amyl methyl ether	ND	2.0	ug/l	1	11/25/20	
tert-Butylbenzene	ND	0.50	ug/l	1	11/25/20	
Tetrachloroethene	ND	0.50	ug/l	1	11/25/20	
THMs, Total	ND	0.50	ug/l	1	11/25/20	
Toluene	ND	0.50	ug/l	1	11/25/20	
trans-1,2-Dichloroethene	ND	0.50	ug/l	1	11/25/20	
trans-1,3-Dichloropropene	ND	0.50	ug/l	1	11/25/20	
Trichloroethene	ND	0.50	ug/l	1	11/25/20	
Trichlorofluoromethane	ND	0.50	ug/l	1	11/25/20	
Vinyl chloride	ND	0.50	ug/l	1	11/25/20	
Xylenes, Total	ND	0.50	ug/l	1	11/25/20	

Surrogate(s)

1,2-Dichlorobenzene-d4	*94%*	*Conc: 9.39*	*70-130*	*11/25/20*
4-Bromofluorobenzene	*102%*	*Conc: 10.2*	*70-130*	*11/25/20*

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Project Manager: Rachel Kistler

Reported: 12/22/2020 14:55

Sample Results

(Continued)

Sample: GW-03

Sampled: 11/19/20 14:45 by Rachel Kistler

0K24078-03 (Water)

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Volatile Organic Compounds by P&T and GC/MS						
Method: EPA 524.2		**Instr:** GCMS12				
Batch ID: W0K1456 **Preparation:** EPA 524.2 P&T		**Prepared:** 11/25/20 07:44				**Analyst:** cam
1,1,1,2-Tetrachloroethane	ND	0.50	ug/l	1	11/25/20	
1,1,1-Trichloroethane	ND	0.50	ug/l	1	11/25/20	
1,1,2,2-Tetrachloroethane	ND	0.50	ug/l	1	11/25/20	
1,1,2-Trichloroethane	ND	0.50	ug/l	1	11/25/20	
1,1-Dichloroethane	ND	0.50	ug/l	1	11/25/20	
1,1-Dichloroethene	ND	0.50	ug/l	1	11/25/20	
1,1-Dichloropropene	ND	0.50	ug/l	1	11/25/20	
1,2,3-Trichlorobenzene	ND	0.50	ug/l	1	11/25/20	
1,2,4-Trichlorobenzene	ND	0.50	ug/l	1	11/25/20	
1,2,4-Trimethylbenzene	ND	0.50	ug/l	1	11/25/20	
1,2-Dichloroethane	ND	0.50	ug/l	1	11/25/20	
1,2-Dichloropropane	ND	0.50	ug/l	1	11/25/20	
1,3,5-Trimethylbenzene	ND	0.50	ug/l	1	11/25/20	
1,3-Dichloropropane	ND	0.50	ug/l	1	11/25/20	
1,3-Dichloropropene, Total	ND	0.50	ug/l	1	11/25/20	
2,2-Dichloropropane	ND	0.50	ug/l	1	11/25/20	
2-Butanone	ND	5.0	ug/l	1	11/25/20	
2-Chlorotoluene	ND	0.50	ug/l	1	11/25/20	
2-Hexanone	ND	5.0	ug/l	1	11/25/20	
4-Chlorotoluene	ND	0.50	ug/l	1	11/25/20	
4-Methyl-2-pentanone	ND	5.0	ug/l	1	11/25/20	
Benzene	ND	0.50	ug/l	1	11/25/20	
Bromobenzene	ND	0.50	ug/l	1	11/25/20	
Bromochloromethane	ND	0.50	ug/l	1	11/25/20	
Bromodichloromethane	ND	0.50	ug/l	1	11/25/20	
Bromoform	ND	0.50	ug/l	1	11/25/20	
Bromomethane	ND	0.50	ug/l	1	11/25/20	
Carbon tetrachloride	ND	0.50	ug/l	1	11/25/20	
Chlorobenzene	ND	0.50	ug/l	1	11/25/20	
Chloroethane	ND	0.50	ug/l	1	11/25/20	
Chloroform	ND	0.50	ug/l	1	11/25/20	
Chloromethane	ND	0.50	ug/l	1	11/25/20	
cis-1,2-Dichloroethene	ND	0.50	ug/l	1	11/25/20	
cis-1,3-Dichloropropene	ND	0.50	ug/l	1	11/25/20	
Dibromochloromethane	ND	0.50	ug/l	1	11/25/20	

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Sample Results

(Continued)

Sample: GW-03

Sampled: 11/19/20 14:45 by Rachel Kistler

0K24078-03 (Water)

(Continued)

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Volatile Organic Compounds by P&T and GC/MS (Continued)						
Method: EPA 524.2		**Instr:** GCMS12				
Batch ID: W0K1456 **Preparation:** EPA 524.2 P&T		**Prepared:** 11/25/20 07:44				**Analyst:** cam
Dibromomethane	ND	0.50	ug/l	1	11/25/20	
Dichlorodifluoromethane (Freon 12)	ND	0.50	ug/l	1	11/25/20	
Di-isopropyl ether	ND	2.0	ug/l	1	11/25/20	
Ethyl tert-butyl ether	ND	2.0	ug/l	1	11/25/20	
Ethylbenzene	ND	0.50	ug/l	1	11/25/20	
Freon 113	ND	5.0	ug/l	1	11/25/20	
Hexachlorobutadiene	ND	0.50	ug/l	1	11/25/20	
Isopropylbenzene	ND	0.50	ug/l	1	11/25/20	
m,p-Xylene	ND	0.50	ug/l	1	11/25/20	
m-Dichlorobenzene	ND	0.50	ug/l	1	11/25/20	
Methyl tert-butyl ether (MTBE)	ND	2.0	ug/l	1	11/25/20	
Methylene chloride	**0.62**	0.50	ug/l	1	11/25/20	
Naphthalene	ND	0.50	ug/l	1	11/25/20	
n-Butylbenzene	ND	0.50	ug/l	1	11/25/20	
n-Propylbenzene	ND	0.50	ug/l	1	11/25/20	
o-Dichlorobenzene	ND	0.50	ug/l	1	11/25/20	
o-Xylene	ND	0.50	ug/l	1	11/25/20	
p-Dichlorobenzene	ND	0.50	ug/l	1	11/25/20	
p-Isopropyltoluene	ND	0.50	ug/l	1	11/25/20	
sec-Butylbenzene	ND	0.50	ug/l	1	11/25/20	
Styrene	ND	0.50	ug/l	1	11/25/20	
Tert-amyl methyl ether	ND	2.0	ug/l	1	11/25/20	
tert-Butylbenzene	ND	0.50	ug/l	1	11/25/20	
Tetrachloroethene	ND	0.50	ug/l	1	11/25/20	
THMs, Total	ND	0.50	ug/l	1	11/25/20	
Toluene	ND	0.50	ug/l	1	11/25/20	
trans-1,2-Dichloroethene	ND	0.50	ug/l	1	11/25/20	
trans-1,3-Dichloropropene	ND	0.50	ug/l	1	11/25/20	
Trichloroethene	ND	0.50	ug/l	1	11/25/20	
Trichlorofluoromethane	ND	0.50	ug/l	1	11/25/20	
Vinyl chloride	ND	0.50	ug/l	1	11/25/20	
Xylenes, Total	ND	0.50	ug/l	1	11/25/20	
Surrogate(s)						
1,2-Dichlorobenzene-d4	*93%*	*Conc: 9.31*	*70-130*		*11/25/20*	
4-Bromofluorobenzene	*102%*	*Conc: 10.2*	*70-130*		*11/25/20*	

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Sample Results

(Continued)

Sample: GW-01
0K24078-04 (Water)

Sampled: 11/19/20 15:03 by Rachel Kistler

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Metals by EPA 200 Series Methods						
Method: EPA 200.8		**Instr:** ICPMS06				
Batch ID: W0K1476 **Preparation:** EPA 200.2		**Prepared:** 11/25/20 09:29				**Analyst:** mpn
Arsenic, Total	**20**	0.40	ug/l	1	12/03/20	
Barium, Total	ND	1.0	ug/l	1	12/03/20	
Cadmium, Total	ND	0.20	ug/l	1	12/03/20	
Chromium, Total	**4.3**	0.20	ug/l	1	12/03/20	
Copper, Total	ND	0.50	ug/l	1	12/03/20	
Lead, Total	ND	0.20	ug/l	1	12/03/20	
Nickel, Total	ND	2.0	ug/l	1	12/03/20	
Selenium, Total	**0.77**	0.40	ug/l	1	12/03/20	
Silver, Total	ND	0.20	ug/l	1	12/03/20	
Method: EPA 245.1		**Instr:** HG03				
Batch ID: W0L0010 **Preparation:** EPA 245.1		**Prepared:** 12/02/20 15:40				**Analyst:** asn
Mercury, Total	ND	0.050	ug/l	1	12/03/20	

Sample: GW-01
0K24078-04RE1 (Water)

Sampled: 11/19/20 15:03 by Rachel Kistler

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Radiological Parameters by APHA/EPA Methods						
Method: EPA 200.8		**Instr:** ICPMS06				
Batch ID: W0L0664 **Preparation:** EPA 200.2		**Prepared:** 11/25/20 13:35				**Analyst:** mpn
Uranium Rad	**0.36**	0.13	pCi/L	1	12/03/20	

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Sample Results

(Continued)

Sample: GW-02 — Sampled: 11/19/20 15:04 by Rachel Kistler

0K24078-05 (Water)

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Metals by EPA 200 Series Methods						
Method: EPA 200.8		**Instr:** ICPMS06				
Batch ID: W0K1476 **Preparation:** EPA 200.2		**Prepared:** 11/25/20 09:29				**Analyst:** mpn
Arsenic, Total	**21**	0.40	ug/l	1	12/03/20	
Barium, Total	ND	1.0	ug/l	1	12/03/20	
Cadmium, Total	ND	0.20	ug/l	1	12/03/20	
Chromium, Total	**5.2**	0.20	ug/l	1	12/03/20	
Copper, Total	**0.58**	0.50	ug/l	1	12/03/20	
Lead, Total	ND	0.20	ug/l	1	12/03/20	
Nickel, Total	ND	2.0	ug/l	1	12/03/20	
Selenium, Total	**0.73**	0.40	ug/l	1	12/03/20	
Silver, Total	ND	0.20	ug/l	1	12/03/20	
Method: EPA 245.1		**Instr:** HG03				
Batch ID: W0L0010 **Preparation:** EPA 245.1		**Prepared:** 12/02/20 15:40				**Analyst:** asn
Mercury, Total	ND	0.050	ug/l	1	12/03/20	

Sample: GW-03 — Sampled: 11/19/20 14:48 by Rachel Kistler

0K24078-06 (Water)

Analyte	Result	MRL	Units	Dil	Analyzed	Qualifier
Metals by EPA 200 Series Methods						
Method: EPA 200.8		**Instr:** ICPMS06				
Batch ID: W0K1476 **Preparation:** EPA 200.2		**Prepared:** 11/25/20 09:29				**Analyst:** mpn
Arsenic, Total	ND	0.40	ug/l	1	12/03/20	
Barium, Total	ND	1.0	ug/l	1	12/03/20	
Cadmium, Total	ND	0.20	ug/l	1	12/03/20	
Copper, Total	ND	0.50	ug/l	1	12/03/20	
Lead, Total	ND	0.20	ug/l	1	12/03/20	
Nickel, Total	ND	2.0	ug/l	1	12/03/20	
Selenium, Total	ND	0.40	ug/l	1	12/03/20	
Silver, Total	ND	0.20	ug/l	1	12/03/20	
Method: EPA 200.8		**Instr:** ICPMS06				
Batch ID: W0L0961 **Preparation:** EPA 200.2		**Prepared:** 12/17/20 15:05				**Analyst:** mpn
Chromium, Total	ND	0.20	ug/l	1	12/21/20	
Method: EPA 245.1		**Instr:** HG03				
Batch ID: W0L0010 **Preparation:** EPA 245.1		**Prepared:** 12/02/20 15:40				**Analyst:** asn
Mercury, Total	ND	0.050	ug/l	1	12/03/20	

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Quality Control Results

Metals by EPA 200 Series Methods

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W0K1476 - EPA 200.8										
Blank (W0K1476-BLK1)				**Prepared: 11/25/20**	**Analyzed: 12/03/20**					
Arsenic, Total	ND	0.40	ug/l							
Barium, Total	ND	1.0	ug/l							
Cadmium, Total	ND	0.20	ug/l							
Chromium, Total	ND	0.20	ug/l							B-07
Copper, Total	ND	0.50	ug/l							
Lead, Total	ND	0.20	ug/l							
Nickel, Total	ND	2.0	ug/l							
Selenium, Total	ND	0.40	ug/l							
Silver, Total	ND	0.20	ug/l							
LCS (W0K1476-BS1)				**Prepared: 11/25/20**	**Analyzed: 12/03/20**					
Arsenic, Total	50.2	0.40	ug/l	50.0		100	85-115			
Barium, Total	48.7	1.0	ug/l	50.0		97	85-115			
Cadmium, Total	49.8	0.20	ug/l	50.0		100	85-115			
Chromium, Total	50.5	0.20	ug/l	50.0		101	85-115			
Copper, Total	53.5	0.50	ug/l	50.0		107	85-115			
Lead, Total	49.0	0.20	ug/l	50.0		98	85-115			
Nickel, Total	52.2	2.0	ug/l	50.0		104	85-115			
Selenium, Total	48.5	0.40	ug/l	50.0		97	85-115			
Silver, Total	52.8	0.20	ug/l	50.0		106	85-115			
Matrix Spike (W0K1476-MS1)	**Source: 0K24078-04**			**Prepared: 11/25/20**	**Analyzed: 12/03/20**					
Arsenic, Total	69.9	0.40	ug/l	50.0	19.9	100	70-130			
Barium, Total	50.1	1.0	ug/l	50.0	0.791	99	70-130			
Cadmium, Total	50.3	0.20	ug/l	50.0	ND	101	70-130			
Chromium, Total	55.2	0.20	ug/l	50.0	4.34	102	70-130			
Copper, Total	55.8	0.50	ug/l	50.0	0.340	111	70-130			
Lead, Total	48.1	0.20	ug/l	50.0	0.125	96	70-130			
Nickel, Total	54.1	2.0	ug/l	50.0	0.217	108	70-130			
Selenium, Total	47.0	0.40	ug/l	50.0	0.771	92	70-130			
Silver, Total	51.7	0.20	ug/l	50.0	ND	103	70-130			
Matrix Spike Dup (W0K1476-MSD1)	**Source: 0K24078-04**			**Prepared: 11/25/20**	**Analyzed: 12/03/20**					
Arsenic, Total	70.9	0.40	ug/l	50.0	19.9	102	70-130	1	30	
Barium, Total	49.3	1.0	ug/l	50.0	0.791	97	70-130	2	30	
Cadmium, Total	49.8	0.20	ug/l	50.0	ND	100	70-130	1	30	
Chromium, Total	54.4	0.20	ug/l	50.0	4.34	100	70-130	1	30	
Copper, Total	54.5	0.50	ug/l	50.0	0.340	108	70-130	2	30	
Lead, Total	48.7	0.20	ug/l	50.0	0.125	97	70-130	1	30	
Nickel, Total	52.1	2.0	ug/l	50.0	0.217	104	70-130	4	30	
Selenium, Total	47.6	0.40	ug/l	50.0	0.771	94	70-130	1	30	
Silver, Total	51.9	0.20	ug/l	50.0	ND	104	70-130	0.3	30	

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Quality Control Results (Continued)

Metals by EPA 200 Series Methods (Continued)

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W0K1476 - EPA 200.8 (Continued)										
Matrix Spike Dup (W0K1476-MSD1)	**Source: 0K24078-04**			**Prepared: 11/25/20**	**Analyzed: 12/03/20**					
Batch: W0L0010 - EPA 245.1										
Blank (W0L0010-BLK1)				**Prepared: 12/02/20**	**Analyzed: 12/03/20**					
Mercury, Total	ND	0.050	ug/l							
LCS (W0L0010-BS1)				**Prepared: 12/02/20**	**Analyzed: 12/03/20**					
Mercury, Total	1.01	0.050	ug/l	1.00		101	85-115			
Matrix Spike (W0L0010-MS1)	**Source: 0K24060-01**			**Prepared: 12/02/20**	**Analyzed: 12/03/20**					
Mercury, Total	0.985	0.050	ug/l	1.00	ND	99	70-130			
Matrix Spike (W0L0010-MS2)	**Source: 0K25025-01**			**Prepared: 12/02/20**	**Analyzed: 12/03/20**					
Mercury, Total	1.03	0.050	ug/l	1.00	0.0252	100	70-130			
Matrix Spike Dup (W0L0010-MSD1)	**Source: 0K24060-01**			**Prepared: 12/02/20**	**Analyzed: 12/03/20**					
Mercury, Total	0.998	0.050	ug/l	1.00	ND	100	70-130	1	20	
Matrix Spike Dup (W0L0010-MSD2)	**Source: 0K25025-01**			**Prepared: 12/02/20**	**Analyzed: 12/03/20**					
Mercury, Total	1.03	0.050	ug/l	1.00	0.0252	100	70-130	0.07	20	
Batch: W0L0961 - EPA 200.8										
Blank (W0L0961-BLK1)				**Prepared: 12/17/20**	**Analyzed: 12/21/20**					
Chromium, Total	ND	0.20	ug/l							
LCS (W0L0961-BS1)				**Prepared: 12/17/20**	**Analyzed: 12/21/20**					
Chromium, Total	50.5	0.20	ug/l	50.0		101	85-115			
Matrix Spike (W0L0961-MS1)	**Source: 0L16016-01**			**Prepared: 12/17/20**	**Analyzed: 12/21/20**					
Chromium, Total	50.7	0.20	ug/l	50.0	0.914	99	70-130			
Matrix Spike Dup (W0L0961-MSD1)	**Source: 0L16016-01**			**Prepared: 12/17/20**	**Analyzed: 12/21/20**					
Chromium, Total	50.8	0.20	ug/l	50.0	0.914	100	70-130	0.3	30	

Quality Control Results (Continued)

Radiological Parameters by APHA/EPA Methods

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W0L0664 - EPA 200.8										
Blank (W0L0664-BLK1)				**Prepared: 11/25/20**	**Analyzed: 12/03/20**					
Uranium Rad	ND	0.13	pCi/L							
LCS (W0L0664-BS1)				**Prepared: 11/25/20**	**Analyzed: 12/03/20**					
Uranium Rad	32.3	0.13	pCi/L	33.5		96	85-115			
Matrix Spike (W0L0664-MS1)	**Source: 0K24078-04RE1**			**Prepared: 11/25/20**	**Analyzed: 12/03/20**					
Uranium Rad	32.6	0.13	pCi/L	33.5	0.362	96	70-130			
Matrix Spike Dup (W0L0664-MSD1)	**Source: 0K24078-04RE1**			**Prepared: 11/25/20**	**Analyzed: 12/03/20**					
Uranium Rad	33.2	0.13	pCi/L	33.5	0.362	98	70-130	2	30	

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Quality Control Results

(Continued)

Volatile Organic Compounds by P&T and GC/MS

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W0K1456 - EPA 524.2										
Blank (W0K1456-BLK1)				**Prepared & Analyzed: 11/25/20**						
1,1,1,2-Tetrachloroethane	ND	0.50	ug/l							
1,1,1-Trichloroethane	ND	0.50	ug/l							
1,1,2,2-Tetrachloroethane	ND	0.50	ug/l							
1,1,2-Trichloroethane	ND	0.50	ug/l							
1,1-Dichloroethane	ND	0.50	ug/l							
1,1-Dichloroethene	ND	0.50	ug/l							
1,1-Dichloropropene	ND	0.50	ug/l							
1,2,3-Trichlorobenzene	ND	0.50	ug/l							
1,2,4-Trichlorobenzene	ND	0.50	ug/l							
1,2,4-Trimethylbenzene	ND	0.50	ug/l							
1,2-Dichloroethane	ND	0.50	ug/l							
1,2-Dichloropropane	ND	0.50	ug/l							
1,3,5-Trimethylbenzene	ND	0.50	ug/l							
1,3-Dichloropropane	ND	0.50	ug/l							
1,3-Dichloropropene, Total	ND	0.50	ug/l							
2,2-Dichloropropane	ND	0.50	ug/l							
2-Butanone	ND	5.0	ug/l							
2-Chlorotoluene	ND	0.50	ug/l							
2-Hexanone	ND	5.0	ug/l							
4-Chlorotoluene	ND	0.50	ug/l							
4-Methyl-2-pentanone	ND	5.0	ug/l							
Benzene	ND	0.50	ug/l							
Bromobenzene	ND	0.50	ug/l							
Bromochloromethane	ND	0.50	ug/l							
Bromodichloromethane	ND	0.50	ug/l							
Bromoform	ND	0.50	ug/l							
Bromomethane	ND	0.50	ug/l							
Carbon tetrachloride	ND	0.50	ug/l							
Chlorobenzene	ND	0.50	ug/l							
Chloroethane	ND	0.50	ug/l							
Chloroform	ND	0.50	ug/l							
Chloromethane	ND	0.50	ug/l							
cis-1,2-Dichloroethene	ND	0.50	ug/l							
cis-1,3-Dichloropropene	ND	0.50	ug/l							
Dibromochloromethane	ND	0.50	ug/l							
Dibromomethane	ND	0.50	ug/l							
Dichlorodifluoromethane (Freon 12)	ND	0.50	ug/l							
Di-isopropyl ether	ND	2.0	ug/l							
Ethyl tert-butyl ether	ND	2.0	ug/l							

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Las Vegas, NV 89117

Project Number: Lathrop Wells

Project Manager: Rachel Kistler

Reported: 12/22/2020 14:55

Quality Control Results

(Continued)

Volatile Organic Compounds by P&T and GC/MS (Continued)

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W0K1456 - EPA 524.2 (Continued)										
Blank (W0K1456-BLK1)				**Prepared & Analyzed: 11/25/20**						
Ethylbenzene	ND	0.50	ug/l							
Freon 113	ND	5.0	ug/l							
Hexachlorobutadiene	ND	0.50	ug/l							
Isopropylbenzene	ND	0.50	ug/l							
m,p-Xylene	ND	0.50	ug/l							
m-Dichlorobenzene	ND	0.50	ug/l							
Methyl tert-butyl ether (MTBE)	ND	2.0	ug/l							
Methylene chloride	ND	0.50	ug/l							
Naphthalene	ND	0.50	ug/l							
n-Butylbenzene	ND	0.50	ug/l							
n-Propylbenzene	ND	0.50	ug/l							
o-Dichlorobenzene	ND	0.50	ug/l							
o-Xylene	ND	0.50	ug/l							
p-Dichlorobenzene	ND	0.50	ug/l							
p-Isopropyltoluene	ND	0.50	ug/l							
sec-Butylbenzene	ND	0.50	ug/l							
Styrene	ND	0.50	ug/l							
Tert-amyl methyl ether	ND	2.0	ug/l							
tert-Butylbenzene	ND	0.50	ug/l							
Tetrachloroethene	ND	0.50	ug/l							
THMs, Total	ND	0.50	ug/l							
Toluene	ND	0.50	ug/l							
trans-1,2-Dichloroethene	ND	0.50	ug/l							
trans-1,3-Dichloropropene	ND	0.50	ug/l							
Trichloroethene	ND	0.50	ug/l							
Trichlorofluoromethane	ND	0.50	ug/l							
Vinyl chloride	ND	0.50	ug/l							
Xylenes, Total	ND	0.50	ug/l							
Surrogate(s)										
1,2-Dichlorobenzene-d4	*9.31*		*ug/l*	*10.0*		*93*	*70-130*			
4-Bromofluorobenzene	*9.56*		*ug/l*	*10.0*		*96*	*70-130*			
LCS (W0K1456-BS1)				**Prepared & Analyzed: 11/25/20**						
1,1,1,2-Tetrachloroethane	5.12	0.50	ug/l	5.00		102	70-130			
1,1,1-Trichloroethane	5.05	0.50	ug/l	5.00		101	70-130			
1,1,2,2-Tetrachloroethane	4.97	0.50	ug/l	5.00		99	70-130			
1,1,2-Trichloroethane	5.15	0.50	ug/l	5.00		103	70-130			
1,1-Dichloroethane	5.14	0.50	ug/l	5.00		103	70-130			
1,1-Dichloroethene	4.68	0.50	ug/l	5.00		94	70-130			
1,1-Dichloropropene	5.00	0.50	ug/l	5.00		100	70-130			

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Quality Control Results

(Continued)

Volatile Organic Compounds by P&T and GC/MS (Continued)

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W0K1456 - EPA 524.2 (Continued)										
LCS (W0K1456-BS1)				**Prepared & Analyzed: 11/25/20**						
1,2,3-Trichlorobenzene	4.53	0.50	ug/l	5.00		91	70-130			
1,2,4-Trichlorobenzene	4.72	0.50	ug/l	5.00		94	70-130			
1,2,4-Trimethylbenzene	5.30	0.50	ug/l	5.00		106	70-130			
1,2-Dichloroethane	5.06	0.50	ug/l	5.00		101	70-130			
1,2-Dichloropropane	5.12	0.50	ug/l	5.00		102	70-130			
1,3,5-Trimethylbenzene	5.32	0.50	ug/l	5.00		106	70-130			
1,3-Dichloropropane	5.11	0.50	ug/l	5.00		102	70-130			
2,2-Dichloropropane	6.21	0.50	ug/l	5.00		124	70-130			
2-Butanone	5.10	5.0	ug/l	5.00		102	70-130			
2-Chlorotoluene	5.13	0.50	ug/l	5.00		103	70-130			
2-Hexanone	4.96	5.0	ug/l	5.00		99	70-130			
4-Chlorotoluene	5.23	0.50	ug/l	5.00		105	70-130			
4-Methyl-2-pentanone	4.95	5.0	ug/l	5.00		99	70-130			
Benzene	5.11	0.50	ug/l	5.00		102	70-130			
Bromobenzene	5.07	0.50	ug/l	5.00		101	70-130			
Bromochloromethane	4.99	0.50	ug/l	5.00		100	70-130			
Bromodichloromethane	5.03	0.50	ug/l	5.00		101	70-130			
Bromoform	4.71	0.50	ug/l	5.00		94	70-130			
Bromomethane	4.95	0.50	ug/l	5.00		99	70-130			
Carbon tetrachloride	4.96	0.50	ug/l	5.00		99	70-130			
Chlorobenzene	5.19	0.50	ug/l	5.00		104	70-130			
Chloroethane	4.84	0.50	ug/l	5.00		97	70-130			
Chloroform	5.15	0.50	ug/l	5.00		103	70-130			
Chloromethane	4.44	0.50	ug/l	5.00		89	70-130			
cis-1,2-Dichloroethene	5.19	0.50	ug/l	5.00		104	70-130			
cis-1,3-Dichloropropene	5.28	0.50	ug/l	5.00		106	70-130			
Dibromochloromethane	4.84	0.50	ug/l	5.00		97	70-130			
Dibromomethane	5.10	0.50	ug/l	5.00		102	70-130			
Dichlorodifluoromethane (Freon 12)	4.77	0.50	ug/l	5.00		95	70-130			
Di-isopropyl ether	20.9	2.0	ug/l	20.0		105	70-130			
Ethyl tert-butyl ether	21.2	2.0	ug/l	20.0		106	70-130			
Ethylbenzene	5.38	0.50	ug/l	5.00		108	70-130			
Freon 113	4.79	5.0	ug/l	5.00		96	70-130			
Hexachlorobutadiene	4.76	0.50	ug/l	5.00		95	70-130			
Isopropylbenzene	5.34	0.50	ug/l	5.00		107	70-130			
m,p-Xylene	5.34	0.50	ug/l	5.00		107	70-130			
m-Dichlorobenzene	5.10	0.50	ug/l	5.00		102	70-130			
Methyl tert-butyl ether (MTBE)	20.8	2.0	ug/l	20.0		104	70-130			
Methylene chloride	4.93	0.50	ug/l	5.00		99	70-130			

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Project Number: Lathrop Wells

Project Manager: Rachel Kistler

Reported: 12/22/2020 14:55

Quality Control Results

(Continued)

Volatile Organic Compounds by P&T and GC/MS (Continued)

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W0K1456 - EPA 524.2 (Continued)										
LCS (W0K1456-BS1)				**Prepared & Analyzed: 11/25/20**						
Naphthalene	4.30	0.50	ug/l	5.00		86	70-130			
n-Butylbenzene	5.40	0.50	ug/l	5.00		108	70-130			
n-Propylbenzene	5.27	0.50	ug/l	5.00		105	70-130			
o-Dichlorobenzene	4.99	0.50	ug/l	5.00		100	70-130			
o-Xylene	5.35	0.50	ug/l	5.00		107	70-130			
p-Dichlorobenzene	5.10	0.50	ug/l	5.00		102	70-130			
p-Isopropyltoluene	5.29	0.50	ug/l	5.00		106	70-130			
sec-Butylbenzene	5.24	0.50	ug/l	5.00		105	70-130			
Styrene	5.24	0.50	ug/l	5.00		105	70-130			
Tert-amyl methyl ether	21.2	2.0	ug/l	20.0		106	70-130			
tert-Butylbenzene	5.32	0.50	ug/l	5.00		106	70-130			
Tetrachloroethene	5.06	0.50	ug/l	5.00		101	70-130			
Toluene	5.26	0.50	ug/l	5.00		105	70-130			
trans-1,2-Dichloroethene	5.01	0.50	ug/l	5.00		100	70-130			
trans-1,3-Dichloropropene	5.41	0.50	ug/l	5.00		108	70-130			
Trichloroethene	5.01	0.50	ug/l	5.00		100	70-130			
Trichlorofluoromethane	4.77	0.50	ug/l	5.00		95	70-130			
Vinyl chloride	4.77	0.50	ug/l	5.00		95	70-130			
Surrogate(s)										
1,2-Dichlorobenzene-d4	*10.1*		*ug/l*	*10.0*		*101*	*70-130*			
4-Bromofluorobenzene	*10.3*		*ug/l*	*10.0*		*103*	*70-130*			
LCS Dup (W0K1456-BSD1)				**Prepared & Analyzed: 11/25/20**						
1,1,1,2-Tetrachloroethane	4.91	0.50	ug/l	5.00		98	70-130	4	30	
1,1,1-Trichloroethane	4.75	0.50	ug/l	5.00		95	70-130	6	30	
1,1,2,2-Tetrachloroethane	4.90	0.50	ug/l	5.00		98	70-130	2	30	
1,1,2-Trichloroethane	4.92	0.50	ug/l	5.00		98	70-130	5	30	
1,1-Dichloroethane	4.82	0.50	ug/l	5.00		96	70-130	6	30	
1,1-Dichloroethene	4.44	0.50	ug/l	5.00		89	70-130	5	30	
1,1-Dichloropropene	4.78	0.50	ug/l	5.00		96	70-130	5	30	
1,2,3-Trichlorobenzene	4.51	0.50	ug/l	5.00		90	70-130	0.4	30	
1,2,4-Trichlorobenzene	4.66	0.50	ug/l	5.00		93	70-130	1	30	
1,2,4-Trimethylbenzene	5.04	0.50	ug/l	5.00		101	70-130	5	30	
1,2-Dichloroethane	4.91	0.50	ug/l	5.00		98	70-130	3	30	
1,2-Dichloropropane	4.93	0.50	ug/l	5.00		99	70-130	4	30	
1,3,5-Trimethylbenzene	4.99	0.50	ug/l	5.00		100	70-130	6	30	
1,3-Dichloropropane	5.00	0.50	ug/l	5.00		100	70-130	2	30	
2,2-Dichloropropane	5.72	0.50	ug/l	5.00		114	70-130	8	30	
2-Butanone	5.11	5.0	ug/l	5.00		102	70-130	0.3	30	
2-Chlorotoluene	4.92	0.50	ug/l	5.00		98	70-130	4	30	

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Las Vegas, NV 89117

Project Number: Lathrop Wells

Project Manager: Rachel Kistler

Reported: 12/22/2020 14:55

Quality Control Results

(Continued)

Volatile Organic Compounds by P&T and GC/MS (Continued)

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W0K1456 - EPA 524.2 (Continued)										
LCS Dup (W0K1456-BSD1)				**Prepared & Analyzed: 11/25/20**						
2-Hexanone	5.13	5.0	ug/l	5.00		103	70-130	3	30	
4-Chlorotoluene	4.93	0.50	ug/l	5.00		99	70-130	6	30	
4-Methyl-2-pentanone	5.03	5.0	ug/l	5.00		101	70-130	2	30	
Benzene	4.81	0.50	ug/l	5.00		96	70-130	6	30	
Bromobenzene	4.89	0.50	ug/l	5.00		98	70-130	4	30	
Bromochloromethane	4.94	0.50	ug/l	5.00		99	70-130	0.9	30	
Bromodichloromethane	4.90	0.50	ug/l	5.00		98	70-130	3	30	
Bromoform	4.72	0.50	ug/l	5.00		94	70-130	0.3	30	
Bromomethane	4.82	0.50	ug/l	5.00		96	70-130	3	30	
Carbon tetrachloride	4.69	0.50	ug/l	5.00		94	70-130	6	30	
Chlorobenzene	5.00	0.50	ug/l	5.00		100	70-130	4	30	
Chloroethane	4.60	0.50	ug/l	5.00		92	70-130	5	30	
Chloroform	4.90	0.50	ug/l	5.00		98	70-130	5	30	
Chloromethane	4.23	0.50	ug/l	5.00		85	70-130	5	30	
cis-1,2-Dichloroethene	4.92	0.50	ug/l	5.00		98	70-130	5	30	
cis-1,3-Dichloropropene	5.21	0.50	ug/l	5.00		104	70-130	1	30	
Dibromochloromethane	4.71	0.50	ug/l	5.00		94	70-130	3	30	
Dibromomethane	5.01	0.50	ug/l	5.00		100	70-130	2	30	
Dichlorodifluoromethane (Freon 12)	4.59	0.50	ug/l	5.00		92	70-130	4	30	
Di-isopropyl ether	20.3	2.0	ug/l	20.0		102	70-130	3	30	
Ethyl tert-butyl ether	20.9	2.0	ug/l	20.0		105	70-130	1	30	
Ethylbenzene	5.08	0.50	ug/l	5.00		102	70-130	6	30	
Freon 113	4.52	5.0	ug/l	5.00		90	70-130	6	30	
Hexachlorobutadiene	4.53	0.50	ug/l	5.00		91	70-130	5	30	
Isopropylbenzene	5.04	0.50	ug/l	5.00		101	70-130	6	30	
m,p-Xylene	5.02	0.50	ug/l	5.00		100	70-130	6	30	
m-Dichlorobenzene	4.90	0.50	ug/l	5.00		98	70-130	4	30	
Methyl tert-butyl ether (MTBE)	20.9	2.0	ug/l	20.0		105	70-130	0.8	30	
Methylene chloride	4.79	0.50	ug/l	5.00		96	70-130	3	30	
Naphthalene	4.31	0.50	ug/l	5.00		86	70-130	0.2	30	
n-Butylbenzene	5.05	0.50	ug/l	5.00		101	70-130	7	30	
n-Propylbenzene	4.97	0.50	ug/l	5.00		99	70-130	6	30	
o-Dichlorobenzene	4.77	0.50	ug/l	5.00		95	70-130	4	30	
o-Xylene	5.11	0.50	ug/l	5.00		102	70-130	5	30	
p-Dichlorobenzene	4.91	0.50	ug/l	5.00		98	70-130	4	30	
p-Isopropyltoluene	4.96	0.50	ug/l	5.00		99	70-130	6	30	
sec-Butylbenzene	4.93	0.50	ug/l	5.00		99	70-130	6	30	
Styrene	5.00	0.50	ug/l	5.00		100	70-130	5	30	
Tert-amyl methyl ether	21.1	2.0	ug/l	20.0		106	70-130	0.2	30	

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Project Number: Lathrop Wells

Project Manager: Rachel Kistler

Reported: 12/22/2020 14:55

Quality Control Results

(Continued)

Volatile Organic Compounds by P&T and GC/MS (Continued)

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch: W0K1456 - EPA 524.2 (Continued)										
LCS Dup (W0K1456-BSD1)				**Prepared & Analyzed: 11/25/20**						
tert-Butylbenzene	4.98	0.50	ug/l	5.00		100	70-130	6	30	
Tetrachloroethene	4.78	0.50	ug/l	5.00		96	70-130	6	30	
Toluene	5.00	0.50	ug/l	5.00		100	70-130	5	30	
trans-1,2-Dichloroethene	4.75	0.50	ug/l	5.00		95	70-130	5	30	
trans-1,3-Dichloropropene	5.28	0.50	ug/l	5.00		106	70-130	2	30	
Trichloroethene	4.75	0.50	ug/l	5.00		95	70-130	5	30	
Trichlorofluoromethane	4.51	0.50	ug/l	5.00		90	70-130	6	30	
Vinyl chloride	4.57	0.50	ug/l	5.00		91	70-130	4	30	
Surrogate(s)										
1,2-Dichlorobenzene-d4	*10.2*		*ug/l*	*10.0*		*102*	*70-130*			
4-Bromofluorobenzene	*10.4*		*ug/l*	*10.0*		*104*	*70-130*			

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Las Vegas, NV 89117

Project Number: Lathrop Wells

Project Manager: Rachel Kistler

Reported:
12/22/2020 14:55

Notes and Definitions

Item	Definition
B-07	This analyte was found in the method blank at levels above the MDL but below the reporting limit.
%REC	Percent Recovery
Dil	Dilution
MRL	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 MRL is also known as Limit of Quantitation (LOQ)
ND	NOT DETECTED at or above the Method Reporting Limit (MRL). If Method Detection Limit (MDL) is reported, then ND means not detected at or above the MDL.
RPD	Relative Percent Difference
Source	Sample that was matrix spiked or duplicated.

Any remaining sample(s) will be disposed of one month from the final report date unless other arrangements are made in advance.

All results are expressed on wet weight basis unless otherwise specified.

All samples collected by Weck Laboratories have been sampled in accordance to laboratory SOP Number MIS002.

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CHAIN OF CUSTODY RECORD

DRINKING WATER OK24078

Page 1 Of 1

CLIENT NAME: BEC ENVIRONMENTAL, INC.

PROJECT: LATHROP WELLS
PWS ID:
PWS Name:

ADDRESS: 7241 W. SAHARA AVE, #120 LAS VEGAS, NV 89117

PHONE: (702) 304-9830
FAX:
EMAIL: RACHELK@BECNV.COM RACHELS@BECNV.COM

PROJECT MANAGER: KIM G. TU (WECK PM)

SAMPLER: Rachel Kistler

ANALYSES REQUESTED

Coliform: ☐ P/A ☐ Quantitray ☐ MTF
☐ General Physical ☐ General Mineral
Inorganic Chemicals
VOCs: ☐ Regulated ☐ Unregulated (524.2)
SOCs: ☐ 504 ☐ 508 ☐ 507 ☐ 515
SOCs: ☐ 525 ☐ 531 ☐ 547 ☐ 548 ☐ 549
Radiochem: ☐ Alpha ☐ Beta ☐ Uranium
DBPs: ☐ THM 524.2 ☐ HAA 552.2
RCRA 8 + Cu (200.8)
Hg (245.1)

LAB ID# (For lab Use Only)	DATE SAMPLED	TIME SAMPLED	SMPL TYPE	SAMPLE POINT I.D. / NAME	# OF CONT.	COMMENTS
	11/19/20	1455	GW DW AQ	GW-01	3	VOCs via 524.2
	11/19/20	1459		GW-02	3	↓
	11/19/20	1445		GW-03	3	
	11/19/20	1503		GW-01	1	* Two out of Three
	11/19/20	1504		GW-02	1	vials came with
	11/19/20	1448	↓	GW-03	1	headspace. ATH

SPECIAL HANDLING

- ☐ Same Day Rush 150%
- ☐ 24 Hour Rush 100%
- ☐ 48-72 Hour Rush 75%
- ☐ 4 - 5 Day Rush 30%
- ☐ Rush Extractions 50%
- ☒ 10 - 15 Business Days
- ☒ QA/QC Data Package

Charges will apply for weekends/holidays

Method of Shipment:

RELINQUISHED BY	DATE / TIME	RECEIVED BY
Rachel Kistler	11/20/2020 08:00	
	11/23/2020 14:00	FED EX 1405
Fedex	11/24/20 925	

SAMPLE CONDITION:
Actual Temperature: 4.8°
Received On Ice (Y / N)
Preserved (Y / N)
Evidence Seals Present (Y / N)
Container Attacked (Y / N)
Preserved at Lab (Y / N)
T-0230

SAMPLE TYPE CODE:
DW - Drinking Water
SW - Surface Water
RW - Raw Water
GW - Groundwater
RW - Recreational Water
TW - Treated Water

PRESCHEDULED RUSH ANALYSES WILL TAKE PRIORITY OVER UNSCHEDULED RUSH REQUESTS
Client agrees to Terms & Conditions at: www.wecklabs.com

SPECIAL REQUIREMENTS / BILLING INFORMATION ☐ check box if EDT is required
INVOICES TO: RACHELS@BECNV.COM AND BECKYH@BECNV.COM
REPORTS TO: RACHELK@BECNV.COM

Please include Results in Weck Standard Excel 2.6 Format

COC version 042707

eurofins | EMLab P&K

Report for:

Alana Hall
BEC Environmental Inc.
7241 W. Sahara Ave
suite 120
Las Vegas, NV 89117

Regarding: Project: 018.17.001 - Task BC13-21; Lathrop Wells-06 & -08 Phase II ESA
EML ID: 2527347

Approved by:

Technical Manager
Andrew Ikeda

Dates of Analysis:
Lead - Flame AA: 11-23-2020

Service SOPs: Lead - Flame AA (EM-BC-S-8443)
AIHA-LAP, LLC accredited service, Lab ID #178697

Eurofins EMLab P&K
17461 Derian Ave, Suite 100, Irvine, CA 92614
(866) 888-6653 Fax (623) 780-7695 www.emlab.com

Client: BEC Environmental Inc.
C/O: Alana Hall
Re: 018.17.001 - Task BC13-21; Lathrop Wells-06 & 08 Phase II ESA
Date of Sampling: 11-19-2020
Date of Receipt: 11-20-2020
Date of Report: 11-27-2020

LEAD: FLAME ATOMIC ABSORPTION SPECTROMETRY

Location:	PB-06-01-1: Red Paint, metal substrate	PB-06-01-2: Red Paint, metal substrate	PB-06-01-3: Red Paint, metal substrate	PB-06-02-1: Red Paint, metal substrate	PB-08-01-1: Red Paint, metal substrate
Comments (see below)	A	A	A	A	A
Lab ID-Version‡:	12041558-1	12041559-1	12041560-1	12041561-1	12041562-1
Analysis Date:	11/23/2020	11/23/2020	11/23/2020	11/23/2020	11/23/2020
Sample type	Paint Chip sample	Paint Chip sample	Paint Chip sample	Paint Chip sample	Paint Chip sample
Method*	NIOSH 7082 & EPA 7000B modified	NIOSH 7082 & EPA 7000B modified	NIOSH 7082 & EPA 7000B modified	NIOSH 7082 & EPA 7000B modified	NIOSH 7082 & EPA 7000B modified
† Method Reporting Limit	46 ppm	83 ppm	36 ppm	130 ppm	37 ppm
Sample size	0.2159 grams	0.1205 grams	0.2764 grams	0.0771 grams	0.2715 grams
§Total Lead Result	< 46 ppm	< 83 ppm	< 36 ppm	< 130 ppm	< 37 ppm

Comments: A) The relative percent difference of the matrix duplicate pair was above control limits. The laboratory control sample and matrix blank were both within control limits and validated the batch.

Sample results have not been corrected for blank values.

Bulk samples are not covered under the AIHA-LAP, LLC service accreditation.

Wipe samples must meet ASTM E1792 criteria. Method Reporting Limits may not be valid for non-ASTM E1792 wipe samples.

*Sample preparation and analytical methods are based upon NIOSH 7082 and EPA 7000B.

† The Method Reporting Limit is the minimum concentration of Lead that the laboratory can confidently detect in the sample.

§ Total Lead Result has been rounded to two significant figures to reflect analytical precision.

‡ A "Version" indicated by -"x" after the Lab ID# with a value greater than 1 indicates a sample with amended data. The revision number is reflected by the value of "x".

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EMLab P&K

Marlton, NJ: 3000 Lincoln Dr E, Ste. A, Marlton, NJ 08053 * (866) 871-1984
Phoenix, AZ: 1501 West Knudsen Drive, Phoenix, AZ 85027 * (800) 651-4802
SSF, CA: 6000 Shoreline Ct, Ste. 205, S. San Francisco, CA 94080 * (866) 888-6653

WEATHER	Fog	Rain	Snow	Wind	Clear
LEVEL None	x	x	x		
Light				x	
Moderate					
Heavy					

CONTACT INFORMATION

Company:	BEC Environmental, Inc.	Address:	7241 W. Sahara Ave, Ste 120, Las Vegas, NV 89117
Contact:	Alana Holt-Hall	Special Instructions:	
Phone:	(702) 304-9830		rachels@becnv.com; beckyh@becnv.com

PROJECT INFORMATION

Project ID:	018.17.001 - Task BC13-21		
Project Description:	Lathrop Wells -06 & -08 Phase II ESA		
Project Zip Code:	89020	Sampling Date/Time:	11/19/20 1pm - 4pm
PO Number:		Sampled By:	Alana Holt-Hall

TURN AROUND TIME CODES - (TAT)

STD - Standard (Default)
ND - Next Business Day
SD - Same Business Day
WH - Weekend/Holiday/ASAP

Rushes received after 2pm or on weekends, will be considered received the next business day. Please alert us in advance of weekend analysis needs.

REQUESTED SERVICES

SAMPLE ID	DESCRIPTION	Sample Type (Below)	TAT (Above)	Total Volume/Area (as applicable)	NOTES (Time of day, Temp, RH, etc.)
Pb-06-01-1	Red paint, metal substrate	B	STD	4 sq. in	1350, Report per area
Pb-06-01-2	Red paint, metal substrate	B	STD	4 sq. in	1430, Report per area
Pb-06-01-3	Red paint, metal substrate	B	STD	4 sq. in	1440, Report per area
Pb-06-02-1	Red paint, metal substrate	B	STD	4 sq. in	1504, Report per area
Pb-08-01-1	Red paint, metal substrate	B	STD	4 sq. in	1536, Report per area

	Non-Culturable		Culturable											Other Requests					
	Spore Trap	Tape, Swab, Bulk	BioCassette™, Andersen, SAS, Swab, Water, Bulk, Dust, Soil, Contact Plate																
	Spore Trap Analysis	Other biological particles - supplement	Direct Microscopic Exam (Qualitative)	Quantitative spore count direct exam	Dust Characterization	1-Media Surface Fungi (Genus ID + *Asp.* spp.)	Culturable Air Fungi (Genus ID + *Asp.* spp.)	Gram Stain and Counts (Culturable Air and Surface Bacteria)	*Legionella* culture	Total Coliform, *E.coli* (Presence/Absence)	QuantiTray-Sewage Screen	OTHER: (please specify test)		Asbestos in Air - PCM Airborne Fiber Count (NIOSH 7400)	Asbestos Bulk - PLM	Lead (Pb) - Flame AA	PCR (please specify test)	Allergens (please specify test)	
Pb-06-01-1															X				
Pb-06-01-2															X				
Pb-06-01-3															x				
Pb-06-02-1															x				
Pb-08-01-1															x				

SAMPLE TYPE CODES

BC - BioCassette™	CP - Contact Plate	T - Tape	O - Other:
A1S - Andersen	ST - Spore Trap	SW - Swab	
SAS - Surface Air Sampler	B - Bulk	SO - Soil	
NP - Non-potable Water	P - Potable Water	D - Dust	

RELINQUISHED BY	DATE & TIME
Alana Holt	11/20/2020 1:15 PM

RECEIVED BY	DATE & TIME
	11/20/20 1:15

By submitting this Chain of Custody, you agree to be bound by the terms and conditions set forth at http://www.emlab.com/terms-of-service

APPENDIX F

Regulatory Guidelines

National Primary Drinking Water Regulations

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
Acrylamide	TT[4]	Nervous system or blood problems; increased risk of cancer	Added to water during sewage/ wastewater treatment	zero
Alachlor	0.002	Eye, liver, kidney, or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops	zero
Alpha/photon emitters	15 picocuries per Liter (pCi/L)	Increased risk of cancer	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation	zero
Antimony	0.006	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder	0.006
Arsenic	0.010	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	Erosion of natural deposits; runoff from orchards; runoff from glass & electronics production wastes	0
Asbestos (fibers >10 micrometers)	7 million fibers per Liter (MFL)	Increased risk of developing benign intestinal polyps	Decay of asbestos cement in water mains; erosion of natural deposits	7 MFL
Atrazine	0.003	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops	0.003
Barium	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits	2
Benzene	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills	zero
Benzo(a)pyrene (PAHs)	0.0002	Reproductive difficulties; increased risk of cancer	Leaching from linings of water storage tanks and distribution lines	zero
Beryllium	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries	0.004
Beta photon emitters	4 millirems per year	Increased risk of cancer	Decay of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation	zero
Bromate	0.010	Increased risk of cancer	Byproduct of drinking water disinfection	zero
Cadmium	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints	0.005
Carbofuran	0.04	Problems with blood, nervous system, or reproductive system	Leaching of soil fumigant used on rice and alfalfa	0.04

LEGEND

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
Carbon tetrachloride	0.005	Liver problems; increased risk of cancer	Discharge from chemical plants and other industrial activities	**zero**
Chloramines (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort; anemia	Water additive used to control microbes	**MRDLG=4[1]**
Chlordane	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide	**zero**
Chlorine (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort	Water additive used to control microbes	**MRDLG=4[1]**
Chlorine dioxide (as ClO_2)	MRDL=0.8[1]	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Water additive used to control microbes	**MRDLG=0.8[1]**
Chlorite	1.0	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Byproduct of drinking water disinfection	**0.8**
Chlorobenzene	0.1	Liver or kidney problems	Discharge from chemical and agricultural chemical factories	**0.1**
Chromium (total)	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits	**0.1**
Copper	TT[5]; Action Level=1.3	Short-term exposure: Gastrointestinal distress. Long-term exposure: Liver or kidney damage. People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level	Corrosion of household plumbing systems; erosion of natural deposits	**1.3**
Cryptosporidium	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	**zero**
Cyanide (as free cyanide)	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer factories	**0.2**
2,4-D	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops	**0.07**
Dalapon	0.2	Minor kidney changes	Runoff from herbicide used on rights of way	**0.2**
1,2-Dibromo-3-chloropropane (DBCP)	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards	**zero**
o-Dichlorobenzene	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories	**0.6**
p-Dichlorobenzene	0.075	Anemia; liver, kidney, or spleen damage; changes in blood	Discharge from industrial chemical factories	**0.075**
1,2-Dichloroethane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	**zero**

LEGEND DISINFECTANT | DISINFECTION BYPRODUCT | INORGANIC CHEMICAL | MICROORGANISM | ORGANIC CHEMICAL | RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
1,1-Dichloroethylene	0.007	Liver problems	Discharge from industrial chemical factories	**0.007**
cis-1,2-Dichloroethylene	0.07	Liver problems	Discharge from industrial chemical factories	**0.07**
trans-1,2, Dichloroethylene	0.1	Liver problems	Discharge from industrial chemical factories	**0.1**
Dichloromethane	0.005	Liver problems; increased risk of cancer	Discharge from industrial chemical factories	**zero**
1,2-Dichloropropane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	**zero**
Di(2-ethylhexyl) adipate	0.4	Weight loss, liver problems, or possible reproductive difficulties	Discharge from chemical factories	**0.4**
Di(2-ethylhexyl) phthalate	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories	**zero**
Dinoseb	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables	**0.007**
Dioxin (2,3,7,8-TCDD)	0.00000003	Reproductive difficulties; increased risk of cancer	Emissions from waste incineration and other combustion; discharge from chemical factories	**zero**
Diquat	0.02	Cataracts	Runoff from herbicide use	**0.02**
Endothall	0.1	Stomach and intestinal problems	Runoff from herbicide use	**0.1**
Endrin	0.002	Liver problems	Residue of banned insecticide	**0.002**
Epichlorohydrin	TT[4]	Increased cancer risk; stomach problems	Discharge from industrial chemical factories; an impurity of some water treatment chemicals	**zero**
Ethylbenzene	0.7	Liver or kidney problems	Discharge from petroleum refineries	**0.7**
Ethylene dibromide	0.00005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Discharge from petroleum refineries	**zero**
Fecal coliform and *E. coli*	MCL[6]	Fecal coliforms and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Microbes in these wastes may cause short term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a special health risk for infants, young children, and people with severely compromised immune systems.	Human and animal fecal waste	**zero[6]**

LEGEND

DISINFECTANT | DISINFECTION BYPRODUCT | INORGANIC CHEMICAL | MICROORGANISM | ORGANIC CHEMICAL | RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
Fluoride	4.0	Bone disease (pain and tenderness of the bones); children may get mottled teeth	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories	**4.0**
Giardia lamblia	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	**zero**
Glyphosate	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use	**0.7**
Haloacetic acids (HAA5)	0.060	Increased risk of cancer	Byproduct of drinking water disinfection	**n/a[9]**
Heptachlor	0.0004	Liver damage; increased risk of cancer	Residue of banned termiticide	**zero**
Heptachlor epoxide	0.0002	Liver damage; increased risk of cancer	Breakdown of heptachlor	**zero**
Heterotrophic plate count (HPC)	TT[7]	HPC has no health effects; it is an analytic method used to measure the variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.	HPC measures a range of bacteria that are naturally present in the environment	**n/a**
Hexachlorobenzene	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories	**zero**
Hexachloro-cyclopentadiene	0.05	Kidney or stomach problems	Discharge from chemical factories	**0.05**
Lead	TT[5]; Action Level=0.015	Infants and children: Delays in physical or mental development; children could show slight deficits in attention span and learning abilities; Adults: Kidney problems; high blood pressure	Corrosion of household plumbing systems; erosion of natural deposits	**zero**
Legionella	TT[7]	Legionnaire's Disease, a type of pneumonia	Found naturally in water; multiplies in heating systems	**zero**
Lindane	0.0002	Liver or kidney problems	Runoff/leaching from insecticide used on cattle, lumber, and gardens	**0.0002**
Mercury (inorganic)	0.002	Kidney damage	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands	**0.002**
Methoxychlor	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, and livestock	**0.04**
Nitrate (measured as Nitrogen)	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	**10**

LEGEND

DISINFECTANT | DISINFECTION BYPRODUCT | INORGANIC CHEMICAL | MICROORGANISM | ORGANIC CHEMICAL | RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
Nitrite (measured as Nitrogen)	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	1
Oxamyl (Vydate)	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes	0.2
Pentachlorophenol	0.001	Liver or kidney problems; increased cancer risk	Discharge from wood-preserving factories	zero
Picloram	0.5	Liver problems	Herbicide runoff	0.5
Polychlorinated biphenyls (PCBs)	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals	zero
Radium 226 and Radium 228 (combined)	5 pCi/L	Increased risk of cancer	Erosion of natural deposits	zero
Selenium	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum and metal refineries; erosion of natural deposits; discharge from mines	0.05
Simazine	0.004	Problems with blood	Herbicide runoff	0.004
Styrene	0.1	Liver, kidney, or circulatory system problems	Discharge from rubber and plastic factories; leaching from landfills	0.1
Tetrachloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners	zero
Thallium	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories	0.0005
Toluene	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories	1
Total Coliforms	5.0 percent[8]	Coliforms are bacteria that indicate that other, potentially harmful bacteria may be present. See fecal coliforms and *E. coli*	Naturally present in the environment	zero
Total Trihalomethanes (TTHMs)	0.080	Liver, kidney, or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection	n/a[9]
Toxaphene	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticide used on cotton and cattle	zero
2,4,5-TP (Silvex)	0.05	Liver problems	Residue of banned herbicide	0.05
1,2,4-Trichlorobenzene	0.07	Changes in adrenal glands	Discharge from textile finishing factories	0.07

LEGEND

DISINFECTANT | DISINFECTION BYPRODUCT | INORGANIC CHEMICAL | MICROORGANISM | ORGANIC CHEMICAL | RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
1,1,1-Trichloroethane	0.2	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories	**0.2**
1,1,2-Trichloroethane	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories	**0.003**
Trichloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from metal degreasing sites and other factories	**zero**
Turbidity	TT[7]	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites, and some bacteria. These organisms can cause short term symptoms such as nausea, cramps, diarrhea, and associated headaches.	Soil runoff	**n/a**
Uranium	30µg/L	Increased risk of cancer, kidney toxicity	Erosion of natural deposits	**zero**
Vinyl chloride	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories	**zero**
Viruses (enteric)	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	**zero**
Xylenes (total)	10	Nervous system damage	Discharge from petroleum factories; discharge from chemical factories	**10**

LEGEND DISINFECTANT | DISINFECTION BYPRODUCT | INORGANIC CHEMICAL | MICROORGANISM | ORGANIC CHEMICAL | RADIONUCLIDES

NOTES

1 Definitions
- **Maximum Contaminant Level Goal (MCLG):** The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.
- **Maximum Contaminant Level (MCL):** The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.
- **Maximum Residual Disinfectant Level Goal (MRDLG):** The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- **Maximum Residual Disinfectant Level (MRDL):** The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- **Treatment Technique (TT):** A required process intended to reduce the level of a contaminant in drinking water.

2 Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million (ppm).

3 Health effects are from long-term exposure unless specified as short-term exposure.

4 Each water system must certify annually, in writing, to the state (using third-party or manufacturers certification) that when it uses acrylamide and/or epichlorohydrin to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows: Acrylamide = 0.05 percent dosed at 1 mg/L (or equivalent); Epichlorohydrin = 0.01 percent dosed at 20 mg/L (or equivalent).

5 Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10 percent of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

6 A routine sample that is fecal coliform-positive or E. coli-positive triggers repeat samples--if any repeat sample is total coliform-positive, the system has an acute MCL violation. A routine sample that is total coliform-positive and fecal coliform-negative or E. coli-negative triggers repeat samples--if any repeat sample is fecal coliform-positive or E. coli-positive, the system has an acute MCL violation. See also Total Coliforms.

7 EPA's surface water treatment rules require systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:
- ***Cryptosporidium*:** 99 percent removal for systems that filter. Unfiltered systems are required to include Cryptosporidium in their existing watershed control provisions.
- **Giardia lamblia:** 99.9 percent removal/inactivation
- **Viruses:** 99.9 percent removal/inactivation
- ***Legionella*:** No limit, but EPA believes that if *Giardia* and viruses are removed/inactivated, according to the treatment techniques in the surface water treatment rule, *Legionella* will also be controlled.
- **Turbidity:** For systems that use conventional or direct filtration, at no time can turbidity (cloudiness of water) go higher than 1 nephelometric turbidity unit (NTU), and samples for turbidity must be less than or equal to 0.3 NTU in at least 95 percent of the samples in any month. Systems that use filtration other than the conventional or direct filtration must follow state limits, which must include turbidity at no time exceeding 5 NTU.
- **HPC:** No more than 500 bacterial colonies per milliliter
- **Long Term 1 Enhanced Surface Water Treatment:** Surface water systems or ground water systems under the direct influence of surface water serving fewer than 10,000 people must comply with the applicable Long Term 1 Enhanced Surface Water Treatment Rule provisions (e.g. turbidity standards, individual filter monitoring, *Cryptosporidium* removal requirements, updated watershed control requirements for unfiltered systems).
- **Long Term 2 Enhanced Surface Water Treatment:** This rule applies to all surface water systems or ground water systems under the direct influence of surface water. The rule targets additional *Cryptosporidium* treatment requirements for higher risk systems and includes provisions to reduce risks from uncovered finished water storages facilities and to ensure that the systems maintain microbial protection as they take steps to reduce the formation of disinfection byproducts. (Monitoring start dates are staggered by system size. The largest systems (serving at least 100,000 people) will begin monitoring in October 2006 and the smallest systems (serving fewer than 10,000 people) will not begin monitoring until October 2008. After completing monitoring and determining their treatment bin, systems generally have three years to comply with any additional treatment requirements.)
- **Filter Backwash Recycling:** The Filter Backwash Recycling Rule requires systems that recycle to return specific recycle flows through all processes of the system's existing conventional or direct filtration system or at an alternate location approved by the state.

8 No more than 5.0 percent samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or E. coli. If two consecutive TC-positive samples, and one is also positive for E. coli or fecal coliforms, system has an acute MCL violation.

9 Although there is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants:
- **Haloacetic acids:** dichloroacetic acid (zero); trichloroacetic acid (0.3 mg/L)
- **Trihalomethanes:** bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg/L)

NATIONAL SECONDARY DRINKING WATER REGULATION

National Secondary Drinking Water Regulations are non-enforceable guidelines regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, some states may choose to adopt them as enforceable standards.

Contaminant	Secondary Maximum Contaminant Level
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	Noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

FOR MORE INFORMATION ON EPA'S SAFE DRINKING WATER:

visit: **epa.gov/safewater**

call: **(800) 426-4791**

ADDITIONAL INFORMATION:

To order additional posters or other ground water and drinking water publications, please contact the National Service Center for Environmental Publications at: **(800) 490-9198**, or email: **nscep@bps-lmit.com**.

NDEP Draft Guidelines for Discovery Events (Ground Water RCs)

Appendix B--Reportable Concentrations in Groundwater* Version: 1/28/2009

Analyte	CAS No.	Reportable Concentrations ** (ug/L)
Alachlor	15972-60-8	2.00E+00
Antimony (metallic) ***	7440-36-0	6.00E+00
Arsenic, Inorganic ***	7440-38-2	1.00E+01
Atrazine	1912-24-9	3.00E+00
Barium ***	7440-39-3	2.00E+03
Benzene	71-43-2	5.00E+00
Benzo[a]pyrene	50-32-8	2.00E-01
Beryllium and compounds ***	7440-41-7	4.00E+00
Bis(2-ethylhexyl)phthalate	117-81-7	6.00E+00
Bromate ***	15541-45-4	1.00E+01
Cadmium (Water) ***	7440-43-9	5.00E+00
Carbofuran	1563-66-2	4.00E+01
Carbon Tetrachloride	56-23-5	5.00E+00
Chlordane	12789-03-6	2.00E+00
Chlorobenzene	108-90-7	1.00E+02
Copper ***	7440-50-8	1.30E+03
Cyanide (CN-)	57-12-5	2.00E+02
Dalapon	75-99-0	2.00E+02
Di(2-ethylhexyl)adipate	103-23-1	4.00E+02
Dibromo-3-chloropropane, 1,2-	96-12-8	2.00E-01
Dibromoethane, 1,2- (EDB)	106-93-4	5.00E-02
Dichlorobenzene, 1,2-	95-50-1	6.00E+02
Dichlorobenzene, 1,4-	106-46-7	7.50E+01
Dichloroethane, 1,2- (EDC)	107-06-2	5.00E+00
Dichloroethylene, 1,1-	75-35-4	7.00E+00
Dichloroethylene, 1,2-cis-	156-59-2	7.00E+01
Dichloroethylene, 1,2-trans-	156-60-5	1.00E+02
Dichlorophenoxy Acetic Acid, 2,4-	94-75-7	7.00E+01
Dichloropropane, 1,2-	78-87-5	5.00E+00
Dinoseb	88-85-7	7.00E+00
Diquat	85-00-7	2.00E+01
Endothall	145-73-3	1.00E+02
Endrin	72-20-8	2.00E+00
Ethylbenzene	100-41-4	7.00E+02
Fluorine (Soluble Fluoride) ***	7782-41-4	4.00E+03
Glyphosate	1071-83-6	7.00E+02
Heptachlor	76-44-8	4.00E-01
Heptachlor Epoxide	1024-57-3	2.00E-01
Hexachlorobenzene	118-74-1	1.00E+00
Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	2.00E-01
Hexachlorocyclopentadiene	77-47-4	5.00E+01
Lead and Compounds ***	7439-92-1	1.50E+01
Methoxychlor	72-43-5	4.00E+01
Methylene Chloride	75-09-2	5.00E+00
Methyl tert-Butyl Ether (MTBE)	1634-04-4	2.00E+01
Mercury (elemental) ***	7439-97-6	2.00E+00
Nitrate ***	14797-55-8	1.00E+04
Nitrite ***	14797-65-0	1.00E+03
Oxamyl	23135-22-0	2.00E+02
Pentachlorophenol	87-86-5	1.00E+00
Picloram	1918-02-1	5.00E+02
Polychlorinated Biphenyls	1336-36-3	5.00E-01

NDEP Draft Guidelines for Discovery Events (Ground Water RCs)

Appendix B--Reportable Concentrations in Groundwater* Version: 1/28/2009

Analyte	CAS No.	Reportable Concentrations ** (ug/L)
Selenium ***	7782-49-2	5.00E+01
Simazine	122-34-9	4.00E+00
Styrene	100-42-5	1.00E+02
TCDD, 2,3,7,8-	1746-01-6	3.00E-05
Tetrachloroethylene (PCE)	127-18-4	5.00E+00
Thallium (Soluble Salts) ***	7440-28-0	2.00E+00
Toluene	108-88-3	1.00E+03
Toxaphene	8001-35-2	3.00E+00
Trichlorobenzene, 1,2,4-	120-82-1	7.00E+01
Trichloroethane, 1,1,1-	71-55-6	2.00E+02
Trichloroethane, 1,1,2-	79-00-5	5.00E+00
Trichloroethylene (TCE)	79-01-6	5.00E+00
Trichlorophenoxy) Propionic Acid, 2(2,4,5-	93-72-1	5.00E+01
Vinyl Chloride	75-01-4	2.00E+00
Xylene, Mixture	1330-20-7	1.00E+04

Footnotes:

*-This table is only applicable to the discovery of contaminants in groundwater. Any observed release to ***surface water*** is reportable at the time of observation. If a release to surface water is not observed but is discovered through visual indications or sampling, the release is reportable based on the presence of a visible sheen or concentrations above surface water standards established in NAC 445A.11704 to 445A.225.

**-The reportable concentrations in this table are all based on federal Maximum Contaminant Levels (MCL) with the exception of MTBE, which has an NDEP-derived level. However, reporting requirements for groundwater are not limited to constituents with a promulgated MCL. In determining whether the discovery in groundwater of a pollutant or contaminant without an MCL is reportable, a facility owner may rely on background concentrations, secondary standards, or EPA tap water Regional Screening Levels.

***-Background concentrations are not reportable regardless of whether they are above reportable concentrations.

APPENDIX G

Resumes & Certifications

State of Nevada

Department of Conservation and Natural Resources

Division of Environmental Protection

This is to certify that

RACHEL SCHLICK

having given satisfactory evidence of the necessary qualifications as required by the Nevada Revised Statute 459.400 to 459.600, inclusive, and Nevada Administrative Code 459.970 to 459.9729, inclusive, has been granted certification as a

Certified Environment Manager

in the State of Nevada
In testimoney whereof, witness the signature of the Administrator and the Seal of the State of Nevada.

EM2447
Certification Number

10/18/2021
Expiration Date

Greg Lovato, Administrator

State of Nevada
NDEP
Division of Environmental Protection
RACHEL SCHLICK
is certified as an
Certified Environment Manager
in the State of Nevada
EM2447 Expires - 10/18/2021

State of Nevada
NDEP
Division of Environmental Protection
RACHEL SCHLICK
is certified as an
Certified Environment Manager
in the State of Nevada
EM2447 Expires - 10/18/2021

NOTE:

Attached is your official certificate attesting to your certification. Also attached are two (2) pocket cards. Upon request of the Division, client or potential client, a holder of a certificate shall present his certificate for inspection (NAC 459.9729). A pocket card will suffice as proof of certificate at job sites.

You will receive only one (1) notification of expiration and renewal for your certification. It is the certified individual's responsibility to ensure his or her renewal is submitted in a timely manner. There is no grace period (NAC 459.9727).

Any address changes should be forwarded to the Certification coordinator at:

Bureau of Corrective Actions
901 S. Stewart Street, Suite 4001
Carson City, NV 89701-5249

United States Environmental Protection Agency

This is to certify that

Alana E Holt-Hall

has fulfilled the requirements of the Toxic Substances Control Act (TSCA) Section 402, and has received certification to conduct lead-based paint activities pursuant to 40 CFR Part 745.226 as:

Risk Assessor

In the Jurisdiction of:

All EPA Administered Lead-based Paint Activities Program States, Tribes and Territories

This certification is valid from the date of issuance and expires August 05, 2023

LBP-R-I212098-1

Certification #

July 22, 2020

Issued On

Adrienne Priselac, Manager, Toxics Office

Land Division

Team Profile

Rachel Schlick is a Certified Environmental Manager and an Environmental Scientist with BEC. Her professional experience includes brownfields site identification, assessment, and cleanup planning; chemical inventories; Phase I and Phase II Environmental Site Assessments; collection and analysis of aqueous and soil samples contaminated with heavy metals, petroleum hydrocarbons, and other contaminants of concern; NEPA analyses and environmental reviews; surveying, monitoring, and remediating sensitive species and habitats; GIS analysis; and associated reporting and stakeholder coordination.

Rachel's responsibilities include project management, technical reporting, agency communication, and client coordination for brownfields programs. She oversees and performs asbestos surveys, environmental reviews, and site characterizations. She contributes technical expertise to various projects at BEC, including grant applications, community plans, and technical reports.

Rachel has performed biological surveys and monitoring for species protected by the Endangered Species Act, including the Mojave desert tortoise (Gopherus agassizii). She has also monitored and remediated the Mohave tui chub fish (Siphateles bicolor mohavensis) habitat on U.S. Department of Defense firing ranges.

Rachel has worked in community outreach through the Choice Neighborhood Initiative in North Las Vegas and the Rural Desert Southwest Brownfields Coalition across six counties in Nevada and California. Rachel conducted trainings as an instructor for the Environmental Workforce Development and Job Training Program in Pahrump, Nevada.

Rachel received her Associate of Arts in Pre-Engineering from Cerro Coso Community College and her Bachelor of Science in Earth Systems from the University of California, Merced.

Rachel Schlick

Environmental Scientist/ Project Manager

Education and Training

Bachelor of Science, Earth Systems, minor in Applied Math, University of California, Merced

Associate of Arts, Pre-Engineering, Cerro Coso Community College

Desert Tortoise Council Introduction to Surveying, Monitoring, and Handling Techniques Workshop

First Aid/CPR/AED

HUD Region IX Environmental Review

OSHA Class IV Naturally Occurring Asbestos—Asbestos Awareness

PSMJ Project Management Boot Camp

Professional Certifications

Environmental Manager, State of Nevada, Certification Number 2447

NV OSHA Licensed Asbestos Abatement Consultant No. I-1992

AHERA Building Inspector

Water Pollution Control Manager

EPA Lead Risk Assessor

40-Hour OSHA HAZWOPER

Areas of Expertise

- Asbestos inspection
- Brownfields consulting
- Environmental compliance
- Environmental monitoring and surveys
- Project management
- Site characterization
- Soil/water collection and analysis

Team Profile

Alana Holt-Hall
Environmental Technician

Alana is an Environmental Technician at BEC. She received her Bachelor of Science in Biological Science from Southern University and A&M College. She has six years of combined laboratory research, sample preparation, and analytical testing experience with relevant coursework in botany and invasive species identification.

Alana provides project support for a wide variety of environmental projects, including brownfields redevelopment projects from eligibility determination and Phase I Environmental Site Assessments, to cleanup planning through the Analysis of Brownfields Clean-up Alternatives development. She also drafts U.S. Department of Housing and Urban Development compliant Environmental Assessments and Biological Evaluations. She has assisted with planning initiatives to promote economic development, conservation and preservation, and and researched opportunities for local, state, and federal agencies as well as private clients throughout Nevada.

Alana has developed field experience in desert tortoise presence-absence surveys and site surveys to identify potential recognized environmental conditions for Phase I Environmental Site Assessments.

Education and Training
Bachelor of Science, Biology, Southern University and A&M College

First-Aid / CPR / AED

EPA Lead Inspector Initial

Professional Certifications
40-Hour OSHA HAZWOPER

Death Investigator

EPA Lead Risk Assessor

Areas of Expertise
- Environmental Site Assessments
- Project Research and Records Review
- Project Support
- Document Preparation
- Grant Research
- GIS Support

Team Profile

Rachel Kistler is an Environmental Scientist at BEC. She has over seven years of combined laboratory research, analytical testing, field research, and environmental health and safety experience. She contributes technical expertise to various projects at BEC, including grant applications, community plans, and technical reports.

She provides program assistance for brownfields activities conducted through the Nevada Brownfields Program and the Rural Desert Southwest Brownfields Coalition, including developing site eligibility applications, performing Phase I and Phase II Environmental Site Assessments, developing Sampling and Analysis Plans, and assisting with hazardous material surveys at multiple locations. She develops environmental reviews in accordance with the National Environmental Policy Act and associated U.S. Department of Housing and Urban Development requirements. She also provides support for economic development, conservation and preservation, research, and planning initiatives for local, state and federal agencies as well as private clients throughout Nevada.

Rachel provides field support for ongoing projects, such as conducting plant and animal surveys, soil sampling and geotechnical support, and environmental site assessments. As a Field Technician, she has monitored sensitive animal populations for various state and federal agencies on federal and public lands in Nevada; collected soil samples in accordance with relevant EPA Methodology; and developed documentation in support of the programs.

Rachel has experience implementing safety programs, including establishing procedures for chemical safety, biosafety, radiation safety, the use and disposal of hazardous materials, and warehouse and manufacturing safety. She has managed Environmental Health and Safety (EH&S) permitting and licensing and has previously been responsible for training staff to fulfill regulatory requirements. She is BEC's Safety Officer, and provides ongoing support for developing BEC's safety program and site-specific health and safety plans.

Rachel earned her Bachelor's Degree in Environmental Science with a concentration in Plant Resources from Virginia Tech in 2011.

Rachel Kistler

Environmental Scientist

Education and Training

Bachelor of Science, Environmental Science, Virginia Tech

First-Aid / CPR / AED

Professional Certifications

Radon Measurement Technician

NRPP ID #110806 RT

40-Hour OSHA HAZWOPER

30-Hour OSHA Construction

Areas of Expertise

- Biological and Environmental Surveys
- Brownfields
- Environmental Compliance
- Environmental Site Assessments
- GIS Support
- Grant writing
- Health and Safety Training and Compliance
- NEPA Analysis and Compliance
- Project Research and Records Review