



Hill Air Force Base, Utah

Final

**WR111 Little Mountain Test Annex
Magnesium-Thorium Disposal Trench
Remedial Design/Remedial Action
Work Plan**

August 2014

Attachment 3

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Hill Air Force Base Performance-Based Remediation

WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Remedial Design/Remedial Action Work Plan

Hill Air Force Base
Contract No: FA8903-09-D-8560
Task Order 0006

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A	Site-Specific Supplemental Quality Assurance Project Plan
B	Site-Specific Addendum to the Health and Safety Plan
C	Radiation Protection Plan
D	Waste Management Plan
E	Project Completion/Closeout Plan

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Acronyms and Abbreviations

AASHTO	American Association of Highway and Transportation Officials
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
Cabrera	Cabrera Services, Inc.
CFR	Code of Federal Regulations
DCGL _{EMC}	Derived concentration guideline level using the elevated measurement comparison
DCGL _W	Derived concentration guideline level
DP	Decommissioning Plan
DQCR	Daily Quality Control Report
EA	EA Engineering, Science, and Technology, Inc.
EML	Environmental Measurements Laboratory
EPA	U.S. Environmental Protection Agency
FSS	Final status survey
ft	Feet(foot)
GPS	Global Positioning System
GWS	Gamma walkover survey
HASL	Health and Safety Laboratory
HASP	Health and Safety Plan
in.	Inch(es)
JBSA	Joint Base San Antonio
LMTA	Little Mountain Test Annex
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
NRC	Nuclear Regulatory Commission
OP	Operating procedure
Parsons	Parsons Infrastructure and Technology Group, Inc.
pCi/g	Picocuries per gram
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
²²⁶ Ra	Radium-226
RD/RAWP	Remedial Design/Remedial Action Work Plan
RCA	Radiological Control Area

RPP	Radiation Protection Plan
SOR	Sum of ratios
SOR_N	Net sum of ratios
SSV	Soil screening value
SU	Survey unit
^{230}Th	Thorium-230
^{232}Th	Thorium-232
USAF	U.S. Air Force
WMP	Waste Management Plan

1.0 Introduction

This Remedial Design/Remedial Action Work Plan (RD/RAWP) was developed by EA Engineering, Science, and Technology, Inc. (EA) and Cabrera Services, Inc. (Cabrera) to support investigation, remediation, decommissioning, and site closeout at the Little Mountain Test Annex (LMTA) Magnesium-Thorium Disposal Trench Site, Hill Air Force Base (AFB), in Ogden, Utah, under the Hill AFB Performance-Based Remediation Contract No. FA8903-09-D-8560, Task Order 0006. The Magnesium-Thorium Disposal Site, hereafter referred to as Site WR111, is located within the LMTA, which is approximately 15 miles northwest of Hill AFB and adjacent to the Great Salt Lake (Figure 1-1). Site WR111 is approximately 200 × 150 feet (ft) in area and is enclosed by a chain-link fence in the southeastern corner of the LMTA (Figure 1-2). Investigations have confirmed radiological impact to surface and subsurface soil at Site WR111. This RD/RAWP will be used in conjunction with the WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Decommissioning Plan (currently being finalized) and the Quality Program Plan for Performance-Based Remediation (<http://www.hafbdyn docs.com>) during implementation of soil removal activities.

1.1 Work Plan Objectives

The purpose of this RD/RAWP is to summarize the site background; identify the selected remedy for the site and applicable regulatory requirements; describe the remedy elements, quality assurance (QA)/quality control (QC) procedures, and monitoring requirements; and define the metrics for evaluating and documenting completion of the remedy.

This RD/RAWP was prepared in accordance with U.S. Air Force (USAF) guidelines and applicable federal, state, and local requirements. Subplans of the RD/RAWP describe methodologies, procedures, and instructions for site activities, and include a Site-Specific Supplemental Quality Assurance Project Plan (QAPP) (Appendix A), a Site-Specific Addendum to the Health and Safety Plan (HASP) (Appendix B), a Radiation Protection Plan (RPP) (Appendix C), a Waste Management Plan (WMP) (Appendix D), and a Project Completion/Closeout Plan (Appendix E).

Decommissioning activities at WR111 are being conducted in coordination with the Nuclear Regulatory Commission (NRC) via the USAF Radioisotope Committee and the approved Decommissioning Plan (DP) (EA/Cabrera 2014). Site activities will be performed using Cabrera's NRC Decommissioning license in accordance with this RD/RAWP; Cabrera's Radiation Safety Program (Cabrera 2010); Occupational Safety and Health Administration; applicable USAF instructions/standards; and other applicable federal, state, and local regulations.

1.1.1 Soil Removal Activities

This RD/RAWP has been prepared to support the excavation of impacted soil, in accordance with the remedial action objectives, and disposal at an offsite facility that is licensed to accept the material. General tasks will consist of the following:

- Pre-mobilization activities, including obtaining permits, making appropriate notifications, and securing an approved waste profile from the chosen offsite disposal facility for the radioactive material that will be removed from the site during remedial action activities

- Mobilization and site preparation, including establishing temporary facilities, services and site controls to facilitate remediation, administering onsite radiation worker training as needed, ensuring worker and public safety as well as environmental protection, and setting up and calibrating onsite radiological instrumentation for the project
- Excavating contaminated soils
- Waste loading, transportation, and offsite disposal
- Performing a final status survey (FSS), including gross gamma activity scanning and soil sample collection and analysis, to confirm that project cleanup goals (e.g., derived concentration guideline levels [or DCGL_{WS}]) have been met at the limits of excavation in accordance with NRC Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) for radionuclides of concern at the WR111 Site
- Backfilling and compacting the remediated excavations, site restoration, and demobilization.

It is anticipated that the excavation will be conducted within the LMTA fence line (see Figures 1-2 and 1-3). The LMTA fence line is approximately 70 ft to the east of the Site WR111 boundary. The adjacent property to the east is owned by Weber County. Given the remoteness of the site, no impacts to traffic (traffic closures or rerouting) are anticipated.

Upon completion of data evaluation activities, a Remedial Action Completion Report, including an FSS Report, will be prepared that outlines the work described above to support unrestricted release of the WR111 site. A schedule of the planned activities for soil removal at Site WR111 is presented in Worksheet #16 of the QAPP (Appendix A). Additional tasks to be conducted after soil removal activities are provided in the Project Completion/Closeout Plan (Appendix E).

1.2 Work Plan Organization

This RD/RAWP is organized as follows:

- Section 1.0 – Introduction
- Section 2.0 – Background
- Section 3.0 – Selected Remedy
- Section 4.0 – Removal Action Elements
- Section 5.0 – Demonstration of Attainment of Remedial Action Objectives
- Section 6.0 – Construction Quality Plan
- Section 7.0 – References
- Appendix A – Site-Specific Supplemental QAPP
- Appendix B – Site-Specific Addendum to the HASP
- Appendix C – RPP
- Appendix D – WMP
- Appendix E – Project Completion/Closeout Plan

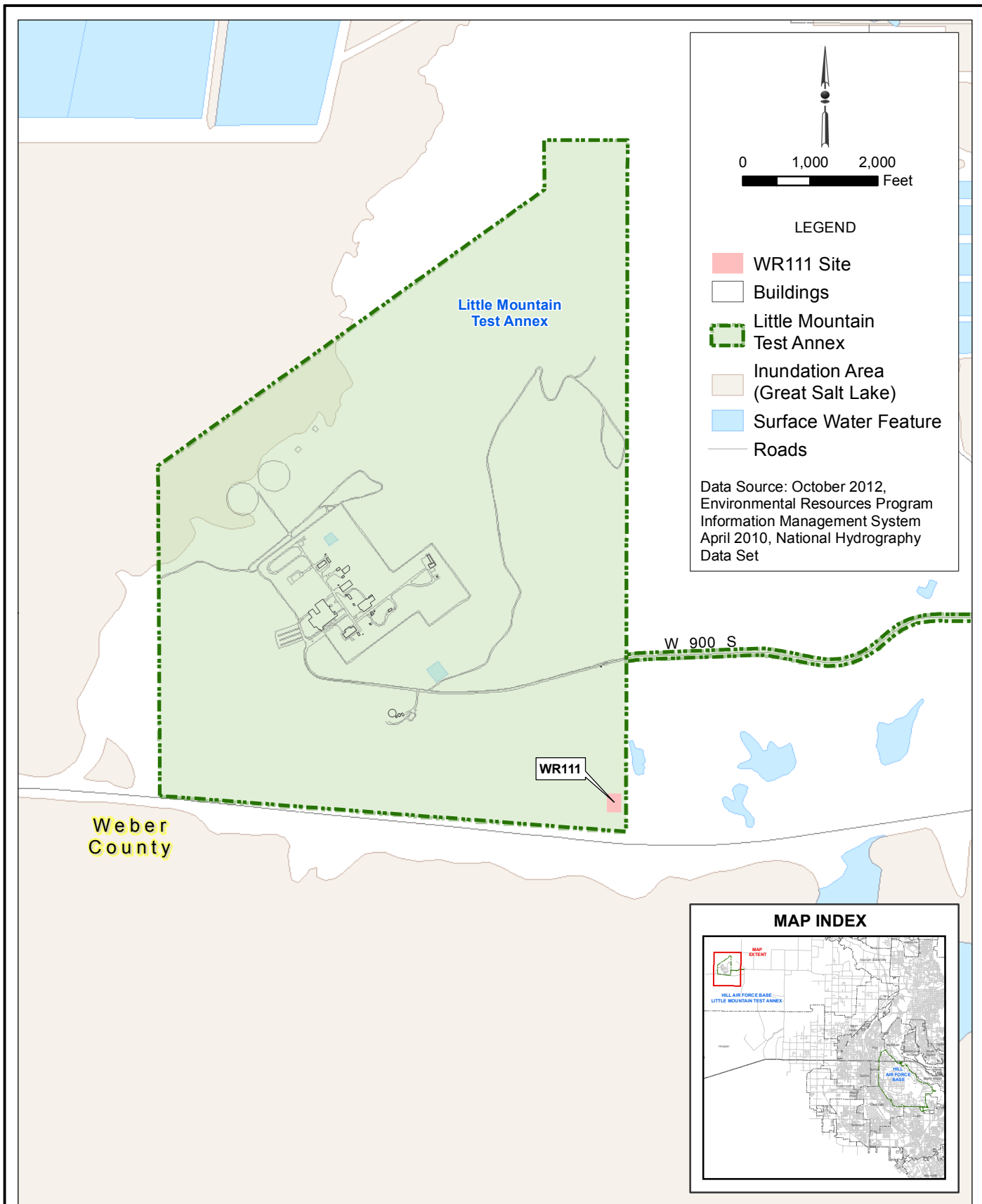
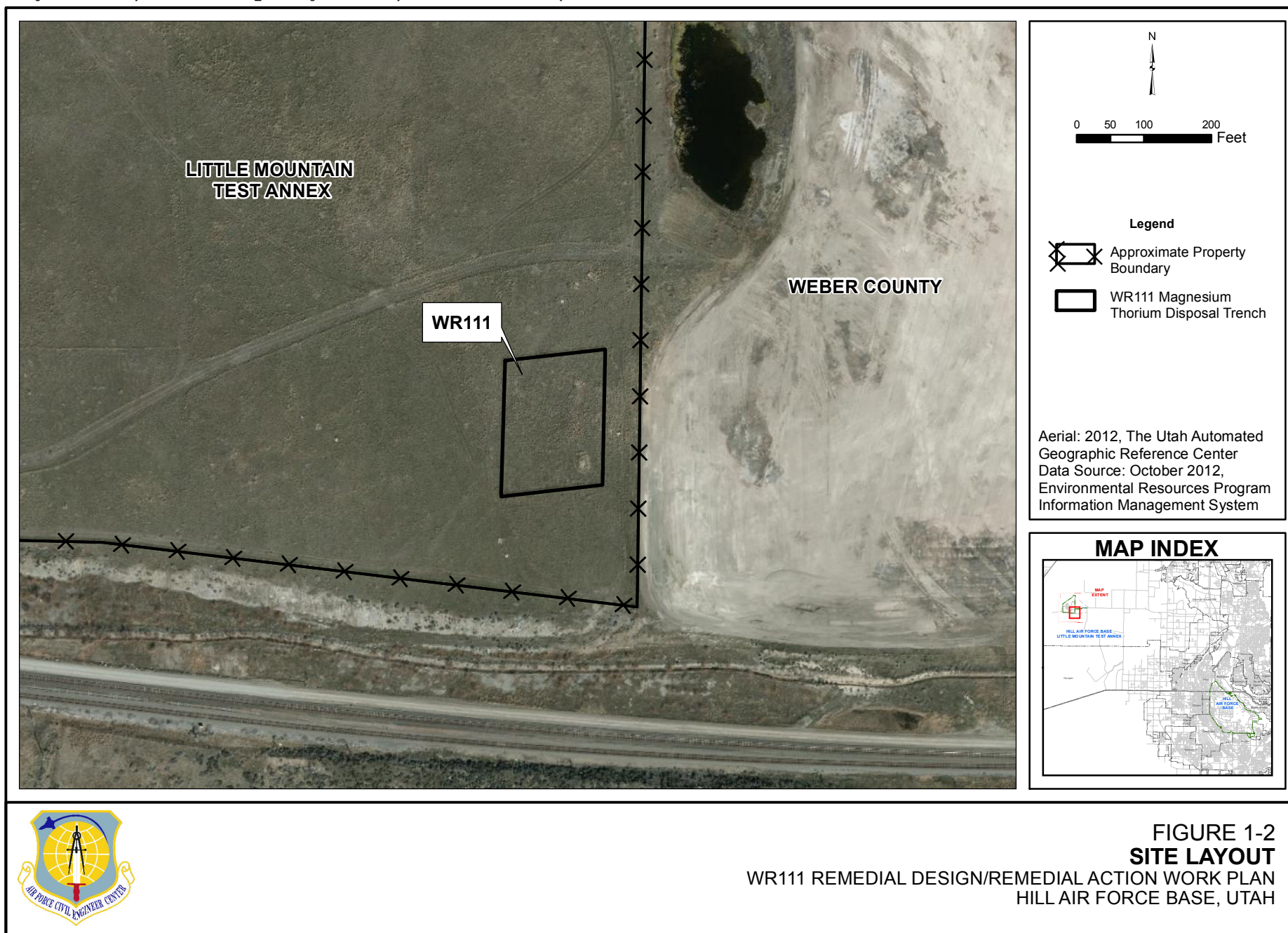


FIGURE 1-1
SITE LOCATION
WR111 REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN
HILL AIR FORCE BASE, UTAH

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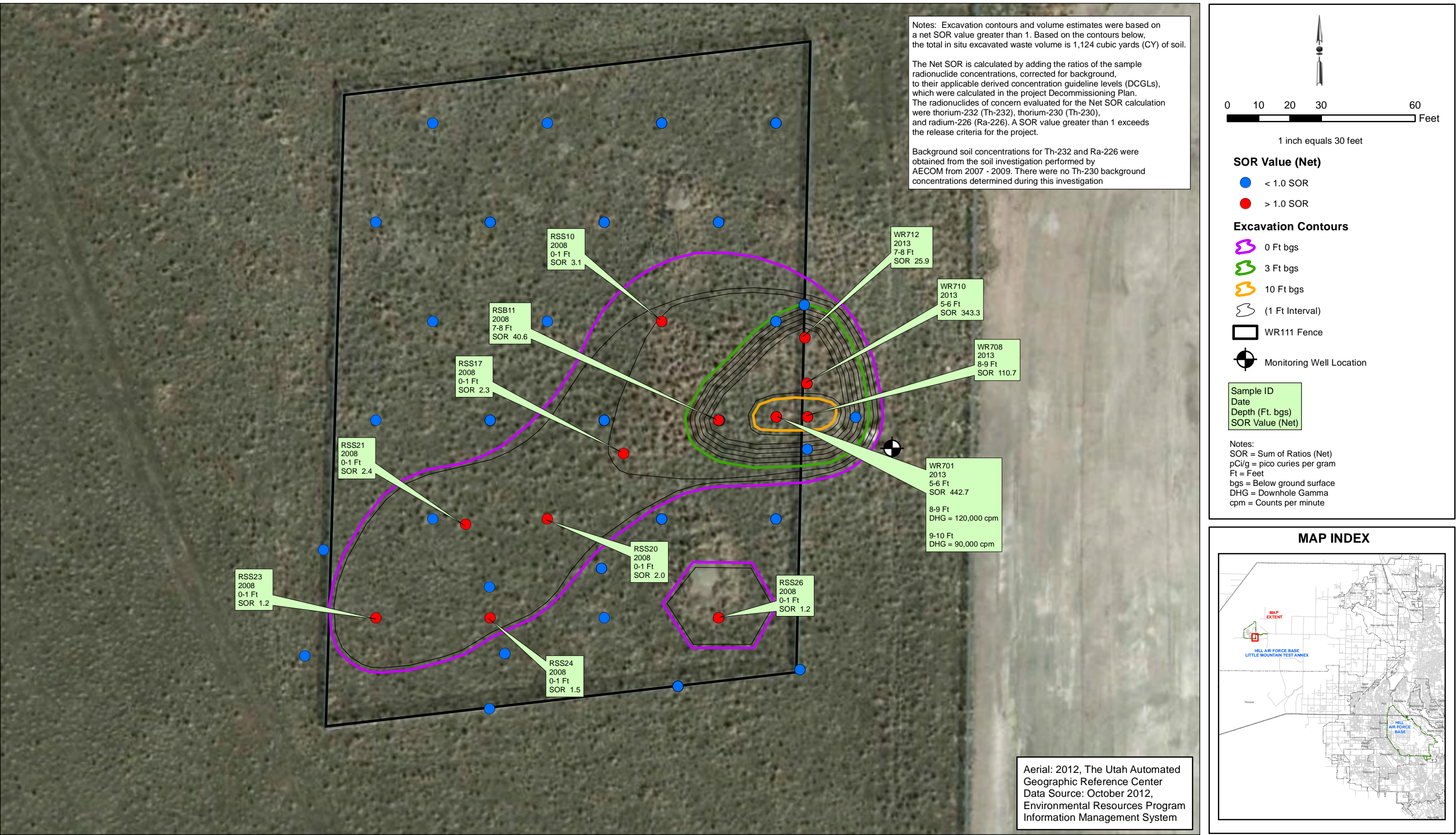


FIGURE 1-3
SOIL EXCAVATION VOLUME ESTIMATE
WR111 REMEDIAL DESIGN/ REMEDIAL ACTION WORK PLAN
HILL AIR FORCE BASE, UTAH

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2.0 Background

2.1 Hill Air Force Base

Hill AFB is a major USAF base located in northern Utah approximately 30 miles north of Salt Lake City. It is the home of the 75th Air Base Wing, one of five wings under the Ogden Air Logistics Complex. The 75th Air Base Wing is responsible for providing support for the operation of the 1,500-square-mile Utah Test and Training Range. They also support all wings of the Ogden Air Logistics Complex, associated units and directly support Air and Space Expeditionary Forces operations.

2.2 Site Description

The LMTA is located in Weber County, Utah approximately 15 miles northwest of Hill AFB in a remote area adjacent to the Great Salt Lake and west of Ogden, Utah (Figure 1-1). Site WR111 is approximately 200 × 150 ft in area and is enclosed by a chain-link fence in the southeastern corner of the LMTA (Figure 1-2). The terrain in the area of Site WR111 is gently sloping at an approximate elevation of 4,245 ft above mean sea level. The LMTA fence line is approximately 70 ft to the east of the Site WR111 boundary (Figure 1-2). The adjacent property to the east is owned by Weber County. Approximately 350 ft south of Site WR111 is the railroad right-of-way and marsh land, mud flats associated with the Great Salt Lake.

2.3 Nature and Extent of Contamination

Historical information indicates that magnesium-thorium scrap and waste materials associated with the manufacture of controls, accessories, and engine parts were burned/buried in a disposal trench at Site WR111 from 1959 through 1961. Results of a recent investigation (2007-2009) indicated that site soils within the fenced area were impacted with thorium-232 (²³²Th) and decay progeny above background levels (AECOM 2009). Results of groundwater sampling that was conducted in 2006 indicate that there are no radiological impacts to groundwater from the thorium alloy scrap metal or potential cutting oil (Parsons Infrastructure and Technology Group, Inc. [Parsons] 2007). A supplemental characterization survey performed in 2013 (EA/Cabrera 2014) confirmed that radiological contamination extended to the east of the WR111 fenceline, and identified two additional radionuclides (radium-226 [²²⁶Ra] and thorium-230 [²³⁰Th]) of concern for the site.

Sampling for chemical constituents has also been conducted at Site WR111. Results from the 2007-2009 investigation showed that no volatile organic compounds or semivolatile organic compounds were detected above reportable limits in soil (AECOM 2009). In addition, during the 2013 supplemental survey by EA/Cabrera, soil sampling was conducted to assess hazardous waste characteristics and support selection of an appropriate offsite disposal facility.

A detailed discussion of previous investigation results is provided in the DP (EA/Cabrera 2014). A summary of the nature and extent of radiological contamination at Site WR111 based on all available data is provided in the subsections below.

2.3.1 Surface and Subsurface Soil

Results of surveys and sample analyses from previous site investigations were used to identify specific areas of radiological contamination in soil at Site WR111. A total of 39 surface and 30 subsurface soil samples were collected between the 2009 and 2013 characterization events at WR111. The results for each radionuclide of potential concern from the 2009 and 2013 sampling events were compared to its site-specific soil screening value (SSV), which was calculated by adding site-specific soil background values to the generic surface SSVs provided in NRC Regulatory Guidance 1757, Volume 2, Appendix H (NRC 2006). When the individual sampling result was found to be in excess of a corresponding site-specific SSV, the area associated with that result was identified to be potentially contaminated. When there are multiple radionuclides of concern present in soils, the sum of the individual ratios of the soil sample concentration levels to the SSV for each radionuclide must not exceed unity (1; also known as the sum of the ratios [SOR]). A detailed description of the SOR is provided in the DP (EA/Cabrera 2014).

Based on an initial evaluation of the 69 total samples collected during the 2009 and 2013 site characterization surveys, 32 samples had an SOR of greater than one. The results of the evaluations showed that sampling results for three radionuclides of potential concern (^{226}Ra and/or ^{230}Th and/or ^{232}Th) exceeded their corresponding SSVs as well as having an SOR exceeding one at 29 sample locations. Therefore, ^{226}Ra , ^{230}Th , and ^{232}Th were identified as the radionuclides of concern for Site WR111. It should be noted that the conservative calculation of the radium soil screening value, which is the mean background plus the NRC screening value (0.7 picocuries per gram [pCi/g] – a small value relative to the background values), with a widely variable background distribution, likely causes more sample results that are within the range of the background distribution to be considered potential exceedances.

After identifying the radionuclides of concern, the data were then used to estimate the nature and extent of the radiological contamination in the surface and subsurface soil based on the SSVs. The majority of the elevated radiological activity in the surface soil is located in the southern two-thirds of Site WR111 with ^{232}Th being the dominant radionuclide of concern. Elevated radiological activity in subsurface soil is present in the east-central portion of WR111 and extends approximately 20 ft east of the WR111 perimeter fence. These results were compared to the project release criteria (DCGL_{WS} listed in Table 3-1 of this plan) and excavation contours were estimated based on sample concentrations exceeding these criteria. These contours are displayed in Figure 1-3. It was also concluded that the highest concentrations for ^{232}Th are co-located with respect to the highest concentrations of the other two radionuclides of potential concern. Therefore, a remedial action conducted for ^{232}Th will also address the other radionuclides of potential concern at the site. A detailed description of the characterization survey results from 2009 and 2013 is provided in the DP (EA/Cabrera 2014).

2.3.2 Surface Water

The area of investigation does not contain any surface water features. The Great Salt Lake is the predominant surface water body in the area and is located approximately 350 ft from Site WR111. However, there is no mechanism for contaminant migration via surface water from Site WR111 and, therefore, surface water decommissioning activities are not warranted.

2.3.3 Groundwater

Natural thorium is not typically mobile in the environment and, therefore, is unlikely to leach into groundwater. The soil to water adsorption coefficient for thorium is high (60,000 square centimeters per gram). The higher the soil to water adsorption coefficient value, the more likely the radionuclide will attract to the soil and the least likely for the radionuclide to leach into the groundwater. The water adsorption coefficient for thorium suggests a strong affinity for adsorbing to soil. At Site WR111, the lack of thorium mobility is confirmed based on a review of groundwater quality data that were obtained from four monitoring wells at the site, as summarized in the Final North Disposal Area, Thorium Site, Oil Emulsion Disposal Area Data Summary Report Little Mountain Test Annex Operable Unit A Remedial Investigation Report 2006 Program (Parsons 2007). In Table C.2 of the Parsons report, upgradient, sidegradient, and downgradient radionuclide sampling results show no detections of ^{232}Th and ^{228}Th in groundwater at any of the wells. Low concentrations of ^{230}Th (progeny of uranium-238) were identified in groundwater at all wells but the concentrations are random and less than 1 picocurie per liter, which is indicative of natural uranium decay. Low concentrations of ^{226}Ra progeny from the naturally occurring uranium decay chain were also detected at approximately equal concentrations in the upgradient, sidegradient, and downgradient wells.

Based on the groundwater data and the analysis above, and consistent with the conclusions provided in the Parsons report, radiological concentrations in groundwater are due to natural uranium decay and are not associated with the magnesium-thorium alloy. As such, groundwater remediation activities are not warranted for Site WR111.

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3.0 Selected Remedy

3.1 Technology Overview

The decommissioning at Site WR111 is being performed in accordance with the requirements for a Group 4 facility – Unrestricted Release with Site-Specific Dose Analysis and No Groundwater Contamination; Decommissioning Plan Required (NRC 2006). The selected remedy for the WR111 site is to perform a remedial action for soil in order to remove residual radioactivity above the specified remedial action objectives identified in Section 3.2. The expected outcome of the selected remedy is that Site WR111 will not present an unacceptable risk to future land users via exposure to contaminated soil and would be suitable for a resident farmer. A detailed description of the decommissioning activities is provided in the DP (EA/Cabrera 2014).

3.2 Remedial Action Objectives

On 21 June 1997, the NRC published the final rule on “Radiological Criteria for License Termination,” the License Termination Rule, as Subpart E to 10 Code of Federal Regulation (CFR) Part 20. The criteria for termination with unrestricted release are:

1. Residual radioactivity that is distinguishable from background, and results in a total effective dose equivalent to an average member of the critical group that does not exceed 25 millirems per year, including that from groundwater sources used for drinking water
2. Residual radioactivity has been reduced to levels that are as low as reasonably achievable.

The remedial action objectives for this project are as follows:

1. Perform a remedial action in accordance with the DP (EA/Cabrera 2014), which has been designed in accordance with the NRC’s License Termination rule listed above, and this RD/RAWP and its appended plans.
2. Perform an FSS in accordance with MARSSIM (NRC 2000) and the approved FSS Plan (Appendix D of the DP [EA/Cabrera 2014])

3.3 Cleanup Goals

Cleanup goals for soil at Site WR111 (DCGL_{WS}) are site-specific soil concentrations determined to be protective of the health of individuals who may become exposed to the residual radioactive materials remaining at the site. The DCGL_{WS} are soil concentrations consistent with the exposure scenario and dose pathways determined for the site to ensure any dose or risk remains protective of the health of individuals and is less than regulatory guidelines. The guidelines are conservatively developed to address the risk to an average member of the critical exposure group.

DCGL_{WS} are based on conservative assumptions with a dose criteria limit of 25 millirem per year peak annual total effective dose equivalent over a 1,000-year time period as provided by 10 CFR Part 20 Subpart E. The DCGL_{WS} for Site WR111 were developed using the residual radioactivity computer code, and are discussed in detail in the DP (Cabrera 2014). The site-specific DCGL_{WS} for the project are

provided in Table 3-1. These DCGL_{ws} (with application of the SOR) will act as the cleanup goals for the site. Remedial support surveys with volumetric sodium iodide detectors will be used to measure the mean plus three standard deviations gross gamma background, which will be used as an indication that cleanup goals have been reached. An FSS will be performed after the completion of remedial activities to ensure compliance with these goals. During field activities, the EA/Cabrera team will coordinate with the Air Force Civil Engineer Center (AFCEC) and USAF Radioisotope Committee to provide adequate notice to perform verification surveys prior to conducting backfilling/restoration activities.

TABLE 3-1

Site-Specific Soil Derived Concentration Guideline Levels

WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench

Remedial Design/Remedial Action Work Plan, Hill Air Force Base, Utah

Radionuclides of Concern	Site-Specific Derived Concentration Guideline Levels (picoCuries/gram)
Radium-226	4.5
Thorium-230	7.3
Thorium-232	2.4

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4.0 Removal Action Elements

4.1 General Requirements and Site Management

Daily site operations will be under the day-to-day management of EA's Project Manager and Cabrera's Site Manager. The organizational chart for remedial activities is provided in the DP for Site WR111 (EA/Cabrera 2014). General requirements governing the work scope are described below.

4.1.1 Site-Specific Logistics and Communications

A detailed table showing logistics and communication considerations that were evaluated for work to be conducted at Site WR111 is provided in Table 1 of the QAPP (Appendix A). Base access passes will be obtained for field personnel. Requests for passes to work at Site WR111 (an uncontrolled area) and Air Force Materiel Command Form 496 shall be submitted to Hill AFB no less than 3 business days prior to the date site access is needed. Personnel driving on-Base shall also obtain a vehicle pass, which will be acquired by submitting Air Force Materiel Command Form 387.

Daily meetings will be held at the start of each work day with project personnel, Hill AFB, and other stakeholders, if present. Topics discussed during daily meetings will include updating personnel on work progress, reviewing the day's planned activities, and discussing safety. Records of the meetings will be recorded in daily safety tailgate meeting forms and attached to each day's Daily Quality Control Report (DQCR). DQCRs will be submitted to the Hill AFB Site Project Manager by the following working day.

The EA/Cabrera team will participate in weekly conference calls to update Hill AFB on project status and discuss upcoming work.

4.1.2 Site Security

Hill AFB is a secure facility. Only approved personnel are allowed entry to the facility, and the site is surrounded by an exterior fence. Hill AFB provides security personnel onsite 24 hours a day, 7 days per week. Access to the EA/Cabrera site office will be restricted after hours, with the office locked during non-working hours. Temporary fencing and/or radiological rope will delineate active excavation/laydown areas at all times.

4.1.3 Site Access

Site access to Hill AFB during project activities will be through the main gate, and access to the gate is controlled by Hill AFB security personnel. Site WR111 is located approximately 2,000 ft south of the main gate. The field team will obtain badges for entry onto Hill AFB.

Site access will be controlled as follows:

- Allowing only authorized personnel to enter Site areas while the remediation is being performed
- Ensuring that the site physical barriers (i.e., the fences, gates, and locks) are maintained
- Ensuring proper posting of the site and individual work areas
- Implementing sign-in and sign-out protocols for personnel moving onsite and offsite
- Ensuring that personnel are properly trained and qualified to be onsite or in specific work areas.

Visitors will be directed to the EA/Cabrera site office, which will be set up in a nearby trailer, for sign-in and escort into the work area if approved by the Cabrera Site Manager and/or Site Safety and Health Officer. Field personnel will also be required to sign in and out each day at the office trailer.

4.1.4 Traffic Controls

Traffic access and control measures will be required to maintain worker and public safety, ensure efficient movement of large vehicles and equipment, and reduce the risk of spreading contaminants at the site. A temporary access roadway shall be established from the main access gate to Site WR111 proceeding southeast through the Support Zone to the Contamination Reduction Zone. The temporary roadway will include access ways and turnarounds to facilitate loading of waste at the edge of the Radiological Control Area (RCA), or Exclusion Zone, and minimize the potential for spillage and cross contamination (Figure 4-1). Traffic control including signage and cones will be used during truck loading and load-out of staged waste.

Vehicular traffic in the work areas is expected to consist of heavy equipment and work support vehicles, including an excavator, loader, dump trucks, and pickup trucks. Site personnel should always be aware of the location and direction of operation of equipment. All personnel working in excavation/remediation and waste management areas as well as haul roads will be required to wear bright reflective vests to help make them more visible to equipment operators. Personnel in support areas such as trailer locations and parking lots, as well as personnel in vehicles arriving and leaving the site, will be reminded to be aware of vehicular traffic and take appropriate precautions.

Parking for visitors and field supervisory personnel will be located southwest of the RCA. Remediation personnel will park in the designated area depicted in Figure 4-1. In general, access will be restricted once remediation activities are initiated. Visitors will be directed to the office trailer for sign-in and escort into the work area if approved by the Site Manager and/or Site Safety and Health Officer. Access to the main portion of the Site after hours will not be permitted.

4.1.5 Permits, Clearances, and Notifications

Permits, notifications, exemptions, and approvals will be completed and/or acquired prior to scheduled remediation activities in accordance with regulatory and USAF requirements, including minimum advance notification requirements. Copies of all permits, approvals, and notifications will be maintained onsite. A list of all prerequisite regulatory requirements anticipated for this project is provided in Table 1-1 of the QAPP and in Table 4-1, and these are also discussed in the following sections.

4.1.5.1 Pre-Mobilization Permits and Notifications

This division of permits and notifications must be completed prior to mobilization to the site. The Project Manager will be responsible for ensuring that these permits and notifications are completed prior to mobilization. Requirements related to radioactive sources and instruments must be completed or obtained in order to transport those items onto Hill AFB. In general these permits, approvals, and notifications will involve the NRC, Hill AFB, and Weber County.

4.1.5.2 Pre-Excavation Permits and Notifications

This division of permits and notifications must be completed prior to commencing any intrusive excavation work. These permits are associated with identifying, marking, and documenting subsurface obstructions in the excavation area to reduce the risk to personnel and critical infrastructure property.

In addition, excavation permits and notifications are required by both USAF regulation and Utah state law. The excavation permits have minimum prior notification requirements and are only valid for a specified period of weeks. The Project Manager and Site Manager will be responsible for ensuring that all required permits and notifications are completed prior to commencing excavation. In addition, the Site Manager will track the excavation permits and ensure that all are maintained current throughout the excavation activities.

4.1.5.3 Waste Transportation and Disposal

Waste transportation and disposal is a highly regulated set of activities requiring careful documentation, advance notifications and approvals, and various state permits. Once approval to transport has been received by the disposal facility, materials will be loaded into tarped dump trucks for transport to US Ecology or EnergySolutions. Approval from specific disposal facilities will require waste profiles based on the results of chemical and radiological laboratory analyses performed on soil and soil-like materials. The Project Manager will be responsible for ensuring that all waste disposal approvals are received prior to waste shipment.

Remediation at the site is expected to generate low activity radioactive waste. EA shall provide the disposal facility with a Notice to Transport prior to shipping the wastes. At the time of waste shipping, Cabrera will provide waste manifests and bills of lading for each shipment. The Cabrera Certified Waste Broker will ensure that all manifests and bills of lading are completed, accurate, and signed by an authorized Government representative, as appropriate, prior to shipment. A detailed description of the waste management activities at Site WR111 is provided in the WMP (Appendix D).

4.1.6 Noise

Workers and visitors may be exposed to excessive noise due to heavy equipment and/or power tool use. Workers and visitors working in proximity to heavy equipment will wear hearing protection to ensure that they are not exposed to excessively high noise levels.

4.1.7 Dust Monitoring and Control

A dust control program will be implemented during active remediation and site restoration to minimize remediation worker and public exposure to respirable dust and airborne radioactive particulate. The program will consist of both dust suppression measures and ambient air monitoring to verify the success of dust suppression. Specific requirements for ambient air monitoring for radioactive particulate are provided in the RPP (Appendix C).

Activities that may generate fugitive dust on this project include:

- Excavating to remove contaminated soil
- Temporary stockpiling of excavated soil
- Loading trucks with contaminated soil for transport and offsite disposal
- Vehicle traffic on haul roads
- Backfilling the excavations and site restoration.

Conventional methods will be used to suppress dust generated during remediation and site restoration, including:

- Wetting remediation equipment and excavation faces as needed
- Applying water on equipment buckets during excavation and loading/unloading as needed
- Covering temporary soil stockpiles overnight and weekends as well as during windy conditions
- Keeping vehicle speeds to below 10 miles per hour
- Applying a water spray during soil handling and to vehicle access and haul roads at the Site, as needed.

An atomizing spray will be used to suppress fugitive dust while preventing overly wet conditions, avoiding ponding and run-off, and conserving water. Each worker will be responsible for observing his/her work area for the potential and actual generation of dust. Areas of actual or potential release of dust will be reported to the Site Manager or Site Safety and Health Officer, who will ensure suppression measures are implemented to minimize dust generation.

4.1.8 Stormwater Management

Stormwater management consists of diverting stormwater, controlling erosion and sediment, and performing inspections and maintenance over the duration of the project. In particular, appropriate best management practices for controlling stormwater and non-stormwater discharges will be implemented as necessary.

The following best management practices for stormwater control will be implemented:

- Any non-stormwater generated during construction activities will not be discharged to the stormwater sewer system.
- Identify storm drain inlets, if applicable, that may be impacted by the construction work. Install sediment control systems around potentially impacted storm drain inlets. Use fiber rolls, silt fence, straw bale barriers, and/or gravel inlet filters to control sediment.
- Delineate the work area to prevent heavy equipment from moving outside the work area and to ensure that soil is not disturbed outside the work area.
- To prevent rain from coming into contact with the stockpiled soil and to minimize wind dispersion of particulate matter, the stockpiles will be covered with a minimum 6-mil polyvinyl chloride liner (or equivalent) and secured with sandbags or an approved biodegradable soil stabilization compound during rainy weather, windy conditions, and at the end of each work day.

To protect excavated areas, straw wattle will be used to divert water. If needed, sandbags will be placed in drainage control swales and at drainage control discharge points or areas with high probability of erosion. The planned locations of these stormwater management practices are displayed in Drawing 4-1.

Although not anticipated, potentially-contaminated water may be generated from excavation dewatering and/or collection of storm or rainwater entering excavations and Exclusion Zones. This water will be collected in an onsite 500-gallon tank to facilitate project execution and prevent the spread of radiological contamination. Potentially contaminated water that is collected will be sampled and analyzed before disposition is determined with the concurrence of Hill AFB.

4.1.9 Spill Control

Procedures and responsibilities for spill prevention, response activities, and cleanup associated with the field activity are presented in the APP/RPP. This section briefly identifies the potential sources of spills during the investigation work and the methods that will be implemented to prevent spills, limit impact to the environment in the event of a spill, and protect personnel and the public from exposure or injury.

For spill response, a spill kit will be maintained onsite. There is not expected to be greater than 20 gallons of fuel onsite at one time to minimize the impact of potential spills. Spills will be reported in accordance with procedures in the Site-Specific Addendum to the HASP (EA/Cabrera 2010).

4.2 Mobilization and Site Preparation

The EA/Cabrera team will mobilize necessary facilities, equipment, materials, and personnel to perform the remediation activities following completion of procurement/subcontracting activities, acquisition of relevant permits and approvals, and accomplishing notifications (as described in Section 4.1.5). Equipment, materials, and personnel will be mobilized in accordance with the project schedule.

The EA and Cabrera Project Managers will be responsible for ensuring that subcontracts, purchase orders, and notifications to vendors are executed on time to enable mobilization to the field to occur on schedule. For security reasons, mobilization to the base of all personnel, large equipment, support facilities, and drop-shipped materials must be coordinated in advance with the Hill AFB Site Project Manager or his designee.

4.2.1 Radiological Control Areas

RCAs are designed to prevent employees, contractors, visitors, and the surrounding environment from receiving unnecessary exposure to radiation and radiological contamination during site activities.

Project-specific RCAs will be established by the Site Radiation Safety Lead. These RCAs will be monitored in accordance with NRC regulations. There is one planned RCA for this project: the Site WR111 excavation area (Figure 4-1). The RCA will be established soon after mobilization to the site to control access to site areas. Movement of personnel and equipment between work areas as well as on and off the site will be controlled by means of designated access points. Contaminated equipment and materials will be stored in the RCA in accordance with the RPP (Appendix C).

4.2.2 Haul Routes

The planned location of the haul road for the project is shown in Figure 4-1. The haul road will be established soon after mobilization to the site. A temporary access roadway shall be established from the main access gate proceeding southeast to the Contamination Reduction Zone. The roadway will be covered with a 3-inch (in.) layer of mulch to minimize dust generation by the vehicle traffic as shown in Drawing 4-1. The temporary roadway will include access ways and turnarounds in the waste loading area to facilitate loading of waste at the edge of the Exclusion Zone and minimize the potential for spillage and cross contamination. Traffic control including signage and cones will be used during truck loading and load-out of staged waste.

4.2.3 Staging Areas

4.2.3.1 Radiological Staging Area

Potentially impacted soil excavated from the WR111 trench will be staged on the western side of the WR111 RCA until the waste shipping begins a few days after excavation has started in the eastern end of WR111. The planned Radiological Staging Area is shown on Figure 4-1. Natural soil will be bermed immediately outside upslope portions of excavation areas to minimize stormwater run-on. A berm constructed of straw wattle or equivalent will be installed along the eastern side of the WR111 RCA excavation areas to contain potential storm run-off.

4.2.3.2 Layback Soils Staging Area

There will be a relatively small volume of non-impacted soil (between 300 and 500 cubic yards) that will be excavated along the perimeter of the excavation area in order to provide sloping for safe entry into the excavation (see Section 4.3.2 for more detail). These layback soils will be stored in a separate area away from the excavation and sampled to determine its suitability for use as backfill.

Prior to staging soils within the Layback Soils Staging Area, the existing surface of the staging area will be surveyed for background gamma radiation using a Ludlum Model 44-20 3- × 3-in. sodium iodide detector paired with a Ludlum Model 2221 ratemeter, or equivalents. The 3- × 3-in. sodium iodide detector will be paired with a Global Positioning System (GPS) unit, and a GWS will be performed as described in the FSS Plan (Appendix D of the DP [EA/Cabrera 2014]).

A layer of 6-mil polyethylene sheeting will be laid down within the Layback Soils Staging Area. Silt fencing will be installed around the perimeter of the area to maintain erosion and sediment controls. Other erosion and sediment control activities are described in detail in Section 4.2.9 of this plan. A drawing displaying the setup of the area is provided in Drawing 4-1. Layback soils will be staged in a continuous stockpile and sampled and analyzed as described in Section 4.3.3.

After soil is removed from the area, a post-remedial GWS of the staging area will be performed to ensure that they were not contaminated as a result of remedial activities. Results will be compared to the baseline GWS results. Areas of elevated gamma activity (a z-score above 3) in post-remedial surveys that were not noted in baseline surveys will require further investigation and possibly remediation.

4.2.4 Background Reference Areas

^{230}Th , ^{232}Th , and ^{226}Ra are naturally present in most soils and, therefore, soils from non-impacted areas at WR111 will be selected as background reference areas for comparison. There are two areas that will require reference area comparison at the conclusion of the remediation: the surface soils underlying the Layback Soils Staging Area, and the subsurface soils at the limits of excavation of the WR111 trench. Therefore, there will be two reference areas for this project: a surface soil reference area and trench reference area. The planned reference area locations are shown in Figures 1-3 and 4-2.

The trench reference area will be excavated within the reference area footprint (Figure 1-3). The trench will be approximately 18 ft long × 6 ft deep × 12 ft wide to simulate background conditions for the WR111 trench survey unit (SU). A GWS will be performed over 100 percent of the floors and sidewalls of the reference trench as described in the FSS Plan (Appendix D of the DP [EA/Cabrera 2014]) using a 3- × 3-in. sodium iodide detector paired with a GPS unit. The average of these scan measurements plus three standard deviations will be used to provide an investigation level for the WR111 trench SU.

The surface soil reference area is located west of WR111 (Figure 1-3). A GWS will be performed over 100 percent of the reference area as described in the FSS Plan (Appendix D of the DP [Cabrera 2014]) using a 3- × 3-in. sodium iodide detector paired with a GPS unit. Gross gamma datasets will consist of surface scan measurements using the same survey instruments to be used for the FSS. The average of these scan measurements plus three standard deviations will be used to provide an investigation level for the WR111 remedial support and FSS surface gamma scans, and surface Layback Soil Staging Area soils after layback soils are removed. Surface soil samples will also be collected at systematic locations within the surface soil reference area as described in the FSS Plan (Appendix D of the DP [Cabrera 2014]).

4.2.5 Decontamination Area

Personnel and equipment decontamination shall be performed in the Contamination Reduction Zone. The Contamination Reduction Zone will contain the equipment necessary for personnel and equipment decontamination and radiological survey instrumentation, and may be equipped with designated “step-off areas” for personnel following doffing of potentially contaminated personal protective equipment.

In order to minimize potential liquid waste, equipment decontamination is anticipated to be performed on a dry basis by brushing using brooms or brushes, or wiping using MASSLINN decontamination wipes. Should the use of water during the decontamination be necessary, a temporary decontamination pad will be constructed and any liquid collected and containerized. Accordingly, any accumulated liquids during decontamination activities will be handled, stored, sampled, and analyzed prior to release.

4.2.6 Security Measures

Site security and site access requirements are provided in Sections 4.1.2 and 4.1.3.

4.2.7 Radiological Controls

Strict radiological controls will be provided through the RPP (Appendix C), Standard Operating Procedures (attached to the QAPP in Appendix A), and trained and qualified personnel and adhered to at the site during all phases of the project. These controls will ensure that site workers and the ambient environment are monitored for and protected from potential exposure to/impact from radiological hazards, and that potentially radiologically-impacted wastes and/or materials/equipment used or generated during the project are carefully monitored and handled to prevent the potential spread of radiological contamination.

Radiological controls will be implemented and enforced under Cabrera’s NRC Radioactive Materials License No. 06-30556-01. General project radiological controls will include the following:

- The flow of personnel and equipment through the site will be strictly controlled at all times to assure that personnel and equipment are properly screened prior to being released from the RCA and into the support area or offsite.
- Equipment will be screened for potential radioactivity both before being accepted onsite or prior to use and after use prior to being released offsite.
- Measures will be taken to preemptively suppress the generation of dust in areas of the site where potentially radiologically-impacted material is handled to avoid the possibility of airborne movement of and/or exposure to radiological contaminants.

- The use of equipment in direct contact with potentially radiologically-impacted materials will be minimized to the extent practicable during the project to minimize the potential for spreading radiological contamination.
- Proper decontamination procedures (see standard Operating Procedure [OP]-018, which is included as an attachment to the QAPP [Appendix A of this RD/RAWP]) will be followed to address potential radiological contamination of equipment and/or materials.
- Proper measures as outlined in the QAPP (Appendix A, see Standard Operating Procedures OP-004 and OP-020) will be taken to prevent the spreading of potentially radiologically-impacted materials.
- General site surveys (Appendix A, see Standard Operating Procedure OP-001) will be completed prior to initiating site activities and upon completion of the investigation to assess the potential for the spread of radiological contamination.
- Air monitoring for airborne radioactive material will be conducted as specified in the RPP.
- Personnel will be monitored regularly for contamination and routine surveys will control potential radiological exposures.

4.2.8 Utility Locating

As part of the pre-mobilization activities, Red Stakes will be contacted for utility clearance activities at Site WR111. The EA Site Project Manager will notify the Hill AFB Site Project Manager to initiate Red Stakes utility clearance when required. Necessary form(s) and required attachments will be prepared and returned to the Hill AFB Site Project Manager at least 30 working days prior to the date utility clearance is required. Red Stakes will issue Excavation Permits when utility location is complete.

4.2.9 Erosion and Sediment Control Measures

Erosion and sediment controls will be installed prior to initiating earthwork and maintained for the duration of excavation and site restoration activities. Berms or pumping will only be implemented if the primary techniques are unsuccessful, as determined by the Site Manager. The following erosion and sediment controls and procedures will be implemented at the Site:

- Natural soil will be bermed immediately outside upslope portions of excavation areas to minimize stormwater run-on.
- Silt fence shall be constructed surrounding the Layback Soils Staging Area to divert stormwater run-on and minimize run-off.
- Existing vegetation shall be preserved before site disturbance begins whenever possible. This may be done by clearly marking the work area and haul routes with barricades/cones and caution tape.
- Stockpiled contaminated soil and debris shall be covered with polyethylene and/or waterproof tarps at the end of each day and during rain events to minimize the volume of impacted water and prevent erosion.

- Trucks entering and leaving the Site shall avoid direct tire contact with contaminated soil to prevent tracking soil offsite.
- Erosion and sediment control measures shall be monitored during all phases of the cleanup to prevent the pollution of surface waters. The inspection of control measures shall occur on a daily basis to ensure that control and preventive measures are in accordance with best management practices. Corrective action shall be taken if the operability of a control measure is in question. Inspections and corrective action shall be documented in DQCRs.
- Daily inspections shall be performed in active excavation locations to ensure the proper performance of run-on and run-off controls.
- Inspections shall be made after each rainfall and daily during extensive periods of rainfall.

Silt accumulated in erosion control structures will be removed upon identification. Silt fences will be inspected and any damaged silt fence will be repaired or replaced. Erosion and sediment controls will be removed upon project completion or following establishment of installed turf, whichever is later.

4.2.10 Existing Site Fence Removal

USAF constructed a chain-link fence around the entire WR111 area in 1994 to limit potential exposure to others. During the supplemental characterization survey performed in 2013 (Cabrera 2014), it was confirmed that subsurface contamination above the release criteria extends under the fenced area to the west. In order to perform the remediation, the fence will be removed and staged as debris within the RCA. The fence posts in contact with potentially contaminated soils will be surveyed to determine if they meet the release criteria in the RPP (Appendix C). If the fencing meets the requirements for unrestricted release, then the fencing will be disposed as construction debris. If the fencing does not meet the requirements for unrestricted release, then the fencing will either be decontaminated, if possible, or disposed of as low activity radioactive waste. Since the soil remedy will result in unrestricted release of the site, fencing will not be re-installed around the site.

4.3 Excavation and Handling of Contaminated Material

After site setup activities have been completed, and all required permits have been received, excavation of contaminated materials at WR111 will begin. The following sections describe the detailed process that will be followed throughout excavation of contaminated soils, temporary staging of soils in the Radiological Staging Area and Layback Soils Staging Area, and remedial support surveys to confirm the limits of excavation have been reached.

4.3.1 Areas of Excavation

4.3.1.1 Initial Area Targeted for Excavation

The planned areas of excavation shown in Figure 1-3 will be marked for visibility using marking paint or pin flags by a Health Physics Technician utilizing a GPS. A 10-foot grid outside the planned areas of excavation will also be marked for referencing purposes. Excavation will begin in the eastern end of WR111 where the deepest contamination (approximately 10 ft) is located. A 330-Cat excavator, or equivalent, will excavate soils and load them into the bucket of a front end loader, which will stage the soils within the RCA starting from the eastern end of the planned excavation area shown in Figure 4-1.

A Health Physics Technician will screen each loader bucket of soils with a doserate meter to check for discrete areas of elevated activity for radiological safety purposes. Soil contamination is assumed to be relatively homogeneous throughout the burial trench. If the Health Physics Technician discovers discrete areas of high activity material while screening, then excavation will stop and the Project Health Physicist will be notified to assess the assumptions of the Radiation Work Permit. The Health Physics Technician and operator will also visually inspect the excavated soils for indications of debris or chemicals (i.e., drums, trash, dark staining, odors, etc.). If anything besides soil and ash are found in the excavated materials, then the excavation will stop and Hill AFB will be notified.

Once the depths shown in Figure 1-3 are reached, a Health Physics Technician will perform a GWS of the excavation floor and sidewalls. The purpose of this survey is to identify elevated areas of activity that exceed the investigation levels (3 sigma above trench reference area background mean count rate). Sloping requirements of the excavation are provided in Section 4.3.4.

4.3.1.2 Hotspot Excavation to Attain Cleanup Goals

After performing a survey at the initial limits of excavation, the Health Physics Technician will use marking paint to identify areas that exceed the applicable investigation level described in Section 4.2.4. After the excavation floors and sidewalls have been remediated, and remedial support surveys confirm that soil elevated gross gamma activity has been removed, these areas will be designated as ready for FSS.

4.3.2 Waste Loading

Dump trucks will be provided to transport low activity radiological waste soils offsite to the disposal site. After being approved for use by onsite personnel, including incoming radiological surveys as described in the RPP (Appendix C), the dump trucks will back up to the edge of the RCA on the western side of WR111. The front end loader with a bucket scale will load stockpiled soils directly into the dump trucks, which have a load limit of 22 tons or 30 tons, depending on the type of trucks used. After being loaded, the dump truck will be checked for loose soil on the tailgate and top of the bed by a laborer. The truck will then be moved away from the edge of the RCA to be radiologically surveyed and for manifests to be generated, signed, and passed on to the driver. A detailed description of the procedures to prepare for loading, load trucks, and prepare for shipment are provided in the WMP (Appendix D).

4.3.3 Layback Soils

Non-impacted layback soils may be excavated along the exterior of the planned excavation areas to comply with sloping requirements listed in Section 4.3.4. Before beginning the excavation of non-impacted soils, the excavator and/or loader will be surveyed for release from the RCA as described in the RPP (Appendix C). The excavator will load non-impacted soils into the bucket of the loader, which will transport the soils to the Layback Soils Staging Area described in Section 4.2.3.2. Soils will be staged in a continuous stockpile. One composite sample will be collected per 100 cubic yards in accordance with Cabrera OP-005: Volumetric and Material Sampling (Cabrera 2010) and OP-351: Surface Soil Sampling. One five-point composite sample will be collected per every 100 cubic yards of non-impacted layback soils material and analyzed for radionuclides of concern to determine suitability for backfill. The first composite sample will be collected as soon as approximately 100 CY of soil volume are accumulated in the area to ensure that samples are representative of the distribution of layback soils. Subsequent samples will be collected as soon as each approximate additional 100 CY is accumulated. Samples will be sent offsite to TestAmerica for alpha spectroscopy analysis for ^{230}Th and ^{232}Th and gamma spectroscopy analysis for ^{226}Ra . Sample chain-of-custody will be maintained in accordance with Cabrera OP-008:

Chain-of-Custody (Cabrera 2010). Laboratory analysis will be performed in accordance with the requirements in the QAPP (Appendix A). If offsite analytical results confirm that soils do not exceed the project DCGL_{ws}, then the soil will be appropriate for use as backfill of the excavation. If offsite analytical results confirm that soils exceed the project DCGL_{ws}, then the soil will be transported and disposed offsite at the chosen disposal site as low activity radiological waste.

4.3.4 Benching and Sloping Requirements

Excavation activities will be performed in accordance with Occupational Safety and Health Administration requirements as set forth in 29 CFR 1926.650 (Subpart P) and the HASP (EA 2013). The Site Manager will ensure Occupational Safety and Health Administration Competent Person oversight of sloping and benching operations. This person will be capable of identifying actual and predictable hazards in the excavation as well as the surrounding area for work conditions that are hazardous to workers. The competent person will also be familiar with the different types of soil encountered during excavation and the various protective systems that can be used such as sloping, benching, and shoring. The competent person will have the authority to stop work until hazards are eliminated. All excavation walls will be appropriately sloped to meet the requirements for worker access. It is conservatively assumed that the soils will be Class C and, therefore, sloping is required at a grade of 1.5:1. Under no circumstances will workers be allowed access to any excavation deeper than 4 ft below ground surface without proper shoring or benching/sloping in place.

4.3.5 Soil and Stockpile Management

Silt fencing shall be installed surrounding the Layback Soils Staging Area to divert stormwater run-on and minimize run-off. Stockpiled contaminated soil within the RCA and non-impacted soil within the Layback Soils Staging Area shall be covered with polyethylene and/or waterproof tarps at the end of each day and during rain events to prevent erosion and contaminant migration.

4.4 Final Status Survey

Following the completion of remediation activities, an FSS will be performed to demonstrate compliance with the established DCGL_{ws} to ensure that the unrestricted release criteria have been achieved. An FSS Plan for conducting a MARSSIM-compliant FSS is included in Appendix D of the DP (Cabrera 2014). All remedial action activities, including the FSS at WR111, are being conducted in coordination with the NRC via the USAF Radioisotope Committee. The FSS process assesses site radiological conditions and document compliance with radiological cleanup criteria to achieve unrestricted release at the site. After FSS samples have been collected, project personnel will demobilize and await sample results from the offsite analytical laboratory. Data assessment will be performed on received data packages in accordance with QAPP requirements.

4.5 Backfill and Handling of Fill Materials

Once pre-FSS results indicate that DCGL_{ws} have been met and before backfilling operations, the USAF will be provided an opportunity to conduct verification surveys of the excavation area. The excavation will then be backfilled with any uncontaminated soils that were previously excavated (if stockpiled) and clean imported fill. The imported material will be obtained from a local source, such as Staker Parson Companies (Ogden, Utah).

Uncontaminated layback soils will have documented radiological survey results showing that radiological concentrations are below soil DCGL_{WS} (i.e., with application of the SOR rule). The imported backfill material will have analytical data showing that the material is clean, as defined as less than EPA Regional Screening Levels for Residential Soil (November 2013) for chemical contaminants or comparable to the background concentrations of metals and radiological constituents at Hill AFB. Imported backfill shall also have a rating of excellent or good by the American Association of Highway and Transportation Officials (AASHTO) classification and shall include Classes A-1-a, A-1-b, A-2-4, A-2-5, and A-3, conforming to the parameters listed in Table 4-2. Prior to placement, a sample of imported backfill material will be obtained from the local source and submitted to the project laboratory for the following laboratory analyses:

- Volatile organic compounds via EPA Method SW8260B
- RCRA metals/mercury via EPA Method SW 6020A/7471A
- Total petroleum hydrocarbons gasoline range organics and diesel range organics via EPA Method SW8015C
- Gamma spectroscopy analysis for ²²⁶Ra via EPA Method 901.1M
- Alpha spectroscopy analysis for ²³⁰Th and ²³²Th via Method Environmental Measurements Laboratory (EML) Health and Safety Laboratory (HASL) 300 Modified (U.S. Department of Energy 1997).

The results of this initial sample will be applicable for the first 1,000 cubic yards of imported material delivered to the site. Additional confirmation samples of imported backfill material will be collected and submitted to the project laboratory for the same analyses as the initial sample at the following frequency: 1 sample per 2,000 cubic yards.

4.5.1 Common Borrow and Compaction

Backfilled soil will be compacted in 8-in. lifts using wheel compaction from a wheeled loader. The wheeled loader will make a minimum of four passes per lift over the backfilled areas. Compaction utilizing four passes conforms to "Table 5. Compaction Equipment and Methods" of the Foundations and Earth Structures Design Manual 7.02 NAVFAC, for both coarse grained and fine-grained soils using a rubber tire roller. No compaction testing will be performed. Backfill will be placed in a manner that maintains positive surface run-off without low spots.

4.5.2 Topsoil

A 6-in. layer of topsoil will be placed on top of backfill to match surrounding grade. Imported topsoil shall meet product requirements specified in UDOT Section 02912, TOPSOIL. At the completion of backfilling activities, the excavation areas will be surveyed to document the as-left topography of the site.

4.6 Site Restoration

Excavated areas, temporary road, and equipment staging areas will be restored to pre-excavation conditions, upon which the disturbed areas will be revegetated using a native seed mixture that is listed in the Hill AFB Standard Operating Procedure 6 Site Restoration. No warranty on the revegetation will be

provided. Site restoration will also include removing any temporary fencing that was used during field work and performing a final walk-down inspection of the Site with Hill AFB to ensure it meets their requirements before final demobilization.

4.7 Demobilization

The EA/Cabrera team will demobilize from the Site at the conclusion of site remediation and restoration activities. Demobilization will occur in two phases.

1. ***Pre-FSS Demobilization***—Personnel and remediation equipment will be demobilized immediately following completion of excavation, transportation of waste for offsite disposal, FSS, and free release of remediation equipment. All equipment coming into contact with contaminated waste will be decontaminated and radiological surveys performed for unconditional free release of potentially contaminated equipment prior to demobilization. Decontamination and free release of equipment are described in the Site-Specific Addendum to the HASP and RPP.
2. ***Post-FSS Demobilization***—After receiving approval to backfill from Hill AFB and USAF Radioisotope Committee, personnel, equipment, and materials will be mobilized to the site to perform the backfilling and site restoration activities described in Sections 4.5 and 4.6. After completing these activities, the personnel, equipment, and materials will be demobilized from the site for the final time.

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TABLE 4-1

Permits, Notifications, and Approvals at Hill Air Force Base

WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench

Remedial Design/Remedial Action Work Plan, Hill Air Force Base, Utah

Requirement	Permit	Notification	Approval	Responsible	Regulatory Body	Timeframe
Pre-Mobilization						
Invoke nation-wide radioactive materials license	X	X		Corporate RSO/PM	Nuclear Regulatory Commission	
Security passes to gain access to Hill Air Force Base	X			PM/SM	Hill Air Force Base	
Radioactive check/quality control sources on base		X		PM/SM	Hill Air Force Base, RSO	
Stormwater Pollution Prevention Plan permit	X			PM	Weber County	
Construction General Permit	X			PM/SM	Hill Air Force Base	
Onsite gas line and offsite utility location and clearance		X	X	PM/SM	Blue Stakes (utilities)	Notification required at least 2 days, but no more than 7 days in advance of work
Onsite utility location and clearance and excavation permit	X			PM/SM	Red Stakes, Hill Air Force Base	Forms must be submitted to Red Stakes no less than 14 calendar days prior to proposed date of activities
Waste Transportation and Disposal						
Waste profile		X	X	PM/Waste Broker	Disposal facility(s)	
Waste acceptance		X	X	PM/Waste Broker	Disposal facility(s)	
Approval to Transport		X	X	PM/Waste Broker	Disposal facility(s)	
Bill of lading/waste manifest to accompany waste shipments		X	X	PM/Waste Broker	Disposal facility(s)	

NOTES:

PM = Project Manager.

RSO = Radiation Safety Officer.

SM = Site Manager.

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TABLE 4-2

Backfill Specifications

*WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench**Remedial Design/Remedial Action Work Plan, Hill Air Force Base, Utah*

PARAMETER	AASHTO CLASS				
	A-1-a	A-1-b	A-2-4	A-2-5	A-3
Sieve Analysis					
% passing					
#10	50 max				
#40	30 max	50 max			51 max
#200	15 max	25 max	35 max	35 max	10 max
Liquid Limit			40 max	41 min	Non plastic
Plasticity Index	6 max	6 max	10 max	10 max	
Usual Type	sand and gravel		silty sand and gravel		fine sand
General Subgrade Rating	excellent to good				

NOTES:

AASHTO = American Association of Highway and Transportation Officials

max = maximum

min - minimum

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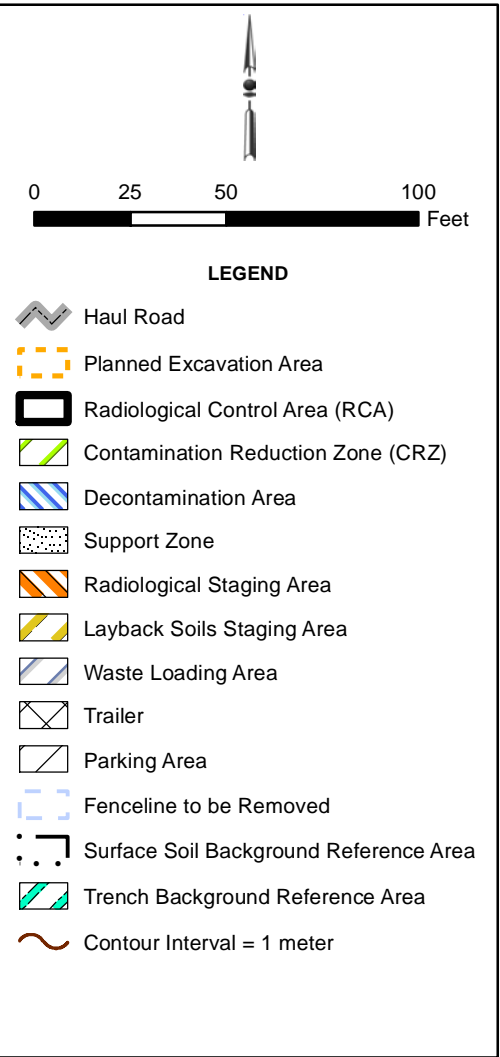
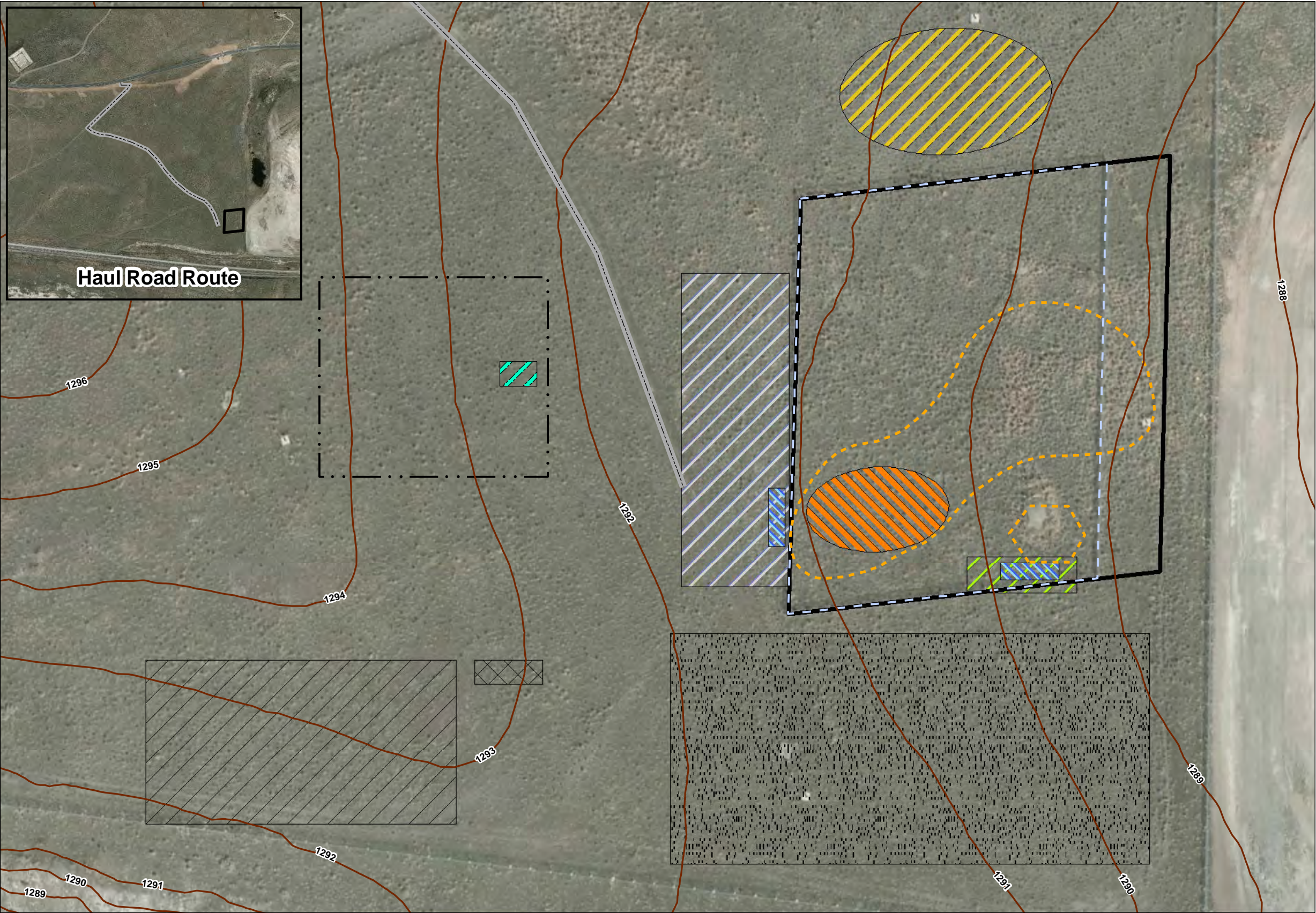


FIGURE 4-1
REMEDIAL SITE LAYOUT
WR111 REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN
HILL AIR FORCE BASE, UTAH

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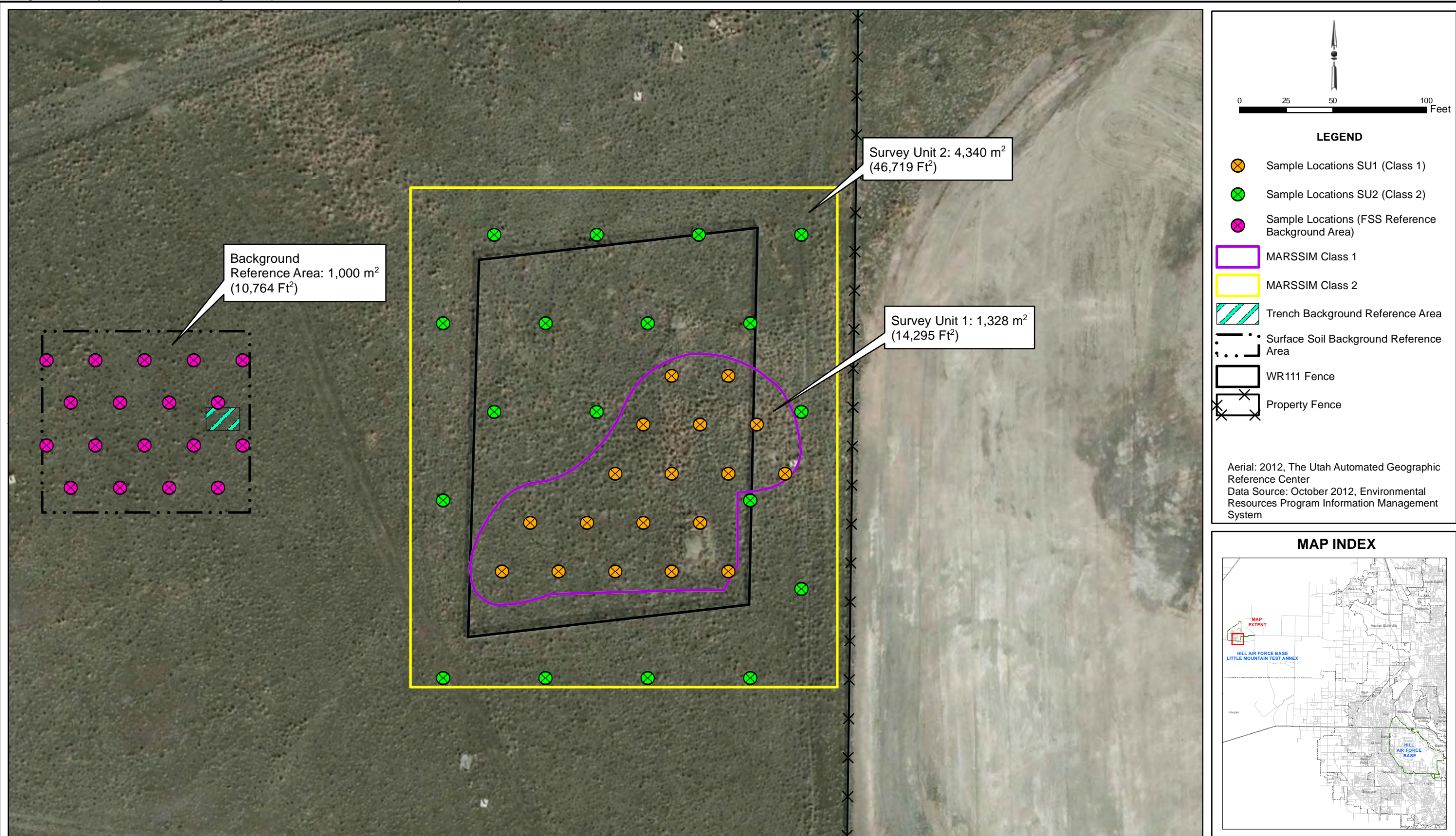


FIGURE 4-2
PLANNED REFERENCE AREA AND SURVEY UNIT DELINEATIONS
WR111 REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN
HILL AIR FORCE BASE, UTAH

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SEQUENCE OF REMEDIATION

1. ESTABLISH E&S AND RADIOLOGICAL CONTROLS ONSITE AND OBTAIN APPLICABLE PERMITS
2. MARK PLANNED EXCAVATION AREAS
3. EXCAVATE LAYBACK SOILS AND STAGE IN THE LAYBACK SOILS STAGING AREA
4. EXCAVATE CONTAMINATED SOILS AND STAGE IN RADIOLOGICAL STAGING AREA
5. EXCAVATE ADDITIONAL CONTAMINATED SOILS BASED ON GROSS GAMMA ACTIVITY SCANNING RESULTS
6. PERFORM FINAL STATUS SURVEY OF EXCAVATION FLOOR AND WALL SURFACES
7. AWAIT SAMPLE RESULTS AND APPROVAL TO BACKFILL FROM AIR FORCE
8. BACKFILL, COMPACT AND RESTORE SITE TO PRE-EXCAVATION CONDITIONS.

EROSION AND SEDIMENT CONTROL NOTES

- NATURAL SOIL WILL BE BERMED IMMEDIATELY OUTSIDE UP-SLOPE PORTIONS OF EXCAVATION AREAS TO MINIMIZE STORM WATER RUN-ON
- SILT FENCE SHALL BE CONSTRUCTED SURROUNDING THE LAYBACK SOILS STAGING AREA TO DIVERT STORM WATER AND MINIMIZE RUN-OFF
- PRESERVE EXISTING VEGETATION BEFORE SITE DISTURBANCE BEGINS, WHENEVER POSSIBLE. THIS MAY BE DONE BY CLEARLY MARKING THE WORK AREA AND HAIL ROUTES WITH BARRICADES/ CONES AND CAUTION TAPE
- STOCKPILED CONTAMINATED SOIL AND DEBRIS SHALL BE COVERED WITH POLYETHYLENE SHEETING AND/OR WATERPROOF TARPIS AT THE END OF EACH DAY AND DURING RAIN EVENTS TO MINIMIZE THE VOLUME OF IMPACTED WATER AND PREVENT EROSION
- TRUCKS ENTERING AND LEAVING THE SITE SHALL AVOID DIRECT CONTACT WITH CONTAMINATED SOIL TO PREVENT TRACKING SOIL OFFSITE

EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES (BMPs)

- EROSION AND SEDIMENT POLLUTION CONTROLS MUST BE CONSTRUCTED, STABILIZED AND FUNCTIONAL PRIOR TO SITE DISTURBANCE WITHIN THE TRIBUTARY AREAS OF THOSE CONTROLS.
- EX/CARRERA WILL NOT DISTURB GROUND COVER AREAS BEYOND THOSE NECESSARY TO SATISFACTORILY COMPLETE THE REQUIRED WORK. EQUIPMENT STAGING SITES SHALL BE LOCATED IN SUPPORT ZONE AREAS UNTIL THE SITE IS STABILIZED, ALL EROSION AND SEDIMENT POLLUTION CONTROL FACILITIES MUST BE PROPERLY MAINTAINED. MAINTENANCE MUST INCLUDE INSPECTIONS OF ALL TEMPORARY AND PERMANENT CONTROLS AFTER EACH RUNOFF EVENT AND ON A WEEKLY BASIS. ALL PREVENTATIVE AND REMEDIAL MAINTENANCE WORK, INCLUDING CLEAN OUT, REPAIR, REPLACEMENT, REGRADING, RESEEDING, AND REMULCHING MUST BE PERFORMED IMMEDIATELY AFTER FINAL SITE STABILIZATION HAS BEEN ACHIEVED (INCLUDING MIN UNIFORM 70% VEGETATIVE COVER ESTABLISHED). TEMPORARY EROSION AND SEDIMENTATION CONTROLS MAY BE REMOVED

STORMWATER MANAGEMENT BMPs

- ANY NON-STORMWATER GENERATED DURING CONSTRUCTION ACTIVITIES WILL NOT BE DISCHARGED TO THE STORMWATER SEWER SYSTEM.
- IDENTIFY STORM DRAIN INLETS, IF APPLICABLE, THAT MAY BE IMPACTED BY THE CONSTRUCTION WORK. INSTALL SEDIMENT CONTROL SYSTEMS AROUND POTENTIALLY IMPACTED STORM DRAIN INLETS. USE FIBER ROLLS, SILT FENCE, STRAW BALE BARRIERS, AND/OR GRAVEL INLET FILTERS TO CONTROL SEDIMENT.
- DELINEATE THE WORK AREA TO PREVENT HEAVY EQUIPMENT FROM MOVING OUTSIDE THE WORK AREA AND TO ENSURE THAT SOIL IS NOT DISTURBED OUTSIDE THE WORK AREA.
- TO PREVENT RAIN FROM COMING INTO CONTACT WITH THE STOCKPILED SOIL AND TO MINIMIZE WIND DISPERSION OF PARTICULATE MATTER, THE STOCKPILES WILL BE COVERED WITH A MINIMUM 6-MIL POLYVINYL CHLORIDE LINER (OR EQUIVALENT) AND SECURED WITH SANDBAGS OR AN APPROVED BIODEGRADABLE SOIL STABILIZATION COMPOUND DURING RAINY WEATHER, WINDY CONDITIONS AND AT THE END OF EACH WORK DAY.

BACKFILL SPECIFICATIONS

- THE EXCAVATION WILL BE BACKFILLED WITH ANY UNCONTAMINATED SOILS THAT WERE PREVIOUSLY EXCAVATED (IF STOCKPILED) AND CLEAN IMPORTED FILL. THE IMPORTED FILL MATERIAL WILL BE OBTAINED FROM A LOCAL SOURCE, SUCH AS STAKER PARSON COMPANIES (OGDEN, UT).
- THE IMPORTED BACKFILL MATERIAL WILL HAVE ANALYTICAL DATA SHOWING THAT THE MATERIAL IS CLEAN, AS DEFINED AS LESS THAN USEPA REGIONAL SCREENING LEVELS FOR RESIDENTIAL SOIL (NOVEMBER 2013) FOR CHEMICAL CONTAMINANTS OR COMPARABLE TO THE BACKGROUND CONCENTRATIONS OF METALS AND RADIOLOGICAL CONSTITUENTS AT HILL AFB. PRIOR TO PLACEMENT, A SAMPLE OF IMPORTED BACKFILL WILL BE OBTAINED FROM THE LOCAL SOURCE AND SUBMITTED TO THE PROJECT LABORATORY FOR THE ANALYSES LISTED IN THE PROJECT QAPP (APPENDIX A OF THE WORK PLAN).

- THE RESULTS OF THIS INITIAL SAMPLE WILL BE APPLICABLE FOR THE FIRST 1,000 CUBIC YARDS (CY) OF IMPORTED MATERIAL DELIVERED TO THE SITE. ADDITIONAL CONFIRMATION SAMPLES OF IMPORTED BACKFILL MATERIAL WILL BE COLLECTED AND SUBMITTED TO THE PROJECT LABORATORY FOR THE SAME ANALYSES AS THE INITIAL SAMPLE AT THE FOLLOWING FREQUENCY: 1 SAMPLE PER 2,000 CY.
- BACKFILLED SOIL WILL BE COMPACTED IN 8-INCH LIFTS USING A WHEEL COMPACTION OR AN EQUIVALENT COMPACTION TECHNIQUE TO PREVENT SETTLEMENT OF THE FILL MATERIAL. NO COMPACTION TESTING WILL BE PERFORMED. BACKFILL WILL BE PLACED IN A MANNER THAT MAINTAINS POSITIVE SURFACE RUNOFF WITHOUT LOW SPOTS.
- THE WHEELED LOADER/ BULLDOZER WILL MAKE A MINIMUM OF FOUR PASSES PER LIFT OVER THE BACKFILLED AREAS
- A SIX (6) INCH LAYER OF TOPSOIL WILL BE PLACED ON TOP OF BACKFILL TO MATCH SURROUNDING GRADE. AT THE COMPLETION OF BACKFILLING ACTIVITIES, THE EXCAVATION AREAS WILL BE SURVEYED TO DOCUMENT THE AS-LEFT TOPOGRAPHY OF THE SITE.

LAYBACK SOILS STAGING AREA NOTES

- A LAYER OF 6-MIL POLYETHYLENE SHEETING WILL BE LAID DOWN WITHIN THE LAYBACK SOILS STAGING AREA. SILT FENCING WILL BE INSTALLED AROUND THE PERIMETER OF THE AREA TO MAINTAIN EROSION AND SEDIMENT CONTROLS. LAYBACK SOILS WILL BE STAGED IN 100 CUBIC YARD (CY) PILES AND SAMPLED AND ANALYZED AS DESCRIBED IN THE QAPP (APPENDIX A OF THE WORK PLAN).

SITE RESTORATION ACTIVITIES

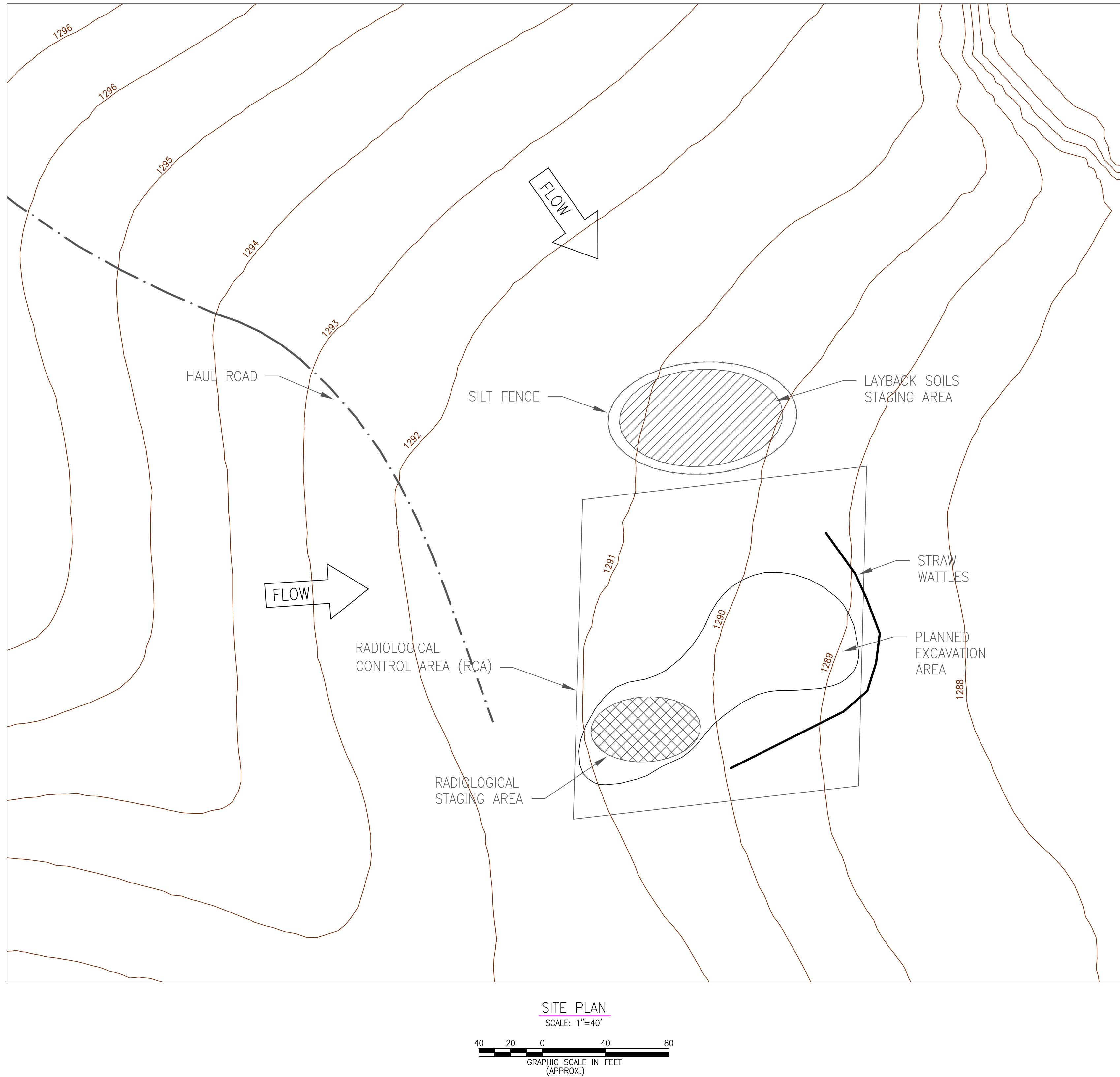
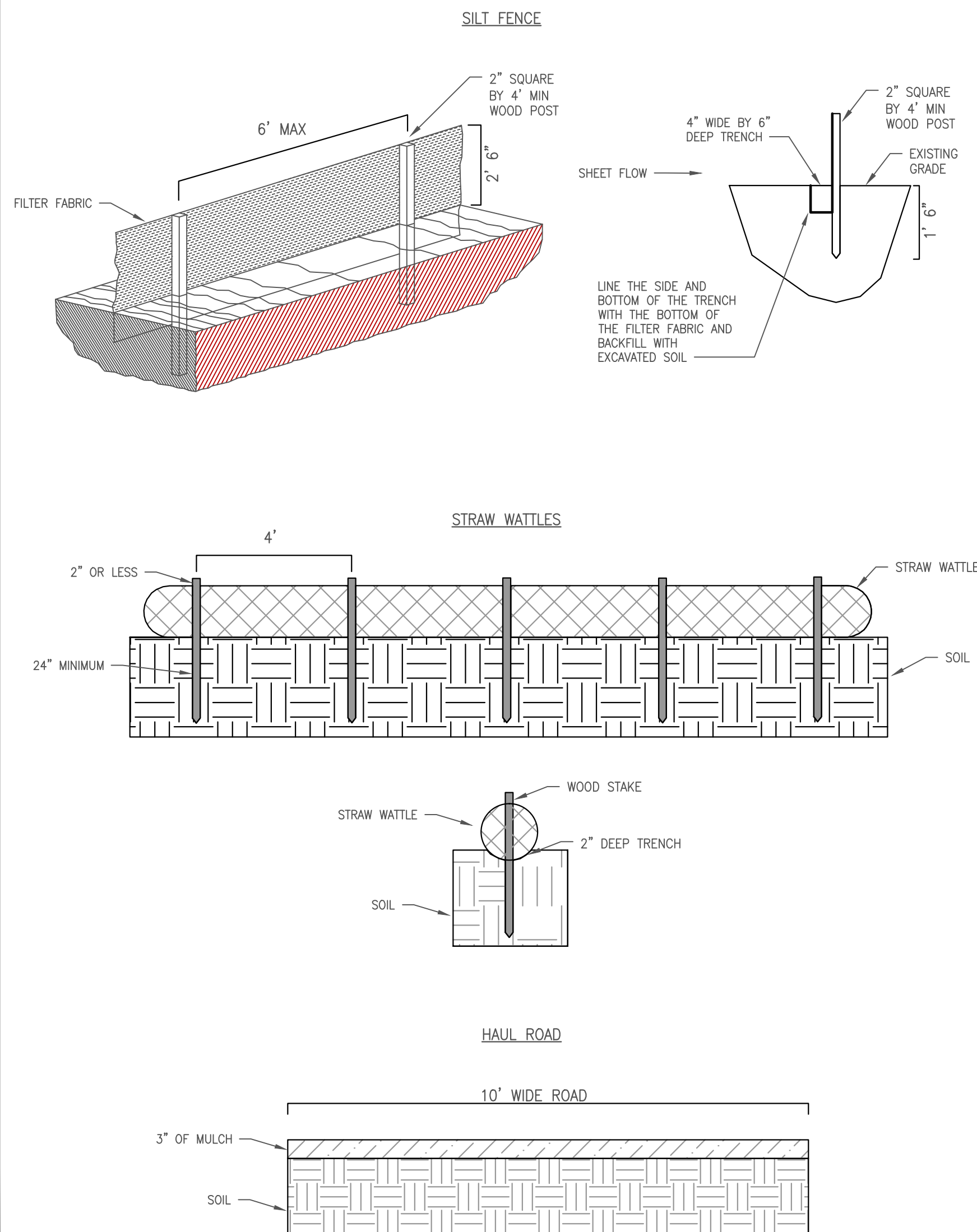
- EXCAVATED AREAS, TEMPORARY ROAD, AND EQUIPMENT STAGING AREAS WILL BE RESTORED TO PRE-EXCAVATION CONDITIONS, UPON WHICH THE DISTURBED AREAS WILL BE REVEGETATED USING A NATIVE SEED MIXTURE IN ACCORDANCE WITH HILL AFB SOP 6, SITE RESTORATION.

HAUL ROAD NOTES

- THE ROADWAY WILL BE COVERED WITH A THREE (3) INCH LAYER OF MULCH TO MINIMIZE DUST GENERATION BY VEHICLE TRAFFIC.
- WATER WILL BE SPRAYED ON THE HAUL ROADS PERIODICALLY TO MINIMIZE DUST GENERATION

SILT FENCE NOTES

- REMOVAL OF SEDIMENT FROM SILT FENCES WILL OCCUR WHEN THE ACCUMULATIONS REACH ONE-HALF THE ABOVE GROUND HEIGHT OF THE FENCE.
- ANY FENCE SECTION WHICH HAS BEEN UNDERMINED OR TOPPED MUST BE IMMEDIATELY REPLACED WITH A ROCK FILTER OUTLET (AS DIRECTED BY THE INSPECTOR IN CHARGE).



HILL AIR FORCE BASE WR111 REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN WEBER COUNTY, UTAH

SITE EROSION AND SEDIMENTATION CONTROLS



Hunt Valley Center
225 Schilling Circle
Hunt Valley, Maryland 21031
(410) 584-7000

DATE	APRIL 2014
DESIGNED BY	SMO
DRAWN BY	SMO
CHECKED BY	GB
PROJECT MANAGER	XXX
PROJECT NUMBER	XXX
DRAWING NUMBER	4-1
SHEET NUMBER	1 OF 1

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5.0 Demonstration of Attainment of Remedial Action Objectives

5.1 Demonstration of Attainment of Cleanup Goals

Excavation of contaminated soils will be performed as described in Section 4.3.1. After excavation and remedial support surveys are completed, the FSS will begin as described in the FSS Plan (Appendix D of the DP [Cabrera 2014]).

Methods to demonstrate the attainment of the cleanup goals include gross gamma surface scanning (GWS) and sample collection. A GWS will be performed over 100 percent of excavation floor and sidewall surfaces (MARSSIM Class 1 areas). Evaluation of the GWS data includes geospatial imaging for visual trend analysis and calculation of count rate Z-scores for identification of distribution outliers. If an adequate GPS signal is not attainable in the deeper parts of the trench, then scan data will be recorded manually on survey sheets. Data will be reviewed for individual data points that exceed the applicable investigation level (i.e., three times the standard deviation of the surface soils and trench soils reference data sets calculated as described in the FSS Plan. The GWS results will be processed and organized and then reviewed by the Data Management Coordinator and evaluated by the Project Health Physicist. The review will combine observation of individual data points that exceed the investigation level with any identifiable spatial patterns or trends that might indicate areas of relatively elevated activity, particularly those that correspond to the areas where historical data indicated contamination within the particular excavation unit. The Health Physics Technician will return to the locations that exceed the investigation level for further investigation, which may include biased sampling.

MARSSIM provides a method to determine the number of measurement locations required in a given SU. A minimum number of measurement locations are required in each SU to obtain sufficient statistical confidence that the conclusions drawn from the measurements are correct. Eighteen samples will be systematically placed within each SU using a triangular grid pattern based on a random starting point. Biased samples will be collected at the areas exhibiting the highest gamma activity in each SU. At least two biased samples will be collected per SU.

Volumetric soil samples will be collected from Site WR111 and the reference area, sent to TestAmerica for analysis, and analyzed in accordance with TestAmerica's standard operating procedure. All soil samples will be analyzed for ^{226}Ra (EPA Method 901.1 modified) and isotopic analysis for ^{230}Th and ^{232}Th (method HASL 300 Modified) (U.S. Department of Energy 1997). A detailed description of the means and methods to be used for sample collection, control, shipping, and analysis is provided in the QAPP (Appendix A).

In accordance with MARSSIM guidance, a preliminary data review will be performed to identify patterns, relationships, and potential anomalies present in the survey data. In this review, basic statistics including the mean, standard deviation, maximum, and minimum values will be calculated for each SU. A graphical review of the data will be performed consisting of posting plots and histograms. Posting plots will be used to review the spatial independence of measurements within SUs, while histograms will be employed to review the overall symmetry of the data.

Once the data have been reviewed, systematic soil sample results for each SU will be compared to the respective DCGL_w . Due to the presence of multiple radionuclides of concern in the soil, the allowed soil concentration levels may be evaluated by employing the SOR. This will ensure that the sum of the

individual fractions for each isotope to its individual $DCGL_w$ fraction does not exceed unity. For every sample location within an SU where the SOR is greater than 1, the SOR_N for that sample location will be calculated. The SOR_N considers the concentration of each radionuclide less its respective background concentration (as established by the reference area soil sample results) divided by the $DCGL_w$ established for the radionuclide.

If the SOR_N results for all samples for an SU are less than 1, then the SU meets the release criteria. If the SOR_N result for any sample in an individual SU is greater than 1, then the SU does not meet the release criteria.

For each biased sample within an SU where individual measurement values exceed the $DCGL_w$ or SOR, a derived concentration guideline level elevated measurement comparison ($DCGL_{EMC}$) is calculated specific to the area represented by the measured activity. The $DCGL_{EMC}$ is the $DCGL_w$ modified using a correction factor (i.e., an area dose factor) to account for the difference in area and the change in dose or risk.

In addition to SOR_N data evaluation, comparison of reference area (background) radionuclide concentrations with SU concentrations will be performed using the two-sample Wilcoxon Rank Sum statistical test. This test is selected because the radionuclides of concern also occur naturally (i.e., background). The two-sample Wilcoxon Rank Sum statistical test assumes the reference area and SU data distributions are similar except for a possible shift in the medians.

When the data are severely skewed, the value for the mean difference between SU measurements and reference measurements may be above the $DCGL_w$, while the median difference is below the $DCGL_w$. In such cases, the SU does not meet the release criterion regardless of the result of the statistical test. On the other hand, if the difference between the largest SU measurement and the smallest reference area measurement is less than the $DCGL_w$, then the Wilcoxon Rank Sum statistical test will always show that the SU meets the release criterion.

5.2 Verification of Final Status Survey Methodology and Implementation

Cabrera will verify the FSS methods and implementation during field work in several different ways. The onsite QC Manager will control quality through the implementation of the three-phase control process for FSS activities as described Section 6.4. An internal QA audit will be performed by the project QA Manager as described in the QAPP. Finally, a field audit will be performed by the Corporate Radiation Safety Officer to ensure that the FSS is being performed in accordance with NRC-approved licensed procedures and approved work plans.

Cabrera will closely coordinate the schedule of FSS activities with the USAF to allow for the performance of verification surveys after Cabrera's FSS is completed. This will most likely be performed after Cabrera completes the FSS, demobilizes from the site awaiting sample results, starts development of the Remedial Action Completion Report and FSS Report, and begins initial data assessment. Verification surveys at Site WR111 will allow the USAF to ensure that the data quality objectives for the FSS have been met, and that the site has met the criteria for unrestricted release.

6.0 Construction Quality Plan

6.1 Purpose of Construction Quality Plan

This section describes the site-specific QC program that will be implemented during decommissioning activities at WR111. The overall QC program for remediation activities associated with the performance-based remediation at Hill AFB is detailed in the Quality Program Plan (EA 2013; includes the Basewide Work Plan and HASP). This site-specific Construction Quality Plan identifies specific methods for inspections, sampling, tests, reporting, and controls necessary to achieve required project quality. This site-specific Construction Quality Plan will ensure that field construction activities are performed in accordance with project objectives and quality standards.

6.2 Required Meetings

Daily and weekly meetings will be held onsite to ensure QC is maintained and project progress is communicated to all project personnel and stakeholders. A detailed description of meetings is provided in Section 4.1.1.

6.3 Organization, Roles, and Responsibilities

Hill AFB, through the USAF Radioisotope Committee, will retain overall responsibility for management and execution of the decommissioning process. EA is responsible for obtaining site closeout to include, but not be limited to, excavation, transport, and disposal of contaminated soil from Site WR111. Management will be provided by EA; health physics and technical support will be provided by Cabrera. Remediation activities will be managed by EA and executed by Cabrera in accordance with the DP (Cabrera 2014). The organization chart for the project is included in the DP. Decommissioning tasks will be performed in accordance with the schedule presented in Worksheet #16 of the QAPP (Appendix A).

6.4 Quality Control Procedures and Methods

6.4.1 Three-Phase Control System

The QC Manager is responsible for verifying compliance with this Construction Quality Plan through implementation of the three-phase control process for each definable feature of work listed in Section 6.4.3, regardless of whether they are performed by EA, Cabrera, or its subcontractors. This section specifies the minimum requirements that must be met and to what extent QC monitoring must be conducted by the QC Manager and QC staff. Each control phase is important for obtaining a quality product. However, the preparatory and initial inspections are particularly invaluable in preventing problems. Production work is not to be performed on a definable feature of work until a successful preparatory phase inspection has been completed.

The three-phase control system consists of:

- Preparatory Phase Inspection
- Initial Phase Inspection
- Follow-up Phase Inspection.

These phases are described in the following subsections and will be performed for each definable feature of work. A definable feature of work is a task, which is separate and distinct from other tasks and has separate control requirements. Checklists for the Preparatory and Initial Phases will be included with the DQCR prepared by the QC Manager.

6.4.1.1 Preparatory Phase Inspection

The QC Manager or designee will perform a Preparatory Phase Inspection prior to beginning each definable feature of work. The purpose of this inspection is to verify that the necessary resources, conditions, and controls are in place and compliant before the start of work activities. Each control phase is important for obtaining a quality product. However, the Preparatory and Initial Phase inspections are particularly invaluable in preventing problems. Production work is not to be performed on a definable feature of work until a successful Preparatory Phase Inspection has been completed.

The Preparatory Phase Inspection will consist of:

- Review specifications, plans, and drawings to ensure all work is expected to proceed with requirements
- Review the contract/task order plans
- Check to ensure that all materials and/or equipment have been tested, submitted, and approved
- Check to ensure that provisions have been made for QC inspection and testing
- Examine the work area to ensure that all required preliminary work has been completed and is in compliance with the contract
- Review the appropriate activity hazard analysis to ensure that safety requirements are met
- Review procedures for conducting the work, including elimination of repetitive deficiencies; this will also serve to document tolerances and workmanship standards for the phase of work
- Check to ensure that AFCEC and Hill AFB have accepted the site-specific Quality Program Plan under which work will be performed.

6.4.1.2 Initial Phase Inspection

The QC Manager or designee is to perform an Initial Phase Inspection the first time a definable feature of work is performed. The purpose of this inspection is to:

- Review a checklist of preliminary work to ensure that it is in compliance with contract and individual task order requirements
- Review minutes of the preparatory meeting
- Establish required levels of workmanship, and verify that they meet minimum acceptable workmanship standards

- Verify current HASP to include compliance with and upgrading of the safety plan and activity hazard analysis; review the activity analysis with each worker
- Discuss and resolve all differences
- Document QC actions during all construction activities.

6.4.1.3 Follow-Up Phase Inspection

The QC Manager or designee will perform the Follow-up Phase Inspections during the performance of a definable feature of work. The purpose is to provide continuous compliance and level of workmanship. The QC Manager or designee is responsible for onsite monitoring of the practices and operations taking place, and for verifying continued compliance with contract requirements until the completion of each definable feature of work. Discrepancies between site practices and approved procedures are to be resolved and corrective actions for unsatisfactory and nonconforming conditions or practices are to be verified by the QC Manager or his designee prior to granting approval to continue work. Follow-up Phase Inspection results are to be summarized in the DQCR.

The Follow-up Phase Inspection covers the day-to-day activities at the site, including:

- Perform daily checks to ensure compliance
- Document checks in daily QC reports
- Correct any deficiencies and perform final follow-up checks prior to starting new task
- Develop punch list items that do not conform to plans and specifications
- Estimate timeframe to correct deficiencies
- Perform final completion inspection prior to notifying customer of final product.

6.4.2 Testing

Testing is to be performed to characterize materials, work-in-progress, and completed work to confirm that requirements are met. Testing in support of the remediation at Site WR111 is detailed in the DP (EA/Cabrera 2014), the RPP (Appendix C), and the Site-Specific Addendum to the HASP (Appendix B). These plans describe specific testing and QC procedures for air, environmental, soil, and waste sampling at the Site for both personnel safety and field remediation purposes. The FSS Plan (Appendix D of the DP) contains the testing requirements for the limits of excavation and surrounding soils at Site WR111 to ensure compliance with the applicable release criteria (DCGL_{WS}) for the site.

6.4.3 Definable Features of Work

The definable features of work consist of individual tasks that together comprise each distinct component. The grouping of individual tasks associated with each definable feature of work was established to create the QC requirements for implementation of the three-phase inspection process.

The following presents a listing of the definable features of work at the Site:

- **Site Mobilization/Demobilization**—This activity will include mobilizing/demobilizing all labor, materials, and equipment necessary to perform the work onsite in a timely manner in order to support the schedule. The first demobilization will occur after contaminated soils are shipped offsite for disposal, FSS activities are completed, and samples have been shipped offsite for analysis. A second mobilization/demobilization will occur after approval to backfill and restore the Site is received from Hill AFB and USAF Radioisotope Committee.
- **Site Preparation**—Activities include delineation of work zones, staging areas, and setup of equipment, calibration, and initial QC checks of instrumentation and instrument systems. It will also include installation of temporary facilities such as trailers, offices, utilities, consumable materials, and other support equipment and setup of provisions for security and communications. Temporary facilities and controls will be established and maintained, including temporary barriers (a combination of traffic cones, grade stakes, and caution tape, rope, and/or fencing) around the work area, potable water for use in dust suppression, setup of a temporary staging for soils, and setup of spill kits (including absorbent booms and pads) for use in responding to a hydraulic or diesel oil leak from construction equipment used on the project.
- **Soil Remediation**—Soil remediation of the WR111 trench soils will be performed as necessary. Contaminated soils will be transported to a laydown stockpile area using a front end loader. The adequacy of remedial efforts will be confirmed by remedial support surveys, consisting of gross gamma activity scans.
- **Final Status Survey**—FSS sampling will be performed following remediation of contaminated soils. This task will be performed within the excavation to ensure there is no residual radiological contamination above DCGL_{ws} after the remediation. The FSS will be performed in accordance with MARSSIM (NRC 2000).
- **Waste Transportation and Disposal**—Stockpiled contaminated soils will be loaded into trucks using a front-end loader with a bucket scale and transported to US Ecology in Grand View, Idaho.
- **Backfilling and Site Restoration**—The excavated area will be backfilled with layback soils from the site and clean material from an offsite source. The area will be re-graded and re-seeded to restore the area to pre-remediation conditions.
- **Decontamination of Equipment**—This task consists of the decontamination and radiological surveys of potentially contaminated equipment and materials prior to removing from the controlled areas for disposition.

6.5 Submittals, Documentation, Notification of Non-Compliance

6.5.1 Submittals

EA's QC team is responsible for certifying that all submittals are in compliance with the contract requirements and for assuring that all certifications provided by others (e.g., subcontractor work plans, equipment and material, vendors, or suppliers) are accurate and in compliance with contract requirements. The QC team will stress the importance of timely and accurate submittals as fundamental to the successful completion of the project, and ensure that such submittals are in full compliance with the contract.

Any variations from specified materials will be described, identified, and justified in the transmittal package. Work on a discrete phase of the project will not be started until approved submittals are received. The Program QA/QC Officer is responsible for ensuring, through detailed review, that field QC submittals, as well as the materials and work they represent, are compliant with applicable contractual specifications and project plans. The Field Team Leader will ensure that the specified materials are in accordance with work plan requirements, and request clarification whenever necessary.

6.5.2 Documentation

The EA Team will maintain a record of QC operations, activities, and tests performed, including the work of subcontractors and suppliers. These records will be maintained on an acceptable form and will include factual evidence that the required QC activities and/or tests have been performed.

At the conclusion of each work day, field forms, site activity notes, and inspection forms will be collected and reviewed. The Field Team Leader will determine if follow-up actions are required and will ensure they are completed. Daily records will be retained for the duration of the project.

Field personnel will maintain QC logbook(s) that summarize field QC inspections. These logbooks will document compliance with the work plan and specify workmanship acceptability.

Any equipment test, maintenance, or calibration task will be documented in a field logbook by the individual performing the task. Testing and maintenance of equipment will be performed per the manufacturer's specifications, the Quality Program Plan, and applicable standard operating procedures.

6.5.2.1 Daily Quality Control Reports

Cabrera will maintain daily records and submit reports of QC activities daily via DQCRs. The reports will contain information on the contractor's daily QC activities and resulting actions. The reports will be submitted to the Hill AFB Project Manager on the DQCR form by the end of the next workday following the day covered by the report.

The report shall contain a record of activities related to the three-phase QC system. Separate reports for different phases of work may be submitted by the QC Manager or the reports may be consolidated into one report if all QC activities and results are covered and the responsible QC personnel are identified. In all cases, the report or reports will be verified and signed by the QC Manager. The verification will contain the statement that all supplies and materials incorporated in the work are in compliance with the terms of the contract except as noted.

The reports will include the following:

- Phase or phases of remediation underway during the time of the report, including a listing of equipment and personnel onsite and hours worked
- QC activities that were performed
- Results of QC activities, including nature of deficiencies observed and corrective actions taken or to be taken
- Photo-documentation – photography will be used to record pre-remediation conditions, post-remediation conditions, and key activities that occur during the course of remediation

- Documentation of samples collected, including samples for chemical and radiological analysis
- Quantity of materials received and statement as to acceptability and storage
- Quantity of waste material characterized, containerized, loaded, and stored or shipped
- Submittals reviewed, by whom, and action taken
- Other information as applicable to the project, including:
 - Weather conditions
 - Subcontractor operations
 - Monitoring materials and equipment upon arrival onsite for compliance with work plans, damage during transit, and proper storage.

6.5.3 Notification of Non-Compliance

AFCEC and/or Hill AFB will notify EA of any detected non-compliance with the foregoing requirements. After the receipt of such notice, EA will immediately take corrective action. Such notice, when delivered at the site of the work, will be deemed sufficient for the purpose of notification. If EA fails or refuses to comply promptly, it is understood that AFCEC or Hill AFB may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop work orders will be made the subject of a claim for an extension of time, excess costs, or damages by EA.

6.6 Project Schedule

It is anticipated that field activities covered under this RD/RAWP will be conducted in September 2014. The anticipated duration of the field effort is 45 calendar days. This schedule is contingent upon stakeholder (including NRC) document review timeframes for this RD/RAWP, which are estimated in the project schedule presented in Worksheet #16 of the QAPP (Appendix A).

7.0 References

- AECOM. 2009. *Radiological Disposal Site Characterization for Little Mountain Training Annex*. AECOM. November.
- Cabrera Services, Inc. (Cabrera). 2007. *Cabrera Services Health and Safety Manual*.
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Appendix A
Site-Specific Supplemental
Quality Assurance Project Plan

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Hill Air Force Base Performance-Based Remediation

WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Site-Specific Supplemental Quality Assurance Project Plan

Hill Air Force Base
Contract No: FA8903-09-D-8560
Task Order 0006

Prepared for:
Air Force Civil Engineer Center
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JBSA Lackland Air Force Base, Texas 78236-9853

Prepared by:
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and



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RADIOLOGICAL • ENGINEERING • REMEDIATION

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AUGUST 2014

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A	Standard Operating Procedures
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Acronyms and Abbreviations

AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AF RIC	Air Force Radioisotope Committee
bgs	Below ground surface
Cabrera	Cabrera Services, Inc.
CHP	Certified Health Physicist
CIH	Certified Industrial Hygienist
CSP	Certified Safety Professional
DCGL	Derived concentration guideline level
DL	Detection Limit
DP	Decommissioning Plan
DQO	Data Quality Objective
DRO	Diesel range organics
EA	EA Engineering, Science, and Technology, Inc.
EML	Environmental Measurements Laboratory
EPA	U.S. Environmental Protection Agency
FSS	Final Status Survey
ft	Foot (feet)
GRO	Gasoline range organics
GWS	Gamma walkover survey
HASL	Health and Safety Laboratory
JBSA	Joint Base San Antonio
LMTA	Little Mountain Test Annex
LOQ	Limit of quantitation
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum detectable concentration
NRC	Nuclear Regulatory Commission
OP	Operating procedure
OSHA	Occupational Safety and Health Administration
Parsons	Parsons Infrastructure and Technology Group, Inc.
PBR	Performance-based remediation
pCi/g	PicoCuries per gram
P.E.	Professional Engineer
P.G.	Professional Geologist

Ph.D.	Doctor of Philosophy
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
QL	Quantitation Limit
QPP	Quality Program Plan
²²⁶ Ra	radium-226
RD/RAWP	Remedial Design/Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
SOP	Standard operating procedure
SU	Survey unit
²³⁰ Th	Thorium-230
²³² Th	Thorium-232
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total petroleum hydrocarbons
UDEQ	Utah Department of Environmental Quality
UFP	Uniform Federal Policy
USAF	U.S. Air Force
VOC	Volatile organic compound

1.0 Introduction

This Site-Specific Supplemental Quality Assurance Project Plan (QAPP) was developed by EA Engineering, Science, and Technology, Inc. (EA) and Cabrera Services, Inc. (Cabrera) to support performance-based remediation (PBR) services at the Little Mountain Test Annex (LMTA) Magnesium-Thorium Disposal Trench Site (Site WR111), under the Hill Air Force Base (AFB) PBR Contract No. FA8903-09-D-8560, Task Order 0006. This QAPP, which was prepared under Sub-Contract Line Item Number 0009BN, provides the sampling and analysis procedures and rationale for the remedial design/remedial action of trench soils at Site WR111. The remedial action work at the site is governed by the site-specific Remedial Design/Remedial Action Work Plan (RD/RAWP), to which this QAPP is appended.

1.1 Plan Organization

This QAPP outlines the policies, organization, and specific quality assurance (QA)/quality control (QC) measures associated with the collection, analysis, and reporting of data collected in support of the remedial actions to achieve the data quality goals. This document meets the requirements and elements set forth in the Intergovernmental Data Quality Task Force Uniform Federal Policy (UFP) for QAPPs (U.S. Environmental Protection Agency [EPA] 2005). The EPA format for combined QAPP worksheets immediately follows this introduction (EPA 2012). This QAPP will be used in conjunction with the Quality Program Plan (QPP) for PBR (<http://www.hafbdydocs.com>). This QAPP is parallel to Attachment 2 of the QPP PBR, Basewide PBR Work Plan, and provides site-specific information unique to this project. Attachment 2 of the QPP for the PBR has been prepared to consistently address information applicable to multiple sites at Hill AFB. Appendix B of the Work Plan is an Addendum Health and Safety Plan to the QPP Attachment 1, Health and Safety Plan. Table 1 details information related to logistics and communications for the work planned for this site. Table 2 lists the combined 37 QAPP worksheets and whether they have been designated as general with full details included in Attachment 2 of the QPP PBR or site-specific with additional or clarifying information included in this QAPP. References used in the preparation of this QAPP are provided in Section 3.0. Standard operating procedures (SOPs) describing the means and methods for collection and analysis of samples, as well as pertinent analytical laboratory information, are provided in Attachment A.

1.2 Background

Site WR111 is located within the LMTA, which is approximately 15 miles northwest of Hill AFB and adjacent to the Great Salt Lake (Figure 1-1 of the RD/RAWP). The disposal trench is approximately 200 × 150 feet (ft) in area and is enclosed by a chain-link fence in the southeastern corner of the LMTA (Figure 1-2 of the RD/RAWP).

Historical information indicates that magnesium-thorium scrap and waste materials associated with the manufacture of controls, accessories, and engine parts were burned/buried in the disposal trench from 1959 through 1961. Results of a recent investigation at the site (2007-2009) indicate that site soils within the fenced area have been impacted with thorium-232 (^{232}Th) and decay progeny above background levels (AECOM 2009). A supplemental characterization survey performed in 2013 (EA/Cabrera 2014) confirmed that radiological contamination extended to the east of the Site WR111 fenceline, and identified two additional radionuclides (radium-226 [^{226}Ra] and thorium-230 [^{230}Th]) of concern for the site. Results of groundwater sampling that was conducted in 2006 indicate that there are no radiological impacts to groundwater from the thorium alloy scrap metal or potential cutting oil (Parsons Infrastructure

and Technology Group, Inc. [Parsons] 2007). A detailed discussion of the radionuclides of concern for Site WR111 is provided in Section 2.3 of the RD/RAWP.

Sampling for chemical constituents has also been conducted at Site WR111. Results from the 2007-2009 investigation showed that no volatile organic compounds (VOCs) or semivolatile organic compounds were detected above reportable limits in soil (AECOM 2009). In addition, during the 2013 supplemental survey by EA/Cabrera, soil sampling was conducted to assess hazardous waste characteristics and support selection of an appropriate offsite disposal facility.

1.3 Objectives and Approach

The performance objective for the site is to obtain site closeout by 2015. Decommissioning activities at Site WR111 will be conducted in coordination with the Nuclear Regulatory Commission (NRC) via the U.S. Air Force (USAF) Radioisotope Committee and the approved Decommissioning Plan (DP) (EA/Cabrera 2014).

It is anticipated that the following general tasks will be completed to achieve site closeout with no land use controls to address the radioactive impact in soil at the site:

- Development of a RD/RAWP for review and regulatory approval by the USAF in coordination with the USAF Radioisotope Committee
- Excavation of impacted soil, in accordance with the remedial action objectives, and offsite disposal at a facility that is licensed to accept the material
- Completion of a Final Status Survey (FSS), in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC 2000), to document that the remedial action objectives have been met
- Completion of site restoration, abandonment of four groundwater monitoring wells (proximal and associated with Site WR111), and removal of the existing fencing around the site
- Preparation of a Site Closeout Report (with FSS Report) for review and regulatory approval by the USAF in coordination with the USAF Radioisotope Committee.

This QAPP has been prepared to support the second and third tasks for this site: excavation of contaminated soils and an FSS. This QAPP documents the project organization, specific procedures for execution of the work, QC, and assessment and oversight planning. For the work activities identified in this QAPP, the performance metrics to be followed to ensure that site closeout criteria will be met include following Comprehensive Environmental Response, Compensation, and Liability Act and MARSSIM (NRC 2000) guidance. Radiological and chemical data will be compared to the project action limits specified in Section 2.0, Worksheet #15.

1.4 Activities

Activities to be performed to meet the objectives described in this QAPP include the following:

1. Pre-mobilization activities, including obtaining permits, making appropriate notifications, and securing an approved waste profile from the chosen offsite disposal facility for the radioactive material that will be removed from the site during remedial action activities
2. Mobilization and site preparation, including establishing temporary facilities, services, and site controls to facilitate field remediation; administering onsite radiation worker training as needed; ensuring worker and public safety as well as environmental protection; and setting up and calibrating an onsite radiological instrumentation for the project
3. Excavating contaminated soils
4. Waste loading, transportation, and offsite disposal
5. Performing an FSS, including gross gamma activity scanning and soil sample collection and analysis, to confirm that project cleanup goals (e.g., derived concentration guideline levels [DCGLs]) have been met at the limits of excavation in accordance with the NRC MARSSIM (NRC 2000) for radionuclides of concern for Site WR111
6. Backfilling the remediated excavations, site restoration, and demobilization.

Upon completion of data evaluation activities, a Remedial Action Completion Report, including an FSS Report, will be prepared that outlines the work described above to support a finding of site closeout.

Based on results of supplemental survey and sampling activities in 2013, it is anticipated that the excavation will be conducted within the LMTA fenceline (Figure 1-3 of the RD/RAWP). The LMTA fenceline is approximately 70 ft to the east of the Site WR111 boundary. The adjacent property to the east is owned by Weber County. Given the remoteness of the site, no impacts to traffic (traffic closures or rerouting) are anticipated.

1.5 Communications Plan

A summary table showing logistics and communication considerations that were evaluated for work to be conducted at Site WR111 is provided in Table 1. Base access passes will be obtained for field personnel. Requests for passes to work at Site WR111 (an uncontrolled area) and Air Force Materiel Command Form 496 shall be submitted to Hill AFB no less than 3 business days prior to the date site access is needed. Personnel driving on Base shall also obtain a vehicle pass, which will be procured by submitting Air Force Materiel Command Form 387. Permits, clearances, and notifications are also described in detail in Section 4.1.5 of the RD/RAWP.

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TABLE 1

Potential Site-Specific Logistics and Communications Checklist

WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Site-Specific Supplemental Quality Assurance Project Plan, Hill Air Force Base, Utah

Logistics Consideration	Applicable?⁽¹⁾	Type	General Comments	Basewide QAPP Reference⁽²⁾
Permits	Yes	Excavation	Many existing systems are operating under permits. Permit requirements must be considered during implementation of site work. Monitoring well permits must be obtained from the Utah Department of Natural Resources/Division of Water Resources for wells greater than 30 feet deep.	See Basewide QAPP SOP 1 Site Access 9.0
Base Access and Access Passes	Yes	Security passes – Base access passes	Required for all on-Base work.	See Basewide QAPP SOP 1 Site Access 4.1
	No	Line badges	Required if work to be done in controlled areas. Request no less than 30 days in advance.	See Basewide QAPP SOP 1 Site Access 4.2
	No	Area access	Coordinate with Base Point-of-Contact to determine if there are physical restrictions to gaining access to the site or site sampling locations (e.g., gated areas, locked wells, etc.). OU 3: ST004 – Site is located in industrial area under a parking lot. OU 3: WP005 – Site is located in industrial area under ramp, parking lots, etc. OU 7: SS027 – Site is within an active production facility. OU 8: OT033 – Access to certain areas restricted by buildings and the flight line. BP504 – Access to the site requires coordination with 649 MUNS/MXWKA and is through a locked gate. Indoor Air Program – Coordination with shops in the industrial area is required to access the various affected buildings on-Base.	
Government Employee Escort	No	Escort for high security areas	Base security escorts may be required to perform work in some security-restricted areas of the Base. The contractor must coordinate through Base Point-of-Contact for escort. Includes, but not limited to all industrial area buildings, MAMS I and MAMS II (OU 6).	

TABLE 1

Potential Site-Specific Logistics and Communications Checklist

WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Site-Specific Supplemental Quality Assurance Project Plan, Hill Air Force Base, Utah

Logistics Consideration	Applicable?⁽¹⁾	Type	General Comments	Basewide QAPP Reference⁽²⁾
Flight Line Clearance	No		Flight line includes runway, all taxiways, ramps and aprons, hot pads, hangars, and airfield roadways. Separate, specific flight line badges/passess may be required to access and work in these areas. Flight line construction waivers (may require a 30- to 60-day review) may be required for performing work within the flight line. OU 8: OT033 – Access to certain areas restricted by buildings and the flight line. OU 9: SD034 – Site is within the flight line and requires a flight line waiver.	See Basewide QAPP SOP 1 Site Access 6.0
Off-Base Access Agreements	No		Valid access agreement must be in place before work can take place on property not owned by the Base. OU 1: LF001, WP002 – Easements/access agreements in place for off-Base plume monitoring wells. No current access agreement for private property directly north of the extraction trench system. OU 4: LF011 – Some site wells located off-Base. Current agreements for access to wells are in place. OU 5: SS017 – Both systems for the site are off-Base. Site impacted by Enhanced Use Lease. OU 6: ST022, ST026 – Some site wells located off-Base. Current agreements for access to wells are in place. Indoor Air Program – All affected properties located off-Base require access from individual homeowners. OU 9: SS089 – Access to Interstate 15 and Main Street in Roy.	
Communications Plan	Yes	LMTA personnel will be notified of work to be conducted	If work affects off-Base property owners, owners must be made aware in advance of the activity. If work occurs on-Base in an active area, Base personnel affected must be notified in advance of the activity. If EA is contacted by public, property owners, or on-Base personnel (beyond AFCEC and AFCEC-led communications) EA will notify AFCEC and update the contacts database.	
Adjusted Work Schedule	No	Weekend/after regular business hours	Work to be performed near active Base operations may require an adjusted work schedule to accommodate Base activities. Activities must be coordinated with affected Base personnel through the performance-based remediation Base Point-of-Contact. SR502 – Access to the site is restricted to when the indoor range is not being used and must be coordinated with 75 SFS/S4C.	

TABLE 1

Potential Site-Specific Logistics and Communications Checklist

WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Site-Specific Supplemental Quality Assurance Project Plan, Hill Air Force Base, Utah

Logistics Consideration	Applicable?⁽¹⁾	Type	General Comments	Basewide QAPP Reference⁽²⁾
Construction/332 Process	Yes		Required for most construction, modification, installation, and repair projects. If needed, must be submitted no less than 30 days in advance of start of work.	
Review by 75 CES Abatement Section	No		Required for asbestos-related work. Allow minimum of 10 working days for review.	
Coordination/Approval by 75 CES Pest Management Office	No		Required if pesticides are to be used. Allow minimum of 10 working days in advance of the activity.	
Impedance/ Hindering of Traffic	No	On-Base	For any work where traffic, especially emergency vehicles, will be hindered or impeded. This includes closures of parking lots, in part or whole. Base Site Managers must submit Outages form. This is done during or immediately after the 332 process.	See Basewide QAPP SOP 1 Site Access 10.0
	No	Off-Base	Utah Department of Transportation permits required for road/lane closures for all work conducted on designated highways or shoulder areas of designated highways. OU5: SS017 – Work on aeration curtain requires lane restrictions on a major road and coordination with Utah Department of Transportation.	
Utility Location and Clearance	Yes	Red Stakes (On-Base)	Permits for drilling or excavation activities on-Base. Base Site Managers must submit request for clearance. This is done during or immediately after the 332 process. Clearance is valid for 30 days but can be extended.	See Basewide QAPP SOP 1 Site Access 7.0
	No	Blue Stakes (Off-Base)	For planned work off-Base. Central location for notification to multiple utility companies. Permits must be obtained by subcontractor who is physically performing the work. Notification required at least 2 days, but no more than 7 days, in advance of work.	See Basewide QAPP SOP 1 Site Access 8.0
Utility Connections and Outages	No		All electrical modifications/connections must be reviewed by the 75 CES Infrastructure Flight. Allow minimum of 10 working days for electrical review. Request shall contain:	

TABLE 1

Potential Site-Specific Logistics and Communications Checklist

WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Site-Specific Supplemental Quality Assurance Project Plan, Hill Air Force Base, Utah

Logistics Consideration	Applicable?⁽¹⁾	Type	General Comments	Basewide QAPP Reference⁽²⁾
			<ul style="list-style-type: none"> • Name of contractor • Requested date and time for shutdown • Duration of shutdown • Buildings or parts of buildings affected • Utilities affected. 	
Work in High Visibility/Use Areas	No		Hill AFB Point-of-Contact must be notified prior to conducting intrusive work.	
Union Notification	Yes		Check with Base contacts if this applies to work at a specific site. Linda Telford is the Labor Relations contact at Hill AFB and acts as the liaison with the union. Union notification is included in the 332 process. Indoor Air Program – Coordination with the union is required to access the various affected buildings on-Base.	
Hazardous Materials	No		For hazardous materials brought onto Base, registration is required with the Hill AFB Hazardous Material Management System. Check with Base for additional reporting requirements.	
Hazardous Waste	No		<p>Hazardous waste disposal documentation must be provided to Contracting Officer's Representative and/or Base Point-of-Contact.</p> <p>Additional federal, state, local, and Base requirements for tasks involving transportation of radiological waste, hazardous wastes, and/or contaminated materials to offsite treatment, storage, and/or disposal facilities.</p>	
Fire Department Clearance (Air Force Form 592 U.S. Air Force Welding, Cutting, or Brazing Permit)	No		<p>Work that requires welding, cutting, brazing, or other "hot work."</p> <p>Hill AFB Fire Department to be notified no less than 24 hours prior to hot work in hazardous environments. Personnel performing work must have completed annual Fire Safety Training class.</p>	See Basewide QAPP SOP 1 Site Access 5.0

NOTES:

(1) Add a "Y" to the column if the logistics concern is applicable to the site discussed in this QAPP.

(2) Basewide Quality Assurance Project Plan. This document is available as a Hill AFB Environmental Restoration Dynamic Document at the following location: <http://www.hafbdydocs.com>.

AFB = Air Force Base.

AFCEC = Air Force Civil Engineer Center.

MAMS = Munitions and Missile Storage

OU = Operable Unit.

QAPP = Quality Assurance Project Plan.

SOP = Standard Operating Procedure.

TABLE 2

Uniform Federal Policy-Quality Assurance Project Plan Worksheet Summary

WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Site-Specific Supplemental Quality Assurance Project Plan, Hill Air Force Base, Utah

Worksheet No.	Worksheet Title	Worksheet Types Generic vs. Site Specific	Location
1 and 2	Title and Approval Page	Generic and site specific	Attached worksheet
3 and 5	Project Organization and Quality Assurance Project Plan Distribution	Generic and site specific	Attached worksheet
4, 7, and 8	Personnel Qualifications and Sign-Off Sheet	Generic and site specific	Attached worksheet
6	Communication Pathways	Generic	Attached Worksheet
9	Project Planning Session Summary	Site specific	Attached worksheet
10	Conceptual Site Model	Site specific	Attached worksheet
11	Project/Data Quality Objectives	Site specific	Attached worksheet
12	Measurement Performance Criteria	Generic	Attached Worksheet
13	Secondary Data Uses and Limitations	Site specific	Attached worksheet
14 and 16	Project Tasks and Schedule	Site specific	Attached worksheet
15	Project Action Limits and Laboratory-Specific Detections/Quantitation Limits	Site specific	Attached worksheet
17	Sample Design and Rationale	Site specific	Attached worksheet
18	Sampling Locations and Methods	Site specific	Attached worksheet
19 and 30	Sample Containers, Preservation, and Hold Times	Site specific	Attached worksheet
20	Field Quality Control Summary	Site specific	Attached worksheet
21	Field Standard Operating Procedures	Site specific	Attached worksheet
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	Generic and Site specific	Attached worksheet
23	Analytical Standard Operating Procedures	Generic and Site specific	Attached Worksheet
24	Analytical Instrument Calibration	Generic and Site specific	Attached Worksheet
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	Generic and Site specific	Attached Worksheet
26 and 27	Sample Handling, Custody, and Disposal	Generic	Attachment 2 of the QPP PBR (www.hafbdyndocs.com)
28	Analytical Quality Control and Corrective Action	Generic	Attachment 2 of the QPP PBR (www.hafbdyndocs.com)
29	Project Documents and Records	Generic	Attachment 2 of the QPP PBR (www.hafbdyndocs.com)
31, 32, and 33	Assessments and Corrective Action	Generic	Attachment 2 of the QPP PBR (www.hafbdyndocs.com)
34	Data Verification and Validation Inputs	Generic	Attachment 2 of the QPP PBR (www.hafbdyndocs.com)
35	Data Verification Procedures	Generic	Attachment 2 of the QPP PBR (www.hafbdyndocs.com)
36	Data Validation Procedures	Generic and Site Specific	Attached Worksheet
37	Data Usability Assessment	Generic	Attachment 2 of the QPP PBR (www.hafbdyndocs.com)

NOTE:

PBR = Performance-based remediation.

QPP = Quality Program Plan.

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2.0 Quality Assurance Project Plan Worksheets

This section documents the project organization, specific procedures for execution of the work, QC protocols, and the assessment and oversight planning that will help ensure the quality of the investigation. The format follows the current UFP Guidance for QAPPs (EPA 2005) and optimizes the original 37 worksheets into 28 worksheets (EPA 2012). As noted in Section 1.0 and Table 2, this QAPP includes worksheets that contain site-specific information not included in Attachment 2 of the QPP PBR (Basewide PBR Work Plan) (www.hafbdydocs.com).

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QAPP Worksheets #1 and #2

Title and Approval Page

Document Title: Site-Specific Supplemental QAPP, WR111 LMTA Magnesium-Thorium Disposal Trench Site

Site Name/Project Name: WR111 LMTA Magnesium-Thorium Disposal Trench Site

Site Location: Hill AFB, Utah

Contract: FA8903-09-D-8560-0006

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gbright@cabreraservices.com

Preparation Date (Month/Year): May 2014

Lead Organization: Air Force Civil Engineer Center (AFCEC)

AFCEC Contracting Officer Representative: Adria Bodour, PhD

Hill AFB Site Manager: Kyle Gorder

Regulatory Program: Nuclear Regulatory Commission (NRC) via Air Force Radioisotope Committee (AF RIC)

Regulatory Contact: Dr. Ramachandra Bhat (AF RIC)

State Regulatory Contact: N/A

PBR Contractor Affiliation: EA Team: Cabrera

Document Control Numbering System: Not required for this project

QA/QC Contact: Frank Barranco, PhD, P.G., P.E./EA

The Work Plan is (select one): ☐ Generic ☒ Site-Specific

List dates and titles of documents written for previous site work, if applicable:

Title	Date	Author/Organization
Final Field Sampling Plan Little Mountain Radiological Disposal Sites Characterization	May 2008	AECOM
Final Work Plan Supplemental Site Characterization WR111 LMTA Magnesium-Thorium Disposal Trench	June 2013	EA/Cabrera
WR111 LMTA Magnesium-Thorium Disposal Trench DP	Currently being finalized	EA/Cabrera

Project Organization and Quality Assurance Project Plan Distribution



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QAPP Worksheets #4, #7, and #8

Personnel Qualifications and Sign-Off Sheet

The qualifications of AFCEC and Hill AFB personnel are under the purview of the Department of Defense and will not be outlined in this QAPP. In addition, state and federal stakeholders' qualifications are under the purview of their respective agencies and will not be presented in this QAPP. The table below summarizes the responsibilities and provides a space for the signatures of personnel key to this QAPP; information for overall PBR contract personnel (e.g., Program Manager, Senior Project Manager, Deputy Senior Project Manager, Program Chemist, etc.) is presented in the Attachment 2 of the QPP PBR (www.hafbdydocs.com). Signatures below indicate personnel have read and agree to implement this QAPP as written.

Organization: EA, Cabrera

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Sandy Staigerwald	EA Senior Project Manager	>20 years of experience in project management	• Project Manager Professional	
Amy Sponaugle	EA Site Project Manager	>13 years of experience in project management	• Professional Engineer (P.E.), Certified Hazardous Materials Manager	
Brenda Nuding	EA Project Chemist	>10 years of experience in chemistry	• Data Quality Objectives training	
Tony Mason	Cabrera Project Certified Health Physicist	>25 years of experience in environmental health physics	• Certified Health Physicist (CHP)	
Greg Bright	Cabrera Project Manager	>4 years of experience in project management	<ul style="list-style-type: none"> • Radiation Worker Training • 40-Hour Occupational Safety and Health Administration (OSHA) Training • 8-Hour OSHA Supervisor Training • First Aid 	
Mike Plonski	Cabrera Project Health Physicist	>10 years of experience in health physics field support		
Wade Fillingame	Cabrera Site Manager	> 20 years of experience in field management and remediation activities		
Stephan Owe	Cabrera Site Safety and Health Officer	> 5 years of experience in field management and safety		
Mahmud Rahman	Cabrera Data Manager	5 years of experience in QA/QC	• Radiation Worker Training	

Organization: TestAmerica St. Louis

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Elaine Walker	Offsite Laboratory Manager (TestAmerica)	On file with Laboratory Human Resources	On file with Laboratory Human Resources	

Organization: ALS Global

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Julie Ellingson	Offsite Laboratory Project Manager (ALS Environmental)	On file with Laboratory Human Resources	On file with Laboratory Human Resources	

QAPP Worksheet #6

Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Modifications to Contract	AFCEC Contracting Officer	Arturo Castro	(210) 395-8764	Coordinate with Contracting Officer's Representative to execute contract modifications.
Modifications to Program	AFCEC Contracting Officer's Representative	Adria Bodour	(210) 395-8426	Primary point-of-contact for AFCEC for programmatic information, coordination issues, and reports. Coordinate with Contracting Officer and EA Senior Project Manager.
Programmatic Coordination and Significant Corrective Actions	Hill AFB Task Order Manager	Dr. Barbara Hall	(801) 777-0493	Coordinate programmatic direction and issue resolution for all projects at Hill AFB.
	Hill AFB Radiation Safety Officer	Allen Kidner	(801) 586-6090	Provide technical review of project documents and interface with USAF Radioisotope Committee.
	Hill AFB Site Project Manager	Kyle Gorder	(801) 775-2559	Coordinate field work, programmatic direction and issue resolution for the site.
	Hill AFB Remedial Project Manager	Jarrold Case	(801) 777-3943	Notification of issues to Senior Project Manager, AFCEC, and Hill AFB. Coordination and resolution of issues between USAF/EPA/UDEQ Remedial Project Managers.
Modifications to Contractor Program Management	EA Program Manager	Joel Lazzeri	(410) 329-2404	Oversee and manage the overall PBR program with AFCEC
Modifications to Contractor Program	EA Senior Project Manager	Sandra Staigerwald	(410) 215-6142	Coordinate field work, programmatic direction and issue resolution.
Modifications to Technical Direction	EA Site Project Manager	Amy Sponaugle	(410) 329-5103	Oversee and manage the progress of the project.
Modifications of all Cabrera Project Phases	Cabrera Program Manager	Bill Lorenz	(716) 635-4755	Notify EA Senior Project Manager of Cabrera Project Phase issues.
Quality issues for Cabrera Project Phases	Cabrera QA Manager	Sean Liddy	(410) 982-0726	Notify Cabrera Senior Project Manager of Cabrera Project Phase quality issues.
Modification to Technical Direction of Cabrera Project Phases	Cabrera Project Manager	Greg Bright	(781) 264-4445	Notify Cabrera Senior Project Manager of Cabrera Project Phase issues.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Modifications to Work Plan Procedures and Site Status Updates	Cabrera Site Manager	Wade Fillingame	(865) 300-5789	Notify Cabrera Project Manager of field-related issues and implement corrective actions for field and analytical issues.
Modifications to Site Health and Safety Protocols	Cabrera Site Health and Safety Officer	Stephan Owe	(410) 982-0718	Notify Cabrera Site Manager of field-related health and safety issues and implement corrective actions, as necessary.
Reporting Data Quality Issues	Contractor Quality Systems Manager	Mahmud Rahman	(410) 982-0720	All QA/QC issues with project field samples will be reported to Cabrera QA Manager within 2 business days

QAPP Worksheet #9

Project Planning Session Summary

Site Name/Project Name:	WR111 LMTA Magnesium-Thorium Disposal Trench Site/PBR at Hill AFB, Utah
Site Location:	Hill AFB, Utah
Projected Date(s) of Work:	November 2014
Site Specific Project Manager:	Amy Sponaugle (EA)
Date of Session:	June 9, 2014
Planning Session Purpose:	Discuss logistics for upcoming remedial action at Site WR111

Participants

Name	Organization	Project Role	Phone	E-mail Address
Kyle Gorder	Site Project Manager	Hill AFB	(801) 775-2559	kyle.gorder@hill.af.mil
John Monk	Site Manager	EA	(801) 896-2075	jmonk@eaest.com
Amy Sponaugle	Site Project Manager	EA	(410) 329-5103	aspenaugle@eaest.com
Greg Bright	Project Manager	Cabrera	(781) 264-4445	gbright@cabreraseservices.com

Comments

The following issues were discussed during the conference call (note: action items in bold type following each discussion item):

1. Review/approval of the Decommissioning Plan for WR111 by other regulatory agencies (agencies other than NRC Region 4)

Kyle Gorder indicated that Dr. Bhat (Air Force Radioisotope Committee [AF RIC]) recently sent him emails requesting approval of the Decommissioning Plan from NRC Region I, USEPA, and the State of Utah by 6 July 2014.

Greg Bright indicated that gaining concurrence from NRC Region IV on the Decommissioning Plan for Site WR111 is appropriate since the work is being conducted in that NRC region (i.e., NRC Region IV is the regulatory authority for Utah). AF RIC recently submitted the Draft Final Decommissioning Plan for Site WR111 to NRC Region IV for review and concurrence.

NRC Region I issued Cabrera's radiological license to conduct radiological decommissioning work. Per Cabrera's license requirements, Cabrera is required to notify Region I of upcoming work at a temporary job site in another NRC region. This notification protocol was previously followed when EA/Cabrera conducted the supplemental sampling activities at WR111 in July 2013. Copies of the notifications (pre- and post-work notifications to NRC Region I) were provided to Kyle Gorder and Allen Kidner (Hill AFB Radiation Safety Officer [RSO]).

- **ACTION ITEM – Kyle Gorder will follow up with Allen Kidner (Hill AFB RSO) to discuss Dr. Bhat's recent emails.**

2. Coordination with LMTA personnel (notification protocol during fieldwork)

Kyle Gorder will conduct initial coordination with LMTA personnel about activities at Site WR111 during the 332 process. EA will need to provide Kyle with a brief description of site activities and a map showing the limits of disturbance (LOD).

Amy Sponaugle indicated that EA/Cabrera would like to have VIN cards issued by LMTA security office so that the EA/Cabrera remediation team can enter the LMTA main fence as needed to conduct work at Site WR111. Using the VIN cards, EA/Cabrera will also be able to easily coordinate access for transportation and disposal (T&D) personnel/trucks down to the site.

- **ACTION ITEMS**

- **Kyle Gorder will follow up with LMTA personnel to obtain the process for getting VIN cards activated by EA personnel. Currently EA has 2 VIN cards that need to be reactivated; in addition, EA would like to receive 2 additional VIN cards for Cabrera personnel.**
- **Amy Sponaugle will send information to Kyle Gorder so that he can start the 332 process for Site WR111.**

3. Truck access to the fenced area for T&D vehicles (haul route)

The truck haul route was discussed. John Monk (EA) indicated that the proposed haul route will provide the easiest access for T&D vehicles. Based on observations during the supplemental sampling activities in July 2013, there are two posts with chain currently blocking access to this route. Kyle Gorder had no personal concerns with EA using this route, but he needs to coordinate with LMTA personnel to verify that EA can temporarily remove the chain to obtain access.

- **ACTION ITEM – Kyle Gorder will follow up with LMTA personnel to confirm that EA can temporarily remove the chain blocking the proposed haul route and utilize this haul route for upcoming remedial action activities.**

4. Signatures for disposal documentation (transportation and offsite disposal)

Greg Bright (Cabrera) indicated that the Cabrera Site Manager identified in the Working Copy RD/RAWP for Site WR111 (Wade Fillingame) will be acting as the Waste Treatment and Disposal Coordinator for T&D activities during the RA. Mr. Fillingame is a DoD Certified Waste Broker. As such, Mr. Fillingame is DoD certified to sign transportation and disposal documentation for the waste stream at Site WR111, and he could perform this duty if formally authorized by Hill AFB. This approach is likely to streamline the T&D process for Site WR111.

- **ACTION ITEM – Kyle Gorder will follow up with Allen Kidner regarding Hill AFB protocol for off-site shipments and for potential to provide signatory authority to Mr. Fillingame.**

5. Coordination with AFRIC for verification surveys

AF RIC will be able to conduct any planned verification surveys during Cabrera's FSS activities or after Cabrera has completed FSS and is awaiting sample results and approval to backfill/restore the site. Mr. Bright indicated that verification surveys are typically conducted either "side-by-side" with the FSS team or after the FSS has been completed.

Kyle Gorder indicated that he will be the point of contact with AF RIC during implementation of the verification surveys.

- **ACTION ITEM – Kyle Gorder will follow up with AF RIC regarding the general approach for excavation (discussed above) and their preferred verification survey protocol (side-by-side or after FSS is completed).**

6. Protocol for obtaining sample location identification numbers (LOCIDs)

Kyle Gorder indicated that EA/Cabrera will need to request LOCIDs for environmental samples collected at the site. Samples associated with health and safety, equipment clearance, etc. will not require LOCIDs.

- **ACTION ITEM – Kyle Gorder will follow up with appropriate Hill AFB personnel regarding the protocol for requesting LOCIDs (i.e., point of contact, lead time, etc.).**

7. Requirements for badges at LMTA

EA/Cabrera asked whether security badges will be required for all workers conducting RA activities at LMTA.

- **ACTION ITEM – Kyle Gorder will follow up with LMTA personnel regarding badge requirements for RA workers.**

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QAPP Worksheet #10

Conceptual Site Model

The conceptual site model identifies the relationship between the sources of contamination, source areas, contaminants, transport mechanisms, exposure routes, and receptors. The conceptual site model provides a description of how contaminants enter into the environment, how they are transported within the environment, and the routes of exposures to humans.

1.0 Sources and Areas of Contamination

Historical information indicates that magnesium-thorium scrap and waste materials associated with the manufacture of controls, accessories, and engine parts were burned/buried in the disposal trench, located in the far southeastern corner of the LMTA from 1959 through 1961. The results of data evaluations performed for both historical and newly-collected surface and subsurface soil samples show that existing surface and subsurface radiological soil contamination is present at Site WR111. Radiological surface soil contamination is present in the southern portion and radiological subsurface contamination is present in the east-central portion of the site. Most of the subsurface contamination is present at a depth of 5-10 ft below ground surface (bgs). The estimated areal extent of impact soil in the east-central portion and southern portions is approximately 4,500 and 4,100 square ft, respectively.

2.0 Known Contaminants

As mentioned in Section 1.2, results of a recent investigation at the site (2007-2009) indicate that site soils within the fenced Radioactive Disposal Area were impacted with ^{232}Th and decay progeny above background levels (AECOM 2009). A supplemental characterization survey performed in 2013 (EA/Cabrera 2014) identified two additional radionuclides of concern (^{226}Ra and ^{230}Th). Therefore, ^{226}Ra , ^{230}Th , and ^{232}Th have been identified as the radionuclides of concern for soil.

3.0 Release Mechanism and Fate of Transport

Contaminants could be released from the primary sources into one of the four environmental media: (1) atmosphere, (2) groundwater, (3) surface water, and (4) stream sediments. The primary release mechanisms for the radionuclides of concern may include:

- Erosion
- Wind-blown dust
- Surface water runoff
- Operation activities/construction disturbances
- Infiltration/percolation to adjacent and underlying soils
- Solubility or suspension in groundwater
- Groundwater infiltration/discharge to surface water.

Secondary sources of radionuclides of concern may include surface water and features receiving surface water such as drainage-ways, groundwater, and soils surrounding and underlying storage and disposal areas.

Natural thorium is not typically mobile in the environment and, therefore, is unlikely to leach into groundwater. At Site WR111, the lack of thorium mobility is confirmed based on a review of groundwater quality data that were obtained from four monitoring wells at the site, as summarized in the Final North Disposal Area, Thorium Site, Oil Emulsion Disposal Area Data Summary Report LMTA Operable Unit A Remedial Investigation Report 2006 Program (Parsons 2007).

In Table C.2 of the Parsons report, upgradient, sidegradient, and downgradient radionuclide sampling results show no detection of ^{232}Th and ^{228}Th in groundwater at any of the wells, indicating that magnesium-thorium impact is not migrating to groundwater. Low concentrations of ^{230}Th (progeny of Uranium-238) were identified in groundwater at all wells but the concentrations are random and less than 1 picoCurie per liter, which is indicative of natural uranium decay. The remaining radionuclide of concern, ^{226}Ra , is typically more mobile in the environment, and low concentrations of ^{226}Ra progeny were also detected in the wells. However, the upgradient and downgradient groundwater concentrations are statistically equal. Based on the groundwater data, and consistent with the conclusions provided in the Parsons report, radiological concentrations in groundwater are due to natural uranium decay and are not associated with the magnesium-thorium alloy. Due to existing groundwater data indicating that there is no impact from magnesium-thorium to groundwater, low mobility of thorium, the spatial separation of impacted soils (10 ft bgs) from the surficial groundwater table (approximately 34 ft bgs), and the apparent low permeability of the bedrock layer between the impacted soil and groundwater, a complete groundwater pathway does not exist for the site.

There are no surface water bodies present within the site boundaries. Although the major surface water body in the area, the Great Salt Lake, is located approximately 1,000 ft from Site WR111, there is no evidence of contaminant migration from the magnesium-thorium disposal area in the direction of the lake. As such, a complete surface water pathway does not exist for the site.

4.0 Land Use Considerations and Potential Receptor and Exposure Pathway Scenarios

The goal of this remediation is to achieve site closeout with no land use controls to address the radioactive impact in soil at the site. Therefore, a residential farmer scenario was considered for the Site. Under a resident farmer scenario, a family is assumed to move onto the site after it has been released for use without radiological restrictions, build a home, and raise crops and livestock for family consumption. The resident farmer can incur a radiation dose via the following exposure pathways after unrestricted release of the site:

- Direct radiation from radionuclides in the soil
- Inhalation of re-suspended dust (if the contaminated area is exposed at the ground surface)
- Ingestion of food from crops grown in contaminated soil
- Ingestion of milk from livestock raised in the contaminated area
- Ingestion of meat from livestock raised in the contaminated area
- Direct ingestion of contaminated soil.

The exposure pathways are depicted in Figure 10-1.

Key Physical Aspects of the Site

Geology

Bedrock at Site WR111 occurs at depths ranging from 2 to 13 ft bgs and is highly fractured. The bedrock surface has an apparent downward slope trending from west to east.

The bedrock in the area of Site WR111 consists of two lithological units: slate argillite, and tillite. These units contact along a fault line to the south that continues in a northwesterly direction. The bedrock stratigraphic sequence at the LMTA consists of the slate overlain by a relatively thin clastic, calcareous unit, loosely-termed calcareous phyllite that transitions upward to a greenstone. The thick tillite overlays the calcareous phyllite and greenstone sequence. Tillite juxtaposed against the slate suggests a large offset along this fault with an apparent strike-slip component to the offset. Low water yield during drilling, development, and sampling of the site monitoring wells indicates low permeability of the bedrock at all well locations and limited groundwater flow.

Hydrogeology

Both shallow and deep aquifers are present in this region. The uppermost water-bearing zone is encountered at an approximate depth of 30 ft bgs, corresponding to an elevation of approximately 4,208 ft above mean sea level. The site-specific groundwater flow direction is southerly with a southwest component. In 2006, four monitoring wells were installed in the vicinity of Site WR111 and are screened in bedrock. Low water yield during drilling, development, and sampling of the site monitoring wells indicates low permeability of the bedrock at all well locations and limited groundwater flow. Low permeability is also consistent with the relatively steep hydraulic gradient.

Site WR111 is located within the Weber River Watershed. The Weber River Basin is a flat, fertile plain, which was formed by alluvial deposits from the former Lake Bonneville. The Ogden River is a major tributary to the Weber River and drains the Ogden Valley and the eastern portion of Weber County. The flow of the Weber River and its tributaries is controlled by reservoirs that have a great effect on water quality. The Willard Reservoir, commonly known as Williard Bay, is the last major reservoir in the Weber River Basin. Closest to Site WR111 is the Williard Reservoir, which is located on the shores of the Great Salt Lake, and used for irrigation in the lower basin and some fishing and boating. There are no known wetlands in the immediate vicinity of Site WR111.

Climate

Based on the climatological data for this area from 1981 through 2010, Ogden and the surrounding area experience a dry summer continental climate where the summers are hot and dry, with temperatures typically reaching 95 degrees Fahrenheit. Annual rainfall is typically less than 16 inches. During the summer months, infrequent thunderstorms result in average monthly rainfall totaling:

- 1.54 inches in June
- 0.83 inches in July
- 0.92 inches in August
- 1.67 inches in September.

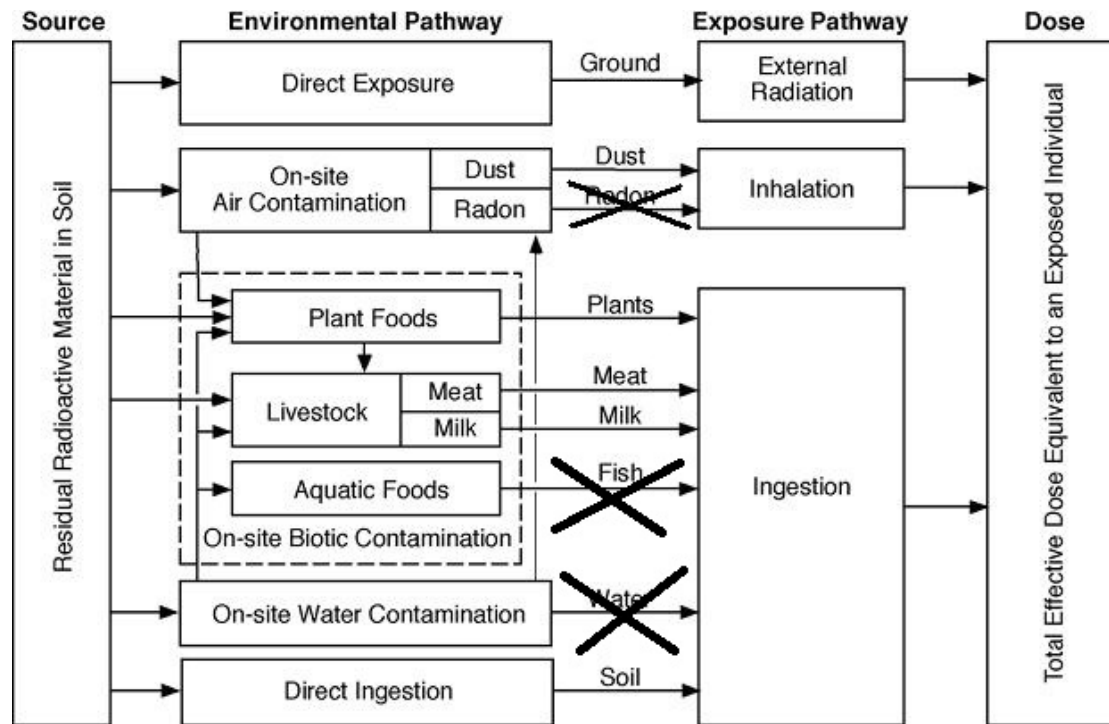
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FIGURE 10-1

Schematic of Residual Radioactivity Pathways for Resident Farmer

WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Site-Specific Supplement

Quality Assurance Project Plan, Hill Air Force Base, Utah



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QAPP Worksheet #11

Project/Data Quality Objectives

An integral part of a UFP-QAPP is the formulation of the Project Quality Objectives and Data Quality Objectives (DQOs). The Project Quality Objectives incorporate the elements of an EPA DQO process, which in turn consists of a series of seven planning steps that are designated to ensure that the type, quantity, and quality of the environmental data used in the decision making are appropriate for their intended application. The problem statement, goals of the study, data inputs, study boundaries, analytical approach, and plan for obtaining data are presented in the following sections of this worksheet, and mirror the 7-step DQO process outlined in the EPA 2006 guidance document (Guidance on Systematic Planning Using the DQO Process [EPA/240/B-06/001, February 2006]) (EPA 2006).

The specific QA/QC requirements developed for the site are consistent with those presented in the Department of Defense Quality Systems Manual, Version 4.2 (Department of Defense 2010).

Problem Definition

Soils located on Site WR111 have been impacted by radionuclides (primarily by three radionuclides of concern: ^{226}Ra , ^{230}Th , and ^{232}Th). Therefore, remedial action will be initiated to address the radiologically-impacted soil present at the site.

The problem of this UFP-QAPP is to identify the types, quality, and quantity of data that will be used to support the remedial action within the planned project schedule. These data will be used to demonstrate that the residual radionuclide concentrations following remediation comply with concentration and exposure-based criteria per the decision documents. The ultimate decision regarding site disposition will rest with the AFCEC and AFCEC decision makers.

Identification Of Decisions

The following key decisions must be made to support project objectives.

1. **Remedial Support Surveys**—Following the completion of remedial action, remedial support surveys, consisting of gamma walkover surveys (GWS), will be used to identify elevated areas of gamma activity at the limits of excavation. If elevated activity is recorded during the GWS, then these locations will be investigated. If elevated activity is confirmed following additional investigation (i.e., follow-up gamma activity scans), then this area will be excavated in 1-ft lifts until remedial support survey scan results are consistent with background reference area GWS results.

There will be two investigation levels calculated per instrument: one for surface soils, and one for trench soils. For this project, elevated activity for GWS data (i.e., investigation level [IL]) will be set at the mean count rate plus three sigma, where σ is the standard deviation of the newly obtained gamma measurements. Surface soil scans will be evaluated against the surface soil IL, and trench floor and sidewall soil scans will be evaluated against the trench soils IL. Cabrera's project CHP will evaluate gamma survey count rates and provide GWS maps to the Site Manager for use in selecting sample locations. The key question for remediation is:

- Do post-remedial site soil concentrations meet their appropriate ILs?

2. **FSS**—Following the completion of remedial action, FSS will be conducted for various classes (Class 1, Class 2, and Class 3) of survey units (SUs) by utilizing the guidelines presented in MARSSIM (NRC 2000). GWS will be performed to identify areas of elevated gamma activity and biased soil sample locations. Confirmatory soil samples will be collected from each SU. The key questions include:
 - Are the sum of the ratios for each confirmatory sample less than 1?
 - If small areas of elevated radioactivity exist in a SU, are these concentrations at levels below the DCGL used for elevated measurement comparison?
 - Do soil sample results satisfy the Wilcoxon Rank Sum statistical test as described in the MARSSIM?
 - Project action levels for all three radionuclides of concern are presented in Worksheet #15.
3. **Layback Soils Sampling**—To ensure safe entry into excavations, sidewalls will be sloped and any non-contaminated layback soils will be staged in the Layback Soils Staging Area (Figure 4-1 of the RD/RAWP) in 100-cubic yard piles. Soils will be sampled to ensure that they meet the radiological reuse criteria (equivalent to the project action levels [DCGLs] presented in Worksheet #15). The key question for layback soils is:
 - Do layback soil concentrations meet their appropriate project action levels?
4. **Offsite Borrow Source Backfill Sampling**—Once excavation and FSS activities have been completed, backfill activities will be performed. Backfill will consist of non-impacted layback soils below reuse criteria and clean borrow material from an approved offsite source. Clean borrow materials will be sampled prior to being used as backfill to ensure that they meet the radiological reuse criteria (equivalent to the project action levels [DCGLs] presented in Worksheet #15) and chemical reuse criteria from the Basewide QAPP (<http://www.hafbdydocs.com>). The key question for offsite borrow source material sampling is:
 - Do offsite borrow backfill materials meet their appropriate project action levels?

In addition, air monitoring samples, periodic routine and release surveys, and contamination control surveys will be conducted at the site in order to protect the workers and general public from exposure to airborne radioactive contaminated materials and to prevent the contaminated radioactive materials from leaving the site.

Data Needed to Meet Objectives and Development of Analytical Approach

1. **Remedial Support Surveys**—One major input decision is assurance that the site work area has been remediated. This will be demonstrated through the use of GWS during remedial support surveys (and later FSS). Gross gamma activity data will be compared to the ILs for GWS to determine if further excavation is required.
2. **FSS**—An FSS will be performed for various classes of SUs and is made up of the following:
 - GWS using hand-held radiation survey instruments to small areas of elevated activity exceeding the action level of three standard deviations above the reference area mean count rate.

- Systematic soil samples collected for each SU. Samples will be analyzed for radionuclides of concern (UFP-QAPP Worksheet #23).
- Biased soil samples collected from the relative maxima of each GWS. Samples will be analyzed for radionuclides of concern (UFP-QAPP Worksheet #23).
- Collection of surface soil samples from the background reference area.

These sample result concentrations will be used in non-parametric statistical tests as part of the FSS to demonstrate successful remediation for all radionuclides of concern at Site WR111.

3. **Layback Soils Sampling**—Non-impacted layback soils will be used for backfill. Prior to backfilling, radiological sample data will be used to ensure suitability as backfill.
4. **OffSite Borrow Source Backfill Sampling**—Clean borrow material from an approved offsite source will be used for backfill. Prior to backfilling, radiological and chemical sample data will be used to ensure suitability as backfill. Samples will be analyzed for VOCs, Resource Conservation and Recovery Act (RCRA) metals/mercury, total petroleum hydrocarbons (TPH)-gasoline range organics (GRO), TPH-diesel range organics (DRO), and gamma and alpha spectroscopy. Worksheet #12 provides measurement performance criteria for these analytes.

Data needed for air monitoring samples, periodic routine and release surveys, and contamination control surveys are included in Worksheet #17.

Definition of Study Boundaries

Data Population

The data population of interest for Site WR111 is the concentration of radionuclides of concern and their associated comparison to their project action limits in soils.

Spatial and Temporal Boundaries

Both surface and subsurface radiological soil contamination is present at Site WR111. Radiological surface soil contamination is present in the southern portion and radiological subsurface contamination is present in the east-central portion of the site. Most of the subsurface contamination is present at a depth of 5-10 ft bgs. The estimated areal extent of impact soil in the east-central portion and southern portions is approximately 4,500 and 4,100 square ft, respectively.

Performance and Acceptance Criteria

Definitive data are required for supporting project decisions. For soil remediation, decisions pertaining to remediation will be based on analytical data, utilizing the guidelines provided within the FSS Plan, which is included as Appendix D of the Decommissioning Plan (EA/Cabrera 2014). To limit decision errors, analytical method performance criteria for accuracy and precision for QC sample results have been established and are presented in Worksheet #12. All sampling results will be qualified with respect to the performance criteria specified in Worksheet #12. All qualified data will be reported and utilized to evaluate the performance of the remedial actions.

Acceptability decisions are often made based on acceptance criteria. If the mean and median concentrations of a contaminant are less than the associated acceptance criteria; for example, the results can usually be accepted. In cases where data results are not so clear, statistically-based decisions are necessary. Statistical acceptability decisions, however, are always subject to error. Two possible error types are associated with such decisions.

The Type I decision error provides a 95 percent confidence level that the statistical tests will not incorrectly indicate that an SU satisfies acceptance criteria when, in fact, it does not. The Type II decision error provides a 95 percent confidence level that the statistical tests will not incorrectly indicate that an SU does not satisfy acceptance criteria when, in fact, it does. Type II errors are more a function of labor and survey costs and do not adversely impact public safety or health, and thus are subject to adjustment as needed. For the purposes of the FSS, the acceptable error rate for both Type I and Type II errors is 5 percent (i.e., $\alpha = \beta = 0.05$).

Optimize the Design

The variability of data will have an effect on the sampling design. If necessary, the sample frequency and the analytical procedures will undergo changes to optimize the design. Changes will occur concurrently for several steps with the DQO process. The design options, such as sample collection design, sample size, and analytical procedures, will be evaluated based on cost and the ability to meet the DQOs. A more detailed discussion on the sampling design with analytical design requirements is presented in Worksheets #19, #20, #24, #25, #26, #28, and #30.

QAPP Worksheet #12

Measurement Performance Criteria

Measurement performance criteria for standard methods (VOCs via EPA Method SW8260B, RCRA metals/mercury via EPA Method SW 6020A/7471A, TPH-GRO and TPH-DRO via EPA Method SW8015C, and Gamma spectroscopy analysis for ^{226}Ra via EPA Method 901.1M are provided in Attachment 2 of the QPP PBR (www.hafbdydocs.com). Criteria for alpha spectroscopy analysis for ^{230}Th and ^{232}Th via Method Environmental Measurements Laboratory (EML) Health and Safety Laboratory (HASL) 300 Modified are not included in the Attachment 2 of the QPP PBR (www.hafbdydocs.com) and are, therefore, provided below.

Matrix	Soil				
Analytical Group Concentration Level	²³⁰ Th and ²³² Th				
	Low				
Sampling Procedure	Analytical Method/SOP	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling, Analytical, or both
Surface Soil Sampling (OP-351)	Alpha Spectroscopy/ ST-RD-0210	Completeness	95%	Data Completeness Check	Analytical
		Precision	Normalized absolute difference <1.96 Relative percent difference (+/- 50%)	Field duplicate (not necessary for waste characterization samples)	Analytical
		Precision	Normalized absolute difference <1.96	Laboratory Duplicate	Analytical
		Accuracy/Bias	Recovery (80-120)% Normalized absolute difference <1.96	Laboratory Control Sample	Analytical
			< Total propagated uncertainty or <MDC Warning and Control Limits for Z-Blank are +/- 2sigma and +/- 3sigma, respectively	Method Blank	Sampling and Analytical
		Completeness	90%	Data Completeness Check	Sampling and Analytical

NOTES:

MDC = Minimum detectable concentration.

OP = Operating procedure.

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QAPP Worksheet #13

Secondary Data Uses and Limitations

Data Type	Source	Data Uses Relative to Current Project	Factors Affecting the Reliability of Data and Limitations on Data Use
Data Summary Report	Parsons. Final North Disposal Area, Thorium Site and Oil Emulsion Disposal Area Data Summary Report LMTA Operable Unit A Remedial Investigation 2006 Program. December 2007.	Data have been used to support the decision that no further groundwater monitoring data are required for the site.	None
Characterization Survey Data	USAF Materiel Command, Radiological Disposal Sites Characterization for LMTA, Hill AFB, Utah Report, November 2009	The results were used to determine the nature and extent of residual radiological contamination for the existing site boundary and to provide background ²³² Th concentrations.	None
Supplemental Characterization Survey Data	Cabrera. Final DP WR111 LMTA Magnesium-Thorium Disposal Trench. Currently being finalized.	The results were used to determine the nature and extent of residual radiological contamination in and around the existing site boundary to estimate soil volumes requiring remediation	None

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QAPP Worksheets #14 and #16

Project Tasks and Schedule

This worksheet lists the project tasks and describes the procedures to be followed for activities to be performed in support of the soil removal activities at the site. The sampling design, strategy, and sequencing are further addressed in Worksheet #17.

Activity	Organization	Dates (MM/DD/YY) ⁽¹⁾		Deliverable	Deliverable Due Date
		Anticipated Dates of Initiation	Anticipated Dates of Completion		
Task 1: Supplemental Site Investigation Work Plans	EA/Cabrera	11/1/12	5/3/13	Field Sampling Plan, UFP-QAPP, Site Safety and Health Plan, Radiation Protection Plan	5/3/13
Task 2: Supplemental Site Investigation Field Work	EA/Cabrera	6/30/13	7/4/13	Not applicable	Not applicable
Task 3: DP	EA/Cabrera	8/2/13	5/24/14	DP	5/24/14
Task 4: RD/RAWP	EA/Cabrera	3/17/14	4/4/14	RD/RAWP	10/15/14
Task 5: Remedial Action Mobilization	EA/Cabrera	9/16/14	9/25/14	Not applicable	To be determined
Task 6: Remedial Action	EA/Cabrera	9/26/14	11/14/14	Not applicable	To be determined
Task 7: Demobilization	EA/Cabrera	11/15/15	11/22/15	Not applicable	To be determined

NOTES:

1. Anticipated field work and document deliverable dates follow the integrated master schedule.

Sequence of Work

Daily site operations will be under the day-to-day management of EA's Project Manager and the Site Manager. Major scope activities, which are in addition to the mobilization, site preparation, and utility clearance activities, are identified as follows:

- Remedial Action
 - Coordinate site access through the Hill AFB Project Manager and security personnel at LMTA.
 - Conduct utility location/marketing through coordination with the Hill AFB Project Manager and Red Stakes.
 - Delineate the areas of excavations utilizing a global positioning unit. Once the area of investigation has been delineated, install erosion control measures, and post all applicable radiological and safety signs.
 - Perform a GWS of the stockpile area and install permeation barriers and engineering controls.
 - Excavate the soil wastes and layback soils from the proposed excavation footprint. Excavated soils shall be surveyed as the area is excavated.
 - Perform an FSS of Site WR111 to support release for unrestricted use. FSS will include GWS and systematic soil sample collection.
 - Process GWS data and coordinates will be relayed to the field team to locate biased sample locations.
 - Package wastes, prepare shipping papers, and transport the removed wastes to the offsite disposal facility.
 - Demobilize from the site, awaiting FSS sample results and approval from project stakeholders, including Hill AFB and USAF Radioisotope Committee, to backfill excavation and restore site
 - Upon receiving approval, mobilize to the site, return excavated soils that are below DCGLs to the excavation area, and restore the site to its original condition.
 - Perform "as left" surveys of soil stockpile area, outgoing material and equipment surveys, and demobilize from the site for the final time.
- Preparation of the FSS Report.

Sampling Tasks

Cabrera will collect soil samples from the survey units within Site WR111 and the reference area and will send them to TestAmerica to be analyzed in accordance with TestAmerica's SOPs. Sampling will be

conducted in accordance with the applicable SOPs. Cabrera SOPs are provided in Attachment A, and Hill AFB SOPs are provided in Hill AFB Basewide QAPP (<http://www.hafbdyndocs.com>).

Analysis Tasks

Samples for laboratory analysis will be sent to the offsite laboratory that will process, prepare, and analyze the samples. Worksheet #15 presents the target analytes, project action limits, and project quantitation limits.

Quality Control Tasks

Field QC samples will be collected in accordance with Worksheet #20. Contractor QC will be performed throughout the project using the three-phase control system. This process of continuous QC and assessment is described in detail in the Construction Quality Plan (Section 6.0 of the Work Plan).

Secondary Data

See Worksheet #13 for a synopsis of secondary data.

Data Management Tasks

A Data Management Coordinator will be appointed; duties will include collecting, managing, performing quality checks on and processing data generated in the field. The Data Management Coordinator will store and archive all field data including, but not limited to: GWS data, sample analysis results, health physics surveys, and chain-of-custody records. The Data Management Coordinator will backup all field data daily on an independent storage device to ensure data integrity and availability. Data generated during this remedial action and FSS will also be uploaded into Hill AFB Environmental Resources Program Information Management System. Some important data management tasks are summarized below.

GWS Results:

1. GWS data collected during the remedial action and FSS will be exported to a data management software program (Geographic Information System ArcInfo and ArcMap) to facilitate data review and statistical analysis.
2. The review of validity of GWS data will be performed at two different levels. In the first levels, data will be reviewed at the time of collection by following standard procedures and QC checks. In the second level, after the reduction of data into useable tables or charts, the data will be reviewed for anomalous values. Any inconsistencies or anomalies identified during the review will be immediately resolved by seeking clarification from the field personnel. Inconsistencies that cannot be resolved in such a manner will be discussed with the Project Manager and addressed appropriately.
3. Measurement data collected in the field will be reported in electronic spreadsheets and figures that can be easily transmitted among project members in various physical locations for their respective uses. Electronic data files, including the raw data logs and any tables, charts, and/or maps generated, will be transferred to the Cabrera Project Health Physicist on a regular basis for evaluation and uploading to the electronic project file.

Laboratory Analytical Results

1. The offsite analytical sampling results will be reviewed. The individual analyst constantly reviews the quality of data through calibration checks, QC sample results, and performance evaluation samples. The laboratory manager will review data for reasonableness and consistency with other generated data to determine whether program requirements have been satisfied before submitting the data report to EA/Cabrera.
2. The laboratory shall generate a defensible data package equivalent to those components listed in the Department of Defense Quality Systems Manual Version 4.2 (October 2010). The data package will be in .pdf (Adobe) format (no hard copies). The electronic data deliverable will be formatted for Environmental Resources Program Information Management System and be in Microsoft Excel.

Documentation and Records

In addition to uploading to Hill AFB Environmental Resources Program Information Management System, documentation will be maintained to support the results of the data collection effort. Field, laboratory, and cartographic data generated during this project will be archived on durable electronic media. Backup media containing databases and programs or software utilities will be maintained in a secure location. EA/Cabrera will retain the relevant and appropriate project information in a master project file.

The field and laboratory data generated during the project will be summarized in the FSS Report. The report will present the findings of the FSS, and will summarize the results. The report will include a QA section that summarizes the QC sample results and the results of instrument QC checks.

Assessment/Audit Tasks

Worksheet #32 provides more detailed information regarding project specific assessment/audit task.

Data Review Tasks

See Data Management Tasks section above.

QAPP Worksheet #15

Project Action Limits and Laboratory-Specific Detections/Quantitation Limits

The potential analyte groups, potentially applicable screening levels, Basewide QAPP and/or addendum reporting limits, and achievable laboratory detection limits for matrices of concern at Hill AFB are presented in Table 15-1 – Reference Limits for Soil of the QPP PBR (www.hafbdydocs.com).

This table details the potential analytical groups and concentration levels for each compound for which soil, sediment, groundwater, surface water, air, and waste characterization samples may be analyzed at Hill AFB. Note that the compounds included in each analyte group are comprehensive, including compounds presented in Basewide QAPP as well as Department of Defense Quality Systems Manual analyte lists.

Definitions for the laboratory quantitation limits are provided in Worksheet #37 of Attachment 2 of the QPP PBR (www.hafbdydocs.com). Quantitative concentration results within specified limits of precision and bias can only be achieved at or above the limit of quantitation (LOQ); however, the analytical laboratories may identify analytes between the Detection Limit (DL) and the LOQ. In these instances, the laboratories will report concentration values between the DL and LOQ as estimated values. The laboratory will report non-detectable values as less than the LOD.

The information required in this worksheet is provided in Worksheet #15 in Attachment 2 of the QPP PBR (www.hafbdydocs.com). The information contained therein is applicable to this Site-Specific QAPP, with the exception of the following action limits.

Analyte	CAS Number	Project Action ⁽¹⁾ Limit (applicable units)	Project Quantitation Limit (applicable units)	Analytical Method ⁽²⁾		Achievable Laboratory Limits ⁽³⁾	
				MDCs	Method QLs	MDCs	QLs
²³⁰ Th	14269-63-7	7.3 pCi/g	0.5 pCi/g	0.01 pCi/g	0.5 pCi/g	0.01 pCi/g	0.5 pCi/g
²³² Th	7440-29-1	2.4 pCi/g	0.5 pCi/g	0.01 pCi/g	0.5 pCi/g	0.01 pCi/g	0.5 pCi/g
²²⁶ Ra	7440-14-4	4.5 pCi/g	0.5 pCi/g	0.5 pCi/g	0.5 pCi/g	0.5 pCi/g	0.5 pCi/g

NOTES:

- (1) The project action limit for in soil was calculated in the approved DP (EA/Cabrera 2014). These values do not include background concentrations. Background reference area concentrations will be determined during the FSS after offsite analytical data are received and verified.
- (2) Analytical MDCs and Quantitation Limits (QLs) are those documented in validated methods.
- (3) Achievable MDCs and QLs are limits that an individual laboratory can achieve when performing a specific analytical method.

pCi/g = PicoCuries per gram.

For Worksheet #15 tables relevant to analyses to be performed for layback soils (Toxicity Characteristic Leaching Procedure [TCLP] VOCs, RCRA metals, and TPH-DRO and TPH-GRO), see the Basewide PBR Work Plan.

Release criteria for materials and equipment are discussed in the Radiation Protection Plan (Appendix C of the Work Plan).

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QAPP Worksheet #17

Sample Design and Rationale

During the FSS:

- Cabrera will perform a GWS with a 3- × 3-inch sodium iodide detector coupled with a Global Positioning System to identify the locations of elevated activity.
- The results of GWS will be utilized to determine surface biased soil sampling locations. Project decision conditions (i.e., “If..., then...” statements) for the selection of subsequent sample locations are discussed in Worksheet #10.
- Biased samples will be collected based on scan activity results. The method for selection of biased sample locations is described in detail in the FSS Plan (EA/Cabrera 2014).
- Systematic samples will be collected in each SU. The required number of systematic sample locations and procedures for determining sample spacing are described in detail in the FSS Plan (EA/Cabrera 2014).
- It is anticipated that approximately 58 FSS soil samples (not including QA samples) will be analyzed.
- Field duplicate samples will be collected during soil sampling in accordance with Worksheet #20.
- One five-point composite sample will be collected per every 100 cubic yards of non-impacted layback soils material and analyzed for radionuclides of concern to determine suitability for backfill. The first composite sample will be collected as soon as approximately 100 CY of soil volume are accumulated in the area to ensure that samples are representative of the distribution of layback soils. Subsequent samples will be collected as soon as each approximate additional 100 CY is accumulated. Surface soil samples will be analyzed for ²³⁰Th and ²³²Th via alpha spectroscopy, and for ²²⁶Ra via gamma spectroscopy.
- One sample will be collected per every 500 cubic yards of offsite borrow material and analyzed for radionuclides of concern and chemical parameters listed in Worksheet #15.

During the FSS, the total area included in the survey will depend upon the extent of the remediation and radiological measurements; however, the data collected will achieve the overall goal for the field effort, which is to confirm the remediation of the area has been adequate and that the site meets the specified criteria for unrestricted release. A detailed description of the sampling design and rationale is provided in the FSS Plan (Appendix D of the DP).

Air Monitoring Program—Monitoring for airborne contamination will be performed for both occupational and effluent purposes. Occupational monitoring will be performed using breathing zone air samplers attached to workers in or around active excavation areas and the load-out area. Filters will be replaced daily in all breathing zone samplers with date, run time, and workers’ name recorded for potential derive air concentration tracking purposes. Low volume (0-100 liters per minute) air samplers will be placed at the air sampling locations to monitor for localized effluent airborne releases. Filters in these air samplers may be collected daily or allowed to composite over multiple days to achieve lower MDCs. Site boundary effluent sampling will be performed using high-volume air samplers to achieve

maximum sensitivity. Filters from the low and high volume samplers will be allowed to decay for at least 12 hours (and up to 72 hours) to allow for radon interference to subside. All filters will be counted on a Gross Alpha/Gross Beta counter such as an automated Tennelec or a manual counter such as a Ludlum 2929. Results from all air sampling activities will be compared against Calculated Action Levels, which are typically 10 percent of the published values in Table 2 of 10 Code of Federal Regulations Part 20, Appendix B.

Periodic Routine and Release Surveys—Health physics surveys will be performed in all active site areas to monitor for contamination. Incoming (or baseline) radiological surveys will be performed on all equipment and in working spaces prior to active operations. Routine surveys in work areas will be performed to verify that radiation protection and housekeeping are effective. These surveys will include smears, direct readings with an alpha/beta meter, and dose rate measurements.

Periodic surveys of the site haul roads will also be performed using GWS techniques to verify that contamination is not being transferred to support zones. A pre-established background screening value will be used to determine areas warranting additional investigation as potentially impacted.

Contamination Control—Surface wipe samples will be collected from the outer surfaces of any trucks, automobiles, equipment, sample containers, or other items leaving the exclusion area or rail loading area that could be potentially contaminated. The analysis of removable alpha/beta activity from these objects is required before they can be released from the site for unrestricted use. Wipe samples are used to measure the amount of gross alpha and beta activity that can be removed from a solid surface (i.e., removable activity).

QAPP Worksheet #18

Sampling Locations and Methods

Sampling Location/ Identification Number	Matrix ⁽¹⁾	Depth (Units)	Type	Analyte/Analytical Group(s)	Sampling SOP	Comments
To Be Determined (The sampling locations, types of field samples to be collected, and number of samples collected are presented in the FSS Report. The field duplicate samples (co-located grab samples) will be collected at a minimum frequency of 1 for every 10 samples collected.)	Soil	Not applicable	Grab and biased samples, 10% field duplicate samples	Radiological Contaminants using Alpha (²³⁰ Th and ²³² Th) and Gamma Spectroscopy (²²⁶ Ra)	OP-001, Radiological Surveys OP-351, Surface Soil Sampling OP-062, Sample Handling Packaging and Shipment	Potential systematic sample locations are shown in Figure D-4 of the FSS Plan (EA/Cabrera 2014). Project decision conditions (i.e., "If..., then..." statements) for the selection of biased sample locations are discussed in Worksheet #10.

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QAPP Worksheets #19 and #30

Sample Containers, Preservation, and Hold Times

Sample containers, preservation, and hold time information for standard methods is provided below.

Laboratory: TestAmerica St. Louis
13715 Rider Trail North
Earth City, Missouri 63045
Point-of-contact: Ms. Elaine Walker (314) 298-8566;
email Elaine.walker@testamericainc.com

List any required accreditations/certifications: Department of Defense Environmental Laboratory Analytical Program and State of Utah
Department of Health Environmental Laboratory Certification Program (Attachment A)

Back-up Laboratory: ALS Environmental

Sample Delivery Method: Overnight delivery

Analyte/ Analytical Group	Matrix	Method/SOP	Accreditation Expiration Date	Container Size/Type	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
²³⁰ Th and ²³² Th	Surface soil	Alpha Spectroscopy/ ST-RD-0210 ⁽¹⁾	Attachment A	Plastic 500 milliliter or Ziploc bag	None	6 months	6 months	20 working days
²²⁶ Ra	Surface soil	Gamma Spectroscopy/ ST-RD-0102 ⁽¹⁾	Attachment A	Plastic 500 milliliter or Ziploc bag	None	6 months	6 months	20 working days
TCLP VOCs	Surface soil	(2)	(2)	(2)	(2)	(2)	(2)	(2)
RCRA Metals	Surface soil	(2)	(2)	(2)	(2)	(2)	(2)	(2)
TPH DRO	Surface soil	(2)	(2)	(2)	(2)	(2)	(2)	(2)
TPH GRO	Surface soil	(2)	(2)	(2)	(2)	(2)	(2)	(2)

NOTE:

(1) See Attachment A.

(2) Information pertinent for these tests is provided in the Basewide PBR Work Plan developed by EA.

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QAPP Worksheet #20

Field Quality Control Summary

Matrix	Analyte/ Analytical Group	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Field Blanks	Equipment Blanks	Trip Blanks	Other	Total Analyses
Soil	²³⁰ Th and ²³² Th	Approximately 65 ^(1,2)	10% frequency	Not applicable	Not applicable	5% frequency	Not applicable	Not applicable		Approximately 81
Soil	²²⁶ Ra	Approximately 65 ^(1,2)	10% frequency	Not applicable	Not applicable	5% frequency	Not applicable	Not applicable		Approximately 81
Soil	TCLP VOCs	1 per 2,000 cubic yards ⁽³⁾	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable		To be determined
Soil	RCRA Metals/Mercury	1 per 2,000 cubic yards ⁽³⁾	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable		To be determined
Soil	TPH-DRO	1 per 2,000 cubic yards ⁽³⁾	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable		To be determined
Soil	TPH-GRO	1 per 2,000 cubic yards ⁽³⁾	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable		To be determined

NOTES:

- (1) Anticipated number of sample locations: The total number of samples collected will depend upon the extent of the remediation and radiological measurements. The Site Manager will coordinate with the Cabrera CHP and Project Manager during the field event to confirm that the total number of collected samples meet the project objectives.
- (2) One sample will be collected every 100 cubic yards of staged layback soils.
- (3) An initial sample of backfill will be collected at the offsite borrow material source, which will be applicable for the first 2,000 cubic yards of imported material delivered to the site. Additional confirmation samples of imported backfill material will be collected at the frequency specified in the table above..

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QAPP Worksheet #21

Field Standard Operating Procedures

The table below presents the Cabrera and Hill AFB SOPs that will be used during the remediation at the site.

SOP Number or Reference	Title, Revision Date, and URL (if available)	Organizing Organization	SOP Option or Equipment Type (if SOP provides different options)	Modified for Project Work (Check if yes)	Comments
SOP 1	Site Access	Hill AFB	Not applicable		
SOP 2	Equipment Calibration	Hill AFB	Global Positioning System, rate meters/scalers, air samplers		
SOP 3	Equipment Decontamination	Hill AFB	Dry wipes		
SOP 4	Field Documentation	Cabrera	Not applicable		
SOP 5	Location and Sample Identification	Hill AFB	Global Positioning System		
SOP 6	Site Restoration	Hill AFB	Not applicable		
SOP 7	Survey	Hill AFB	Global Positioning System		
SOP 8	Investigation-Derived Waste	Cabrera	Not applicable		
SOP 9	Soil Classification	Hill AFB	Not applicable		
SOP 15	Sample Handling and Custody	Hill AFB	Rate meter		
AP-014	Classifying Radioactive Waste	Cabrera	Rate meters/scalers		
OP-001	Radiological Surveys	Cabrera	Rate meter/scalers		
OP-002	Air Sampling and Analysis	Cabrera	Air samplers and rate meters		
OP-005	Volumetric and Material Sampling	Cabrera	Rate meter/scalers		
OP-008	Chain of Custody (Revision 1.0)	Cabrera	Not applicable		
OP-018	Decontamination of Radioactivity from Equipment and Tools (Revision 1.0)	Cabrera	Not applicable		
OP-020	Operation of Contamination Survey Meters (Revision 1.0)	Cabrera	Rate meter/scalers		
OP-021	Alpha-Beta Counting Instrumentation (Revision 1.0)	Cabrera	Rate meter/scalers		
OP-023	Operation of micro-R Meters (Revision 0)	Cabrera	micro-R meters		
OP-061	Sample Labeling (Revision 0.1)		Not applicable		
OP-062	Sample Handling Packaging and Shipment	Cabrera	Not applicable		
OP-066	Operating Procedure for Sample Tracking Log	Cabrera	Not applicable		
OP-187	Record Management	Cabrera	Not Applicable		

SOP Number or Reference	Title, Revision Date, and URL (if available)	Organizing Organization	SOP Option or Equipment Type (if SOP provides different options)	Modified for Project Work (Check if yes)	Comments
OP-243	Personal Frisking and Decontamination (Revision 2.0)	Cabrera	Rate meter/scalers		
OP-312	Wipe Sampling Procedures (Revision 0)	Cabrera	Not applicable		
OP-351	Surface Soil Sampling	Cabrera	Rate meters/scalers, trowels		
OP-359	Field Activity Documentation	Cabrera	Not applicable		
OP-360	Sample Numbering	Cabrera	Not applicable		
OP-387	GWS	Cabrera	Rate meters/scalers, Global Positioning System unit		

NOTE:

Cabrera SOPs are provided in Attachment A. Hill AFB SOPs are provided in Hill AFB Basewide QAPP (<http://www.hafbdyndocs.com>).

QAPP Worksheet #22

Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Activity	SOP Reference	Title or Position of Responsible Person	Frequency	Acceptance Criteria	Corrective Action
3 x 3-inch sodium iodide detector (Ludlum Model 44-20, or equivalent) couples with a Ludlum Model 2221 ratemeter (or equivalent)	System efficiency calibration will be based on detector response to a National Institute of Standards and Technology traceable standard or a mathematical calibration using Canberra Industries <i>In Situ Object Counting System</i> ® software. If a mathematical calibration is used, it will be verified in the field using a National Institute of Standards and Technology traceable standard. System energy calibrations will be performed using a designated standard with known gamma energies.	OP-001	Field personnel	Prior to use and at the beginning and end of each workday	1. For Background Checks, +/- 20% of the mean background counts 2. For Source Checks, +/- 20% of the mean of the initial 10 source counts	Instruments with response rates outside the acceptable criteria will be removed from the service. The equipment will be sent to the manufacturer for repair and re-calibrated.
Global Positioning System	Not required; however, daily satellite availability checks will be performed.	SOP 7 and equipment manual			The daily checks will be within one meter of the calibration point.	Global Positioning System unit exhibiting positional error in excess of one meter will be removed from service.
2224-1/43-93 Alpha/Beta Surveys	Personnel and equipment surveys Personnel monitoring (frisking)	OP-020 OP-021 OP-058	Radiation Technician	Daily	OP-020 OP-021 OP-058	OP-020 OP-021 OP-058
Micro Rem, Model 12S Gamma	Dose rate surveys	OP-022 OP-023 OP-058	Radiation Technicians	Daily	OP-22 OP-023 OP-058	OP-22 OP-023 OP-058
GilAir 5	Personnel air sampling pump		Radiation Technicians	Intrusive work		

Field Equipment	Activity	SOP Reference	Title or Position of Responsible Person	Frequency	Acceptance Criteria	Corrective Action
LV-1	General area air sampling pump	OP-002	Radiation Technicians	Intrusive work	OP-002	OP-002
HI-Q	Perimeter air sampling monitoring	OP-002	Radiation Technicians	Intrusive work	OP-002	OP-002
2929/43-10-1	Surveys (removable contamination for equipment, miscellaneous)	OP-001 OP-020 OP-021	Radiation Technicians	Daily	OP-001 OP-020 OP-021	OP-001 OP-020 OP-021

NOTES:

(1) OP-001 is provided in Attachment A. SOP 7 is provided in Hill AFB Basewide QAPP (<http://www.hafbdydocs.com>).

QAPP Worksheet #23

Analytical Standard Operating Procedures

The information required in this worksheet is provided in Worksheet #23 in Attachment 2 of the QPP PBR (www.hafbdydocs.com). The information contained therein is applicable to this Site-Specific QAPP, with the exception of the following analytical standard operating procedures.

Reference Number	Title	Revision	Revision Date	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work
ST-RD-0210	Alpha Spectroscopy Analysis	11	8/21/13	²³⁰ Th ²³² Th	Alpha Spectrometer	TestAmerica, St. Louis	No
ST-RD-0102	Gammavision Analysis	9	5/18/12	²²⁶ Ra	Gamma Spectrometer	TestAmerica, St. Louis	No

NOTE:

For SOP information on general laboratory procedures and analyses to be performed for layback soils (TCLP VOCs, metals, TPH, DRO, GRO), see the Hill AFB Basewide QAPP.

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QAPP Worksheet #24

Analytical Instrument Calibration

The information required in this worksheet is provided in Worksheet #24 in Attachment 2 of the QPP PBR (www.hafbdydocs.com). The information contained therein is applicable to this QAPP, with the exception of the following analytical calibration instrumentation.

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference ⁽¹⁾
<u>Alpha Spectrometer</u>	<p>Energy Calibrations shall be performed using at least three isotopes within the energy range of 3-6 megaelectron volts. Typical isotopes used are ²³⁰-Th, plutonium-239, and Americium-241. Final peak energy positions of all observed isotopes shall be within ± 5 channels (~40 kiloelectron volts) of expected channel/energy. The actual energy vs. channel and the equation with the slope is not calculated. Setting the peaks to within 5 channels of expected will ensure calculations utilizing fixed Regions of Interest for each isotope will provide accurate results with minimal need for manual adjustment of Regions of Interest. Routine pulser checks and continuing calibration verifications will help control/monitor for drift.</p> <p>Efficiency calibration is accomplished by counting a calibrated source of a particular geometry at a reproducible source-to-detector orientation. The measured emission rate of the calibration standard is then compared to the actual disintegration rate to determine the detector counting efficiency. The values for energy and efficiency calibration are maintained in configuration files, which are referenced when analyzing samples.</p>	According to manufacturer's specification	According to manufacturer's specification	Instruments with response rates outside the acceptable criteria will be removed from the service and will be sent to the manufacturer for repair and re-calibrated.	Analyst and Laboratory Manager	ST-RD-0210

<u>High-Purity Germanium Gamma Spectrometer</u>	<p>Energy calibration is performed by counting a radioactive source containing known gamma-ray emitting radionuclides, at a fixed amplifier gain. An energy calibration factor is then generated by determining the channel numbers corresponding to full energy peak centroids from gamma-rays emitted over the full energy range of interest from multi-nuclide radioactivity sources.</p> <p>Efficiency calibration is accomplished by counting a calibrated source of a particular geometry at a reproducible source-to-detector orientation. The measured emission rate of the calibration standard is then compared to the actual disintegration rate to determine the detector counting efficiency. The values for energy and efficiency calibration are maintained in configuration files, which are referenced when analyzing samples.</p>	According to manufacturer's specification	According to manufacturer's specification	Instruments with response rates outside the acceptable criteria will be removed from the service and will be sent to the manufacturer for repair and re-calibrated.	Analyst and Laboratory Manager	ST-RD-0102
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For calibration information on general laboratory procedures and analyses to be performed for layback soils (TCLP VOCs, metals, TPH, DRO, GRO), see the Hill AFB Basewide QAPP.

QAPP Worksheet #25

Analytical Instrument and Equipment Maintenance, Testing, and Inspection

The information required in this worksheet is provided in Worksheet #25 in Attachment 2 of the QPP PBR (www.hafbdyndocs.com). The information contained therein is applicable to this Site-Specific QAPP, with the exception of the following maintenance information.

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference ⁽¹⁾
Alpha Spectroscopy	Preventative	Radio-chemistry	According to manufacturer's specification	According to manufacturer's specification	According to manufacturer's specification and laboratory SOP	According to manufacturer's specification	Analyst	ST-RD-0210
Gamma Spectroscopy	Preventative	Radio-chemistry	According to manufacturer's specification	According to manufacturer's specification	According to manufacturer's specification and laboratory SOP	According to manufacturer's specification	Analyst	ST-RD-0102

NOTE:

- (1) For maintenance information on general laboratory procedures and analyses to be performed for layback soils (TCLP VOCs, metals, TPH-DRO, and TPH-GRO), see the Hill AFB Basewide QAPP.

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QAPP Worksheets #26 and #27

Sample Handling, Custody, and Disposal

The information required in this worksheet is provided in Worksheets #26 and #27 in Attachment 2 of the QPP PBR (www.hafbdydocs.com). The information contained therein is applicable to this Site-Specific QAPP.

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QAPP Worksheet #28

Analytical Quality Control and Corrective Action

The information required in this worksheet is provided in Worksheet #28 in Attachment 2 of the QPP PBR (www.hafbdydocs.com). The information contained therein is applicable to this Site-Specific QAPP.

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QAPP Worksheet #29

Project Documents and Records

The information required in this worksheet is provided in Worksheet #29 in Attachment 2 of the QPP PBR (www.hafbdydocs.com). The information contained therein is applicable to this Site-Specific QAPP.

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QAPP Worksheets #31, #32, and #33

Assessments and Corrective Action

The information required in this worksheet is provided in Worksheets #31, #32, and #33 in Attachment 2 of the QPP PBR (www.hafbdydocs.com). The information contained therein is applicable to this Site-Specific QAPP.

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QAPP Worksheet #34

Data Verification and Validation Input

The information required in this worksheet is provided in Worksheet #34 in Attachment 2 of the QPP PBR (www.hafbdydocs.com). The information contained therein is applicable to this Site-Specific QAPP.

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QAPP Worksheet #35

Data Verification Procedures

The information required in this worksheet is provided in Worksheet #35 in Attachment 2 of the QPP PBR (www.hafbdydocs.com). The information contained therein is applicable to this Site-Specific QAPP.

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QAPP Worksheet #36

Data Validation Procedures

Third-party full data validation is not required for sampling identified in this QAPP. However, the Project Chemist and Data Manager will conduct data verification activities to assess data usability including (1) review of the data package for completeness; (2) review of chain-of-custody forms (against laboratory reported information) for signatures, sample condition upon receipt by the laboratory, and sample preservation; (3) review of hold times; (4) review of QC summaries and case narratives; (5) review of blank results for possible field or laboratory contamination; and (6) review of laboratory detection limits for project samples to verify conformance with project objectives (screening levels). Results of the data verification activities will be documented in a memo to the project file.

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QAPP Worksheet #37

Data Usability Assessment

The information required in this worksheet is provided in Worksheet #37 in Attachment 2 of the QPP PBR (www.hafbdydocs.com). The information contained therein is applicable to this Site-Specific QAPP.

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- EPA. 2012. *Intergovernmental Data Quality Task Force Uniform Federal Policy for Quality Assurance Project Plans, Part 2A: Uniform Federal Policy-Quality Assurance Project Plan Workbook*. Revision 1. March.
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- NRC. 2000. *Multi-Agency Radiation Safety and Site Investigation Manual*. August.
- Parsons Infrastructure and Technology Group, Inc. (Parsons). 2007. *Final North Disposal Area, Thorium Site and Oil Emulsion Disposal Area Data Summary Report Little Mountain Test Annex Operable Unit A Remedial Investigation 2006 Program*. December.

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Attachment A
Standard Operating Procedures

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ATTACHMENT A

Standard Operating Procedures

- Standard Operating Procedures – Cabrera (Hill AFB-specific Standard Operating Procedures are provided in the Basewide Quality Assurance Project Plan [www.hafbdyndocs.com])
- TestAmerica Laboratories Inc. DoD ELAP Certification
- TestAmerica Laboratories Inc. Utah Certification
- TestAmerica SOP No. ST-RD-0102, Rev. 9 – Gammavision Analysis
- TestAmerica SOP No. ST-RD-0210, Rev. 11 – Alpha Spectroscopy Analysis
- TestAmerica Laboratories Inc. Quality Assurance Manual
- ALS Environmental DoD ELAP Certification
- ALS Environmental Utah Certification
- ALS Environmental Laboratory Quality Assurance Plan, Rev. 16
- ALS Environmental SOP No. 739, Rev. 11 – Preparation of Samples for Analysis by Gamma Spectroscopy
- ALS Environmental SOP No. 713, Rev. 12 - Analysis of Gamma Emitting Radionuclides by Gamma Spectroscopy – Method EPA 901.1
- ALS Environmental SOP No. 714, Rev. 12 - Analysis of Alpha Emitting Radionuclides by Alpha Spectroscopy



CABRERA SERVICES
RADIOLOGICAL • ENVIRONMENTAL • REMEDIATION

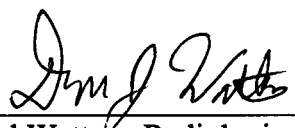
Radiation Safety Procedure

For

Classifying Radioactive Waste

AP-014

Revision 0

Reviewed By: 
David Watters, Radiological Safety Engineer

Date: 1/24/00

Approved By: 
Steven Masciulli CHP, CSP, Radiation Safety Officer

Date: 1/24/00

Approved By: 
Henry Siegrist CHP, P.E., Corporate Health Physicist

Date: 1/24/00

1.0 PURPOSE

The purpose of this procedure is to establish instructions by Cabrera Services, Inc. (CABRERA) used to classify waste for disposal; complete shipment manifest; and verifies waste receipt criteria. Adherence to this procedure will provide reasonable assurance that waste will be properly classified pursuant too 10 CFR 61.

2.0 APPLICABILITY

2.1 This procedure will be used to classify wastes pursuant to 10 CFR 61. Waste classification considerations for disposal at a licensed facility require:

2.1.1 Consideration must be given to the concentration of long-lived radionuclides (and their shorter-lived precursors).

2.1.2 Consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste, form, and disposal methods are effective.

2.2 Description of Procedures

2.2.1 Use of this procedure will demonstrate the methodology for determining:

- If the waste is acceptable for near-surface disposal.
- If the waste is acceptable for near-surface disposal, whether the waste is classified as Class A, Class B, or Class C waste.

2.2.2 Using this procedure CABRERA personnel will be able to determine whether the waste complies with any additional waste form, package or content requirement, which may be in place at the particular disposal facility to which the waste is to be shipped.

3.0 PRECAUTIONS, LIMITATIONS, AND REQUIREMENTS

3.1 Minor differences may exist between individual disposal facilities and the Waste Class tables presented in this procedure. ALWAYS classify waste per the destined facilities criteria.

3.2 The Barnwell facility has a Class C determination form that must be completed and forwarded with the shipment.

3.3 US Ecology facility has a NARM determination required to be completed before shipment.

- 3.4 Certain waste streams such as filter resins etc. also require isotopic analysis to be completed before shipment.

4.0 REFERENCES

- 10 CFR Part 61
- CNSI Barnwell Waste Management Facility License
- US Ecology Hanford License
- Envirocare Utah Department of Environmental Quality Radioactive Material License

5.0 DEFINITIONS AND ABBREVIATIONS

- 5.1 Class A Waste – Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and waste characteristics of Class A waste must meet the minimum requirements set forth in 10 CFR 61.56(a). If Class A waste also meets the stability requirements set forth in 10 CFR 61.56(b), it is not necessary to segregate the waste for disposal.
- 5.2 Class B Waste – Class B waste is waste that must meet more rigorous requirements on waste from to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in 10 CFR 61.56.
- 5.3 Class C Waste – Class C waste is waste that not only must meet more rigorous requirements on waste from to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements set forth in 10 CFR 61.56.

6.0 EQUIPMENT

None

7.0 RESPONSIBILITIES

- 7.1 Project Manager (PM) – The PM is responsible for ensuring that all personnel assigned the task of waste classification are familiar with this procedure and are adequately trained in the use of this procedure, and have access to a copy of this procedure.

- 7.2 Radiation Safety Officer (RSO) – The RSO is responsible for quality audits of waste classification performed by the Waste Broker.
- 7.3 Waste Broker – The Waste Broker is responsible to collect all required information about the waste and classifying the waste as outlined in this procedure.

8.0 INSTRUCTIONS

- 8.1 Procedural determination of concentration may be made by using the following individually or in combination.
- 8.1.1 Compliance through materials accountability, a given quantity (and resulting concentration) of radioactive material may be known to be contained within a given waste or may be inferred through determining the difference between the quantity of radioactive material entering and exiting a given process.
- 8.1.2 Classification by source is similar to the above method of materials accountability and involves determining the radionuclide content and classification of waste through knowledge and control of the source of the waste.
- 8.1.3 Gross radioactivity measurements is an acceptable method for all classes of waste provided that:
- The gross radioactivity measurements are correlated on a consistent basis with the distribution of radionuclides within the particular waste stream analyzed, and
 - The radionuclide distributions are initially determined and periodically verified by direct measurement techniques.
- 8.1.4 Measurements of specific radionuclides may establish an inferential measurement program whereby concentrations of radioisotope which cannot be readily measured (through techniques such as gamma-spectral analysis) are projected through rationing to concentrations of radioisotopes which can be readily measured.
- 8.1.5 The concentration of a radionuclide may be averaged over the volume of the waste or weight of the waste if the units are expressed as nanocuries per gram (using NRC Branch Technical Position Paper on Waste Classification current revision). For double packaged containers, only the inner package volume may be used for classification.

8.2 Preferred Waste Classification Procedure

This algorithm for waste classification is performed using a computer when available. When using a computer ensure data entry is accurate. Waste classification is to be performed by the Waste Broker with quality review performed by the RSO or duly authorized representative.

8.2.1 Classification determined by long-lived radionuclides. If the waste contains only radionuclides listed in Table I classification is determined as follows:

- If the concentration does not exceed 0.1 times the value in Table 1, the waste is Class A.
- If the concentration exceeds 0.1 times the value in Table 1, but does not exceed the value in Table 1, the waste is Class C.
- If the concentration exceeds the value in Table 1, the waste is not generally acceptable for near-surface disposal.
- For waste containing mixtures of radionuclides listed in Table 1, the total concentration shall be determined by the sum of fractions rule.
- Site-specific variations to Tables 1 and 2 may exist. Prior to classifying waste, verify that correct numbers are being used for the planned disposal facility.

Table 1

Radionuclides	Concentration Curies/Cubic Meter
C-14	8
C-14 in activated metal	80
Ni-59 in activated metal	220
Nb-94 in activated metal	0.2
Tc-99	3
I-129	0.08
Alpha emitting transuranic radionuclides with T1/2 >5 years	100 ¹
Pu-241	3,500 ¹
Cm-242	20,000 ¹
Ra-226	100 ¹

¹ Units are in nanocuries per gram; to convert to becquerels (Bq) per gram multiply by 37, to convert from curies to gigabecquerels (GBq) multiply by 37. Specific approval of SCDHEC (South Carolina) is required for disposal of these radionuclides if their concentration is greater than ten percent of the Table 1 values.

8.2.2 Classification determined by short-lived radionuclides. If the waste does not contain any of the radionuclides listed in Table 1, classification shall be determined based on the concentration shown in Table 2. If the radioactive waste does not contain any radionuclides listed in either Table 1 or 2 its is Class A.

8.2.2.1 If the concentration does not exceed the value of Column 1, the waste is Class A.

8.2.2.2 If the concentration value exceeds the value in Column 1, but does not exceed the value in Column 2, the waste is Class B.

8.2.2.3 If the concentration value exceeds the value in Column 2, but does not exceed the value in Column 3, the waste is Class C.

8.2.2.4 If the concentration value exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.

8.2.2.5 For waste containing mixtures of the radionuclides listed in Table 2, the total concentration shall be determined by the sum of fractions rule.

8.2.2.6 Site-specific variations to Table 2 may exist. Prior to classifying waste, verify that correct numbers are being used for the planned disposal facility.

Table 2

Radionuclide	Concentration Curies/Cubic Meter		
	Column 1	Column 2	Column 3
Total of all radionuclides with T1/2 <5 years	700	(*)	(*)
H-3	40	(*)	(*)
Co-60	700	(*)	(*)
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Cs-137	1	44	4600

(*) There are no limits established for these radionuclides in Class B or C wastes. Practical consideration such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes are Class B unless the concentration of other radionuclides in Table 2 determine the waste to be Class C independent of there radionuclides. Specific approval of SCDHEC is required prior to packaging of Class B tritium waste.

8.2.3 Classification determined by both long-lived and short-lived radionuclides. If the waste contains a mixture of radionuclides some of which are listed in Table 1 and some of which are listed in Table 2 classification shall be determined as follows.

- If the concentration of a radionuclide listed in Table 1 is less than 0.1 times the value listed in Table 1 the class shall be that determined by concentration of radionuclides listed in Table 2.

- If the concentration of a radionuclide listed in Table 1 exceeds 0.1 times the value listed in Table 1 the waste shall be Class C provided the concentration of radionuclides listed in Table 2 does not exceed the value shown in Column 3 of Table 2.

8.2.4 Classification of waste with radionuclides other than those listed in Tables 1 and 2. If the waste does not contain any radionuclides listed in either Table 1 or 2, its is Class A.

8.2.5 The sum of fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each radionuclides concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column.

Example: A waste contains Sr-90 in a concentration of 50 Ci/m³ and Cs-137 in a concentration of 22 Ci/m³. Since the concentrations both exceed the values in Column 1, Table 2, they must be compared to Column 2 values. For Sr-90 fraction, $50/150 = 0.33$; for Cs-137 fraction, $22/44 = 0.5$; the sum of the fractions = 0.83. Since the sum is less than 1.0, the waste is Class B.

8.2.6 Determine package type in accordance with 49 CFR 173.431, 173.433, and 173.435.

8.2.7 Determine if R.Q. marking is required using 49 CFR 172.101 Appendix Table 2.

8.2.8 Verify LSA concentrations with 49 CFR 173.403(N).

8.2.9 Any items exceeding a destination facility license shall not be shipped refer to destination facility license. If material does not comply with license for the facility, the shipment ID going to the waste will not be accepted.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 Instrumentation used in the surveys will be checked with standards daily and verified to have current valid calibration.

9.1.2 Waste classification will be documented on AP Form 014-01 or may be computer generated.

9.1.3 Waste classification will be documented when shipping radioactive material to the burial site in accordance with waste broker standard procedures.

9.2 Records

9.2.1 Documented information shall be legibly written in ink or equivalent computer generated form.

9.2.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The individual determining the classification shall review Form AP-014 and any other applicable forms for accuracy and completeness.

9.2.4 Entries on Form AP-014-01 and any other pertinent forms must be dated and initialed by the individual determining the classification to be valid.

9.2.5 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

AP-014-01	Waste Classification Form
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WASTE CLASSIFICATION WORKSHEET**Form AP-014-01**

Generator: _____

Container Number: _____

Container Weight: _____

Container Volume: _____

Package Type: _____

Type A Fraction: _____

RQ Labeling: _____

LSA Concentration: _____

Table 1 Class: _____

Table 2 Class: _____

RADIONUCLIDE QUANTITIES IN THIS CONTAINER (mCi)

Totals: _____ Weight of Waste: _____ LBS

Performed By: _____ Date: _____

Reviewed By: _____ Date: _____



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

RADIOLOGICAL SURVEYS

OP-001

Revision 3.0

Reviewed by:

David Wunsch, Quality Assurance Manager

Date

Approved by:

Henry Siegrist, CHP, PE, Radiation Safety Officer

Date

1.0 PURPOSE

The purpose of this procedure is to establish the framework and to define the requirements for Cabrera Services Inc., (CABRERA) personnel performing radiological surveys. Adherence to this procedure will provide reasonable assurance that the radiological surveys performed yield reproducible results. In addition, adherence to this procedure will provide adequate control of radiation exposures As Low As Reasonably Achievable (ALARA).

2.0 APPLICABILITY

- 2.1 This procedure provides the requirements and general guidelines for identifying, scheduling, and performing routine, radiation, contamination, and airborne surveys by radiation safety personnel. Remediation and facility areas that are radiologically controlled (restricted areas) due to the potential for fixed or transferable contamination are considered for routine survey performance.
- 2.2 The following types of surveys may be performed using this procedure:
 - Surveys for shipping radioactive materials (Department of Transportation [DOT] regulations may require additional consideration).
 - Surveys performed to characterize facilities, sites, and/or release items potentially contaminated with radioactive materials from restricted areas.
 - Surveys performed to provide information used to guide or direct decontamination and decommissioning of facilities and sites.
- 2.3 This procedure does not include survey requirements for radiation generating devices and survey requirements specified in radiation work permits (RWPs).
- 2.4 Approved work plans may require more or fewer surveys and controls to be applied at the site than described in this procedure.

3.0 DEFINITIONS

- 3.1 Radiological Control/Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.
- 3.2 Contamination Survey – A survey technique to determine fixed and removable radioactive contamination on components and facilities.
- 3.3 Radiation Survey – An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation.

- 3.4 As Low As Reasonably Achievable (ALARA) – An approach to radiation exposure control to maintain personnel exposures as far below the federal limits as the technical, economical and practical considerations permit.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- 4.1.1 Instruments used to perform routine surveys should be operated in accordance with the respective operating procedures or manufacturer's recommendations.
- 4.1.2 Large area smears (LAS) may be used to augment (but not replace) the one hundred square centimeter (100 cm²) smear survey. LAS may be counted with a Ludlum Model 3 and 44-9 probe or Ludlum Model 2224-1 and 43-93 probe or equivalent. LAS are used to obtain immediate information concerning loose contamination for the purpose of radiological protection and to minimize time spent performing smears on an item easily identified as contaminated.
- 4.1.3 Personnel performing routine surveys must be logged in on a RWP in accordance with AP-012, *Radiation Work Permits* (if applicable).
- 4.1.4 Audible response instruments should be used during direct scan surveys.
- 4.1.5 The instruments used for routine surveys must be within current calibration and must have had a performance test check performed daily, or before use, in accordance with the instrument's operating procedure.

4.2 Limitations

- 4.2.1 The maximum probe speed during direct scan surveys of surfaces must be 3 centimeters per second (cm/sec).
- 4.2.2 The probe face must be held within ¼ inch of the surface being surveyed for alpha radiation, and within ½ inch of the surface being surveyed for beta-gamma radiation.
- 4.2.3 If an instrument used to perform routine surveys fails operational checks, it will be removed from service. Data collected during the period of instrument failure must be evaluated by the Radiation Safety Officer (RSO) or duly authorized representative.
- 4.2.4 Posting of radiological control areas must be performed in accordance with OP-019, *Radiological Posting*.

4.3 Requirements

- 4.3.1 Individuals performing surveys will obtain and review any previous surveys performed in the area, or on the object, to determine radiation conditions that may be encountered.
- 4.3.2 Only qualified individuals will perform surveys. Qualification will be determined on a case-by-case basis by the Project Manager, Radiation Safety Officer or their duly authorized representative. Qualification considers prior training, experience, and certifications such as Radiation Protection Technician or National Registry of Radiation Protection Technologists.
- 4.3.3 Survey samples must be analyzed in a low-background area, whenever practical, to ensure achieving the required sensitivity of measurements.
- 4.3.4 At a minimum, dose rate surveys must be performed in locations where workers are exposed to radiation levels that might result in: radiation doses in excess of 10% of the occupational dose limits – or – where an individual is working in a dose rate area of 2.0 millirem per hour (mrem/hr), or more.
- 4.3.5 Prevent access to unrestricted areas if contamination is found and immediately notify the RSO or duly authorized representative.

5.0 EQUIPMENT

- 5.1 Radiation and Contamination survey meters will be selected based on job specific requirements and be identified in the Site Work Plans.
- 5.2 Instruments used to perform routine surveys will be used in accordance with the applicable CABRERA administrative and operational procedures.
- 5.3 Authorized suppliers of properly calibrated and maintained equipment will supply/calibrate instruments; although equipment counting efficiencies may be determined by qualified CABRERA personnel.

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) - The PM is responsible for ensuring that personnel assigned the task of performing routine surveys are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.
- 6.2 Radiation Safety Officer (RSO) - The RSO is responsible for monitoring compliance with this procedure and training personnel in performing radiation and contamination surveys. The RSO can also assist in the interpretation of the results obtained during surveys.

- 6.3 Site Radiation Safety Lead (SRSL) - During field assignments, the SRSL is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the SRSL will act as the RSO's duly authorized representative for radiological issues.
- 6.4 Radiation Protection Technicians (RPT) - The RPT performing radiation and contamination surveys are responsible for understanding and complying with this procedure.

7.0 PROCEDURE

7.1 Safety Considerations

The safety requirements specified in the job specific Health and Safety Plans (HASPs) and work plans, the Radiation Safety Program (RSP), and other safety documentation must be adhered to when performing surveys.

7.2 Initial Preparations

Obtain and review any previous surveys performed in the area to determine radiation conditions that may be encountered.

7.2.1 Obtain appropriate survey instruments and assure daily quality control (QC) checks have been performed prior to instrument use.

7.2.2 Obtain necessary forms, smears, and protective clothing, which will be used during the survey.

7.2.3 Plan any strategy for performing the survey before entering the area to reduce exposure time within the area.

7.2.4 If smearable contamination is expected to be above allowable limits, set up an entry/exit area which will prevent the spread of contamination.

7.3 Radiation Surveys

7.3.1 If radiation levels are unknown or previous surveys remain in question, first measure general area radiation levels using a Micro-R Meter or equivalent dose rate meter to determine if elevated radiation levels exist in the survey area.

7.3.2 Small Areas/Items/Containers – This survey technique is used to establish exposure rates from small areas, items, or containers that contain radioactive materials.

- Scan the entire surface area of the area, item, or container with a Micro-R or equivalent meter and record locations and readings on the Survey Form, in Attachment B, or an equivalent form.

- Measure the exposure rate at 30 centimeters from all surfaces or sides of the area, item, or container and record the location and readings on the Survey Form, in Attachment B, or an equivalent.
- Large waste containers used for shipment of bulk quantities of soil debris etc., may have a single dose rate measurement per accessible side of the container for ALARA purposes. DOT regulations may require additional dose rate measurements prior to shipping which is not covered by this procedure. Note readings on the Survey Form or an equivalent.

7.3.3 Facility Surveys – This survey technique may be used to release facilities (buildings, etc.) to “unrestricted” status or to determine the status of facilities requiring decontamination and decommissioning. Final release of a facility will be established using the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance.

- Establish a 1 meter by 1 meter grid system [or another work plan-approved grid] for the facility surfaces and use a marking system that assigns a unique number/letter to the center of each grid section. Graphically illustrate the location of the grid system on the Survey Form, in Attachment B, or an equivalent.
- Using a Micro-R Meter or equivalent obtain radiation levels at 1 meter from the grid center point and at contact with the grid center point. Record the reading on the Survey Form, in Attachment B, or an equivalent. If elevated readings are noted, scan the surface of the grid and note the location of any elevated readings with a marker on the form.
- Obtain Micro-R or equivalent readings from locations surrounding the facility, or within the facility, which do not contain activity. This establishes a background level for comparison to the reading taken above.

7.3.4 Area Surveys – This survey technique may be used to release land masses to “unrestricted” status or determine status of areas requiring decontamination before release. Final release of a site area will be established using MARSSIM guidance

- Establish a 10 meter by 10 meter grid system of the area to be surveyed [or another approved grid as provided by the work plan] using surveyor stakes or equivalent, which are numbered with a unique number/letter to identify the center of each grid. List the locations of the “gridded” system on the Survey Form or an equivalent.
- Using a Micro-R meter or equivalent, obtain radiation levels at 1 meter above the ground surface in the center of the grid. Record all readings on the Survey Form or an equivalent.

- Survey the remainder of the grid at the surface using an “S” pattern for the instrument. If elevated readings are noted above or below the grid center point reading, subdivide the grid into additional sub-grids and obtain readings at 1 meter above the ground surface. Record all readings on the Survey Form or an equivalent.

7.4 Contamination Surveys

7.4.1 If removable contamination is suspected or previous surveys are in question, first scan likely contaminated areas with an alpha (α) and/or beta (β) probe and determine if elevated areas of contamination exists. Obtain smear samples from any elevated areas and count smears in sample counter. If smearable contamination above limits set for the job is found, use appropriate protective clothing and entry control techniques to prevent the spread of contamination.

7.4.2 Small Areas/Items/Containers – This survey technique is used to establish total and transferable contamination levels on small areas, items, or containers, which contain radioactive materials.

- If the area, item, or container contains alpha activity, scan the area with an alpha probe at $\frac{1}{4}$ inch above the surface. Note total (fixed plus transferable) contamination readings on the Survey Form or an equivalent.
- If the area, item, or container contains beta activity, scan the area with a beta probe at approximately $\frac{1}{2}$ inch above the surface to be surveyed and obtain reading following meter stabilization. Record meter reading on the Survey Form or an equivalent. The surface of a container can only be directly surveyed for beta activity if the radiation level from the container does not significantly elevate the beta probe background. Note total (fixed plus transferable) contamination readings on the Survey Form or an equivalent.
- Provide transferable smear contamination survey on the area, item or container by performing 100 cm² smears, at routine intervals, on the subject area, item, or container.
- Large waste containers used for shipment of bulk quantities of material will have one or more contact readings taken at routine intervals on the accessible sides of the container. Note total (fixed plus transferable) contamination readings on the Survey Form or an equivalent. **Note:** DOT regulations may require additional survey points.
- For large waste containers used for shipment of bulk quantities of material for disposal (or other large items such as soil moving equipment), determine the transferable surface contamination by taking LAS. Use Masslinn cloth or equivalent material to obtain a

LAS representative of the potentially contaminated area. Count the LAS, in a low background area, using alpha and beta detection equipment. If no transferable contamination above limits is found on the LAS, take several confirmatory 100 cm² smears at routine intervals on the object and count smears for alpha and beta activity. Record results on the Survey Form or an equivalent. **Note:** DOT regulations may require additional survey points.

Note: The presence of activity above transferable limits on a LAS signifies potential contamination. Determine actions to be taken with the RSO or SRSL.

7.4.3 Facility Surveys – This survey technique is used to aid in the release of facilities (buildings etc.) to “unrestricted” status or determine status of facilities requiring decontamination and decommissioning. Final release of a facility will be established using MARSSIM guidance.

- The grid system established in Section 7.3.3 will also be utilized for contamination surveys.
- Hold the beta probe at approximately ½ inch above the grid center point and obtain reading following meter stabilization. Record the meter reading on the Survey Form or an equivalent.
- If the readings are at background levels, randomly scan the remainder of the grid, concentrating on cracks, floor/wall joints, top of horizontal surfaces, ventilation ducts and grills, and other areas that might collect radioactive materials. Mark any locations above the release criteria on the Survey Form or an equivalent.
- If readings are at or near the release levels, scan grid surface and identify the portion of the grid that is above the release criteria. Note these areas on the survey form and mark the area of the grid with spray marker (or equivalent) on the Survey Form or an equivalent. Repeat steps 8.3.4 with an alpha probe at ¼ inch above the grid center point. If sufficient documentation of previous history is known about the facility and contamination is known not to be present, the alpha survey may not be required.
- One smear sample from a 100 cm² area will be taken in each grid. If the above survey found no elevated readings in the grid, the smear sample will be taken in the center of the grid. If elevated levels readings are identified the smear sample will be taken from the area where the highest reading was obtained.
- Each smear sample will be labeled with the grid location and counted for alpha and beta activity in the sample counter. The smear sample results will be recorded on the Survey Form or an equivalent.

7.4.4 Area Surveys – This survey technique is used to aid release of land masses to “unrestricted” status or determine status of area requiring decontamination before release. Final release of a facility will be established using MARSSIM guidance.

- The grid system established in Section 7.3.4 will be utilized for contamination surveys.
- Hold the beta probe at ½ inch above the grid center point and obtain reading following meter stabilization. Record the meter reading on the Survey Form or an equivalent.
- If readings are at background levels, randomly scan the remainder of the grid. Mark any locations above release criteria on the Survey Form or an equivalent.
- If readings are at or near the release levels scan the grid surface and identify portion of the grid that is above release criteria. Note these areas on the Survey Form or an equivalent.
- Areas contaminated with radioactive materials may require soil sample analysis to determine the activity concentration. The quantity and location of samples will be determined on a case-by-case basis.

7.5 Frequency and Requirements for Routine Surveys

Appropriate routine radiological surveys will be performed at the following frequencies as a minimum:

7.5.1 Radiation Surveys

- Upon initial entry after extended periods of closure,
- Daily, at contamination control points, where the potential exists for personnel to be exposed to dose rates greater than 2 mrem/hr,
- Daily, during continuous operation, and when levels are expected to change,
- Weekly, in routinely occupied areas adjacent to radiological control areas with dose rates greater than 2 mrem/hr,
- Weekly for operating High Efficiency Particulate Air (HEPA)-filtered ventilation units,
- Weekly, for any temporary Radiation Area boundaries to ensure that the Radiation Areas do not extend beyond posted boundaries, and
- Monthly, or upon entry if entries are less than monthly, for Radioactive Material Storage Areas.

7.5.2 Contamination Surveys

- Daily, at contamination control points from areas exhibiting contamination above surface contamination limits for the job site,
- Daily, in office spaces located in the radiological control areas,
- Weekly in lunchrooms or eating areas adjacent to radiological control areas,
- Weekly, in routinely occupied locker rooms or the shower areas adjacent to radiological control areas associated with site radiological work,
- Weekly, or upon entries, if entries are less frequent, in the areas where radioactive materials are handled or stored, and
- Weekly for all project offices on site.

7.5.3 Airborne Surveys

Airborne survey frequency, locations, and methods are determined by the RWPs and by the RSO/SRSL.

7.6 Identifying and Scheduling Routine Radiological Surveys

- 7.6.1 To assist in assuring surveys are scheduled, the RSO or duly authorized representative will identify and schedule routine surveys, as required by the radiological conditions and work activities.
- 7.6.2 Routine Survey Schedules or equivalent should be developed using a standard system for designating surveys such as:

Frequency of Survey

• Daily	D
• Weekly	W
• Monthly	M
• Quarterly	Q
• Semi-Annually	S
• Annually	A
• Upon Entry	U

Type of Survey

• Radiation	R
• Contamination	C
• Area TLD	T
• Air Sample	A

Example: DRC-1

Where:

- D: is the survey frequency (Daily in this example)
- R: is the type of survey (Radiation in this example)
- C: is a type of survey (Contamination)
- 1 corresponds to the numerical sequence of the survey

7.6.3 Routine survey schedules should be submitted to, and reviewed by, the RSO or duly authorized representative.

7.6.4 Routine Survey Schedules should be indicated on form in Attachment A or an equivalent. Task Leaders may elect alternate methods of determining the information contained on the Routine Survey Schedule.

7.7 Using ALARA Principles for Scheduling and Performing Surveys

7.7.1 Routine surveys should not be performed in High Radiation Areas unless other work necessitates entry. Boundary verification surveys would be appropriate if an entry is not required.

7.7.2 Routine surveys should be performed in conjunction with other work surveys as much as practicable.

7.8 Performance of Routine Surveys

7.8.1 RPTs and qualified individuals will perform routine surveys in accordance with the applicable operational procedure.

7.8.2 Upon completion of a routine survey, the RPT will initial and date the appropriate Survey Form.

7.9 Periodic Evaluation of Routine Surveys

7.9.1 Routine Survey Schedules should be reviewed and updated periodically to ensure that all areas within the project boundaries are receiving the appropriate routine survey coverage.

7.9.2 Changes of conditions within the project area will be reported to the RSO or duly authorized representative and may require a modification of the routine radiological survey schedule.

7.10 Management Notification

The RSO should be notified, by the PM or duly authorized representative, of failure to complete a routine survey, as scheduled. The missed survey will be completed within 24 hours (or next working day) of discovering the inconsistency.

8.0 REFERENCES

- Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation, Subpart E, *Radiological Criteria for License Termination*
- Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation, Subpart F, *Surveys and Monitoring*
- Title 10, Code of Federal Regulations, Part 20.2103, *Records of Surveys*
- Radiation Safety Program, Cabrera Services Inc., Manual
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure
- AP-010, *Personnel Protective Equipment Used Within Radiological Controlled Areas*, Cabrera Services Inc., Operating Procedure
- AP-012, *Radiation Work Permits*, Cabrera Services Inc., Operating Procedure
- OP-019, *Radiological Posting*, Cabrera Services Inc., Operating Procedure
- OP-020, *Operation of Contamination Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-021, *Alpha-Beta Counting Instrumentation*, Cabrera Services Inc., Operating Procedure
- OP-022, *Operation of Ionization Chambers*, Cabrera Services Inc., Operating Procedure
- OP-023, *Operation of Micro-R Meters*, Cabrera Services Inc., Operating Procedure

9.0 REQUIRED RECORDS

9.1 Survey records should include the following, at a minimum:

- A diagram of the area surveyed, if applicable.
- A list of items and equipment surveyed.
- Specific locations on the survey diagram where wipe test were taken.
- Background radiation levels with appropriate units.
- Contamination levels with appropriate units.
- Make, model number, and serial number of instruments used.
- Name of the person making the evaluation and recording the results and date.

9.2 Routine Survey Schedule

9.3 Survey Form

10.0 ATTACHMENTS

- Attachment A – Routine Survey Schedule
- Attachment B – Survey Form

Attachment A

Routine Survey Schedule

Routine Survey Schedule

Survey Designation	Location of Survey

Prepared By: _____

Date: _____

Reviewed By: _____

Date: _____

Attachment B

Survey Form

Survey Form

Location: Site:						RWP#				Survey #				Survey Type:				pg. 1 of ____									
Smear (CPM/100 cm ²)						circle one																					
Direct Count (CPM/Direct Frisk)																											
No.	α	β	No.	α	β																						
1			26																								
2			27																								
3			28																								
4			29																								
5			30																								
6			31																								
7			32																								
8			33																								
9			34																								
10			35																								
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19			44																								
20			45																								
21			46																								
22			47																								
23			48																								
24			49																								
25			50																								
Comments						Surveyed By:		Date:		Instrument		Serial #		α Eff.		β Eff.		α Bkg.		β Bkg		γ Bkg		Cal. Due		Key	
																										<input type="checkbox"/> A/S Location	
																										<input type="checkbox"/> Boundary	
																										<input type="checkbox"/> Smear	
																										<input type="checkbox"/> Dose Rate _____ /hr	
						Reviewed By:		Date:																		<input type="checkbox"/> Direct Reading CPM/direct frisk	
																										<input type="checkbox"/> Grab Sample	



CABRERA SERVICES
RADIOLOGICAL · ENGINEERING · REMEDIATION

OPERATING PROCEDURE

FOR

RADIOACTIVE AIR SAMPLING AND ANALYSIS

OP-002

REVISION 1.0

Reviewed by:

David Wunsch, Quality Assurance Manager

4/12/2013

Date

Approved by:



Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

This procedure provides the methods Cabrera Services Inc. (CABRERA) uses in the operation of air samplers and the calculation of radioactive particulate activity in air samples. This procedure describes the methods used to calculate Derived Air Concentration (DAC)-hour exposures to workers. Adherence to this procedure will provide a reasonable assurance that the surveys performed have accurate and reproducible results.

2.0 APPLICABILITY

This procedure will be used by CABRERA personnel to operate air samplers during surveys and work activities at customer facilities as well as calculate and record DAC-hour exposures to workers.

Air samples are considered when the alpha and beta contamination on facility surfaces, equipment and waste packages exceed the contamination limits specified in Table 1 of the Radiation Safety Program (RSP) and included as Attachment C of this procedure. Air monitoring will be performed in areas where there exists potential to exceed 10 percent (%) of any radionuclide DAC.

3.0 DEFINITIONS

- 3.1 Restricted Area – An area where access is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted areas do not include areas used as residential quarters, but separate rooms in a residential building may be set apart as restricted areas.
- 3.2 Smear Sample Survey – A survey technique using filter paper smears to determine quantities of alpha and beta emitting radioactive material which can be removed from facility surfaces and waste packages.
- 3.3 Air Sample Survey – A survey technique which collects particulates from a known volume of air and determines the concentrations of radioactive materials associate with airborne particles.
- 3.4 Annual Limit on Intake (ALI) – The ALI of radioactive materials is the smaller amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year (40 hours per work week for 50 weeks) that would result in a committed effective dose equivalent (CEDE) of 5 rem (0.05 Sievert [Sv]) or a committed dose equivalent (CDE) of 50 rem (0.5 Sv) to any individual organ or tissue.
- 3.5 Derived Air Concentration (DAC) – DAC is the concentration of a given radionuclide in air which, if breathed by “reference man” for a working year (40 hours per week for 50 weeks) under the conditions of light work (inhalation rate

of 1.2 cubic meters of air per hour), results in an air intake of one ALI.

- 3.6 DAC-hour – The product of the concentration of radioactive material in air, expressed as a multiple of the DAC for each nuclide, and the time of exposure to that nuclide in hours; 2,000 DAC-hours represents one ALI.
- 3.7 Airborne Radioactivity Area – A room, enclosure, or area in which the radioactive material is dispersed in the form of dusts, fumes, mists, particulates, or vapors, and the concentration of the dispersed radioactive material is in excess of:
- The DACs specified in Table 1 Column 3 of Appendix B, Title 10, Code of Federal Regulations, Part 20 (10 CFR 20), or
 - Concentrations such that an individual present in the area without respiratory protective equipment could exceed, during the hours the individual is present in a week, an intake of 0.6% of the ALI, or 12 DAC-hours.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- 4.1.1 Air samples run at altitudes in excess of 5,000 feet need to consider pressure adjustments for altitude and recorded flow-meter readings.
- 4.1.2 Air sample media will tear if the filter comes into contact with water. Outdoor sampling requires special consideration to ensure an effective sample is obtained.

4.2 Limitations

Air samplers should only be operated in temperatures between -4°F to 122°F .

4.3 Requirements

- 4.3.1 Air sampler inspections will be performed by qualified Health Physics personnel.
- 4.3.2 The alpha and beta counter used to count air samples will be calibrated daily with a known radioactive source with activity traceable to the National Institute of Standards and Technology (NIST).
- 4.3.3 Radiation Protection Technologists (RPTs) performing air sampling and analysis will review all applicable forms for accuracy and completeness. Entries on all pertinent forms must be dated and initialed, by the RPT performing the air sampling and analysis, to be valid.
- 4.3.4 The RSO or duly authorized representative will review any applicable completed forms for accuracy and completeness.

5.0 EQUIPMENT

- Low volume general area sampler: LV-1
- High volume air sampler: HI-Q
- Personal Breathing zone samplers: BZ

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – Ensuring that personnel assigned the task of air sampling and air analysis know and understand this procedure and are adequately trained with the specific instrument(s) being used to perform surveys.
- 6.2 Radiation Safety Officer (RSO) – Monitoring compliance with this procedure and training personnel in the use of the air sampling and air sampling analysis equipment. The RSO can also assist in the interpretation of the results obtained during surveys.
- 6.3 Site Radiation Safety Lead (SRSL) – During field assignments, the SRSL is the RSO's duly authorized representative for radiological issues when the RSO is not onsite, and is responsible for ensuring that this procedure is properly implemented.
- 6.4 Radiation Protection Technician(s) (RPT) – The RPT(s) performing air sampling and air sampling analysis are responsible for knowing, understanding and complying with this procedure.

7.0 PROCEDURE

7.1 Initial Preparation

- 7.1.1 Select the air sampler to be used, for the type of sample to be used, and verify that the instrument has a currently valid calibration. If the work area contains radioiodine or tritium, contact the RSO for special sampling procedures before proceeding.
 - Area air samples are collected with a low volume air sampler (LV-1) having airflow capability of 20 to 100 liters per minute (LPM) and are routinely set at 80 LPM.
 - Area air samples are collected with high volume air samplers (HI-Q) having airflow capability of 10 to 50 cubic feet per minute (CFM) and are routinely set at 15 to 40 CFM, depending upon the filter size used.
 - Breathing zone (BZ) air samples are normally collected using BZ, or lapel air samplers, which have an airflow capability of 1 to 5 LPM

and are calibrated and set at 4 LPM for radiological air sampling.

Note: Settings should not be changed.

- All air sampling devices will be calibrated to ensure accurate sample volumes are collected. The frequency of calibration will not exceed one (1) year.

7.1.2 Attach the air sampling head to the intake of the low volume sample pump or to the Tygon tubing of the lapel sampler.

7.1.3 Obtain the filter paper, to be used in the sample, and mark the back side of the filter with a unique number or mark, to represent the clean side of the filter. During the collection and handling of air sample filter papers, caution must be used to prevent the samples from being cross-contaminated by radioactive materials.

7.1.4 Place the filter paper in the holder and position the sampler, as indicated below.

- Area air samples are collected by placing the sample head at a distance of 3 to 6 feet above the floor and as close to the work area, as practical. If there is airflow in the work area, the sampler should be placed “downwind” of the area where there is the greatest potential for radioactive material to be suspended in air.
- BZ/lapel air samples are collected from the workers breathing zone. The sample head is attached to the shoulder of the worker with the sample head facing forward. The sample head will be no further than 12” from the breathing zone. The Tygon tubing connecting the sample head to the pump is run down the back of the worker with the sample pump attached to the workers belt.

7.2 Collecting the sample

7.2.1 When the sample head with filter is in position, start the low volume or high volume sample pump and adjust the flow rate to the highest practical flow rate that can be maintained without flow rate fluctuations. BZ/lapel air samplers are not to be adjusted but rather be left at the calibration setting of 4 LPM following manufacturer maximum recommended flow rates.

7.2.2 Record the time the sample was started and the initial flow rate of the sample pump on Attachment A, Air Sample Data Sheet. Approved electronic templates may be used in place of this form as long as the equivalent information is provided, as described in this procedure.

7.2.3 If possible, identify the radionuclides, which will be encountered in the work area and record the radionuclides along with the DAC for each radionuclide in the space provided on the Air Sample Data Sheet. If a mixture of radionuclides is present, the DAC used in the calculations of

DAC-hours will be the most restrictive concentration.

7.2.4 Collect the sample for the maximum time possible, which represents the exposure encountered by the worker.

7.2.5 At the end of the collection period, note the flow rate of the sample pump and record this flow rate and the time, which the sampling stopped on the Air Sample Data Sheet. Collection times must be sufficient to achieve required MDA/MDCs for the radioisotope(s) of concern.

CAUTION: Be sure not to remove activity from the sample surface. Handle the filter with care (tweezers should be used if possible).

7.2.1 Remove the sample filter and place the filter in an individual envelope or poly bag to ensure no possibility of contamination by other sources of radioactivity.

7.2.2 Record the names of workers who were in the area and the time spent in the work area on the Daily Air Sample Record, in Attachment B. Approved electronic templates may be used in place of this form as long as the equivalent information is provided, as described in this procedure.

7.2.3 Determine the average sample flow rate by adding the initial sample flow rate and the final sample flow rate and dividing by 2. Record the average flow sample flow rate in the space provided on the Air Sample Data Sheet.

7.2.4 Calculate the total air volume sampled by multiplying the average flow rate in cubic centimeters per minute by the total minutes the sampler operated using the indicated spaces on the Air Sample Data Sheet.

7.3 Determining Minimum Detectable Activity (MDA) – During calculations or air concentrations in the following sections, the MDA for each analysis is calculated to determine the statistical significance of the calculated air concentrations.

7.3.1 For each air concentration calculation (alpha and beta) in the following sections, calculate the MDA using the following formula:

$$MDA \text{ in } \mu\text{Ci} / \text{cm}^3 = \frac{\frac{k_{\alpha}^2}{T_{s+b}} + 2[k_{\alpha}] \sqrt{\frac{R_b}{T_b} + \frac{R_b}{T_{s+b}}}}{(2.22 \times 10^6)(E)(V)}$$

Where:

E = Counter efficiency in CPM/DPM

- R_b = Background Count Rate in CPM
 T_b = Background Counting Time in Minutes
 T_{s+b} = Sample Counting Time in Minutes
 V = Sample Volume in cm^3
 2.22×10^6 = Disintegrations per minute per microCurie (DPM/ μCi)
 k_α = 1.645 for a confidence level of 95% and 1.96 for a confidence level of 99%

7.3.2 If the MDA is larger than 10% of the DAC, recount the background for a longer time and/or increase the sample count time to lower the MDA. (The maximum count time should not exceed 1 hour for background and 30 minutes for the sample). Enter the MDA for each air concentration calculated in the space provided on the Air Sample Data Sheet.

7.4 Initial Air Sample Analysis – The initial analysis of air samples provides the air concentrations for short-lived radionuclides and a first estimate of the long-lived air concentrations. In situations where there is a potential for worker intakes to exceed 40 DAC-hours in a week, or if the radionuclides of interest are short-lived, air sample results should be available before work resumes the following day.

7.4.1 Air particulate samples are to be analyzed, at a minimum, for gross alpha and gross beta activity using a Ludlum Model 2929 Dual Channel Scaler or equivalent.

7.4.2 Place the air sample collection media in the sample counter with the upstream collection side toward the detector. Count the air sample and calculate the sample activity and record results on appropriate form(s).

7.4.3 Record the alpha and beta sample DPM results in the Air Sample Data Sheet.

7.4.4 Calculate the alpha and beta air concentrations using the following formula. Adjustments due to alpha self-absorption are made, as appropriate.

$$\text{Air Concentration } (\mu\text{Ci} / \text{cc}) = \frac{\alpha \text{ or } \beta \text{ DPM}}{(2.22 \times 10^6 \text{ DPM} / \mu\text{Ci})(\text{Sample Volume}(\text{cm}^3))}$$

7.4.5 Enter the alpha and beta air concentrations on the Air Sample Data Sheet in the space provided for the initial air concentrations.

Note: If air sample concentration is greater than 10% of the DAC value, notify the RSO or duly authorized representative for further instructions.

- 7.4.6 If the air concentration is less than 10% of the most restrictive DAC, no further analysis of the air sample is required. If the air concentration exceeds 10% of the DAC concentration, proceed with the analysis in section 7.5.
- 7.5 Air sample analysis for long-lived radionuclides – This analysis allows for decay of naturally occurring radionuclides and provides for correcting air concentrations for naturally occurring radionuclides.
- 7.5.1 Particulate samples will be analyzed for gross alpha and gross beta following a 30-minute delay to account for radon decay, and again at 4 hours, if necessary, to allow for further decay using a Ludlum Model 2929 Dual Channel Scaler or equivalent.
- 7.5.2 Place the air sample in the sample counter with the collection side toward the detector. Count the air sample and calculate the sample activity and record results on appropriate form(s).
- 7.5.3 Record the alpha and beta sample DPM results in the Air Sample Data Sheet.
- 7.5.4 Calculate the alpha and beta air concentrations using the following formula. Adjustments due to self-absorption are made as appropriate.

$$\text{Air Concentration } (\mu\text{Ci} / \text{cc}) = \frac{\alpha \text{ or } \beta \text{ DPM}}{(2.22 \times 10^6 \text{ DPM} / \mu\text{Ci})(\text{Sample Volume}(\text{cm}^3))}$$

- 7.5.5 Enter the alpha and beta air concentrations, on the Air Sample Data Sheet, in the space provided. If the 30-minute decay air concentration is below 10% of the DAC, no further analysis is required.
- 7.5.6 If the 30-minute air concentration is above 10% of the DAC value, recount the air sample following 4 hours of decay from the time the sample was stopped. Calculate the air concentration using the formula in step 7.5.4 and record the air concentrations in the space provided for the 4-hour decay air concentration on the Air Sample Data Sheet.
- If the 4-hour air concentration is below 10% of the DAC value, no further analysis is required.
 - If the concentrations are above 10% of the DAC value, recount after 24 hours and document on the Air Sample Data Sheet.
 - If the air concentrations exceed 10% of the DAC values, notify the RSO or duly authorized representative for further instructions. Save the air sample for possible further analysis.
 - For air samples, which exceed 10% of the DAC values, an exposure is assigned to the workers residing in the area where the sample was taken.

7.6 Assignment of DAC-hour exposures to workers

7.6.1 For air samples which exceed 10% of the DAC values, calculate the workers DAC-hour exposure using the following formula:

$$\text{Exposure in DAC-hours} = \frac{A \times B}{C}$$

Where:

A = Area or Lapel air sample concentration in microCurie per cubic centimeter ($\mu\text{Ci}/\text{cm}^3$)

B = Hours worker was in the calculated air concentration

C = DAC air concentration in $\mu\text{Ci}/\text{cm}^3$ from regulatory reference.

7.6.2 Enter the DAC-hour exposure on the column provided on the Air Sample Data Sheet. If respiratory protection was used during the exposure period, contact the RSO or duly authorized representative for the protection factor used to adjust DAC-hour exposure.

8.0 REFERENCES

- Title 10, Code of Federal Regulations, Part 20, *Standards for Protection Against Radiation*.
- Radiation Safety Program, Cabrera Services Inc., Manual
- OP-021, *Alpha-Beta Sample Counting Instrumentation*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure
- U.S. Nuclear Regulatory Commission, *Air Sampling in the Workplace*, Regulatory Guide 8.25, (1992).
- U.S. Nuclear Regulatory Commission, Consolidated Guidance About Material Licenses, Vol. 11 - *Program-Specific Guidance About Licenses of Broad Scope*, NUREG-1556, (1999).
- CABRERA Effluent Monitoring Work Instruction, Pohakuloa Training Center, PTA-W1-001, 02 December 2010

9.0 REQUIRED RECORDS

- Air Sample Data Sheet (written or electronic)
- Daily Air Sample Record (written or electronic)

10.0 ATTACHMENTS

- Attachment A – Air Sample Data Sheet
- Attachment B – Daily Air Sample Record
- Attachment C – Contamination Limits

Attachment A

Air Sample Data Sheet

Air Sample Data Sheet

Sample # _____ Date _____

Description: _____

Radionuclides: _____ DAC value: _____

_____ DAC value: _____

_____ DAC value: _____

Initial sample flow rate: _____ Time sampler on: _____

Final sample flow rate: _____ Time sampler off: _____

Average sample flow rate: _____ Total sample time: _____ hours

Total sample volume: _____ cm³

30 min Air Concentration:

Alpha = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ Beta = _____ $\mu\text{Ci } \beta/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \beta/\text{cm}^3$

4 Hour Decay Air Concentration:

Alpha = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ Beta = _____ $\mu\text{Ci } \beta/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \beta/\text{cm}^3$

24 Hour Decay Concentration:

Alpha = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ Beta = _____ $\mu\text{Ci } \beta/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \beta/\text{cm}^3$

Attachment B

Daily Air Sample Record

Daily Air Sample Record

Worker Name	Sample Date	Count Date	Time In	Time out	Total time (Hrs.)	Concentration ($\mu\text{Ci}/\text{cm}^3$)	DAC-Hour Exposure

Attachment C

Contamination Limits

Contamination Limits from Table 1 of RSP

RADIONUCLIDE	ALLOWABLE SURFACE CONTAMINATION (DPM/100 CM²)	
	REMOVABLE	FIXED + REMOVABLE
Transuranics, Ra-226, Ra-228, Th-230, Pa-231, Ac-227, I-125, I-129	20	100
Th-Natural, Th-232, Sr-90, Ra-223 Ra-224, U-232, I-126, I-131, I-133	200	1000
U-Natural, U-235, U-238, and associated Decay products	1000	5000
Beta-Gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	1000	5000



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

VOLUMETRIC AND MATERIAL SAMPLING WITHIN RADIOLOGICAL CONTROL AREAS

OP-005

REVISION 2.0

Reviewed by:

David Wunsch, Quality Assurance Manager

4/12/13

Date

Approved by:

Henry Siegrist

Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

This procedure provides the methods Cabrera Services Inc. (CABRERA) personnel will utilize to collect volumetric and material samples for radiological analysis. Adherence to this procedure will provide assurance that personnel exposures will be As Low As Reasonably Achievable (ALARA), personnel will remain free of contamination, and contamination will not be spread beyond the designated contaminated area.

2.0 APPLICABILITY

This procedure is applicable to all volumetric and material samples collected by CABRERA personnel to fulfill sampling requirements.

3.0 DEFINITIONS

- 3.1 Geiger-Mueller (G-M) Counter – A radiation detection and measuring instrument. It is sometimes called a G-M counter, or Geiger counter, and is the most commonly used portable radiation instrument. It consists of a gas-filled tube containing electrodes between which there is an electrical voltage but no current flowing. When ionizing radiation passes through the tube, a short, intense pulse of current passes from the negative electrode to the positive electrode and is measured or counted. The number of pulses/second measures the intensity of the radiation field.
- 3.2 Global Positioning System (GPS) – A satellite-based global navigation system that consists of: a collection of 24 satellites in orbit above the Earth; several in-orbit spares; and a ground-based control segment. The satellites transmit signals that are used for three-dimensional (latitude, longitude, and elevation) global navigation. A GPS-derived position determination is based on the arrival times, at an appropriate receiver, of precisely timed signals from the satellites above the user's radio horizon.
- 3.3 Impacted Area – According to MARSSIM, impacted areas have a potential for radioactive contamination (1) based on historical data or (2) they contain radioactive contamination based on past or preliminary radiological surveillance. This includes areas where radioactive materials were used and stored; records of spills, discharges, or other unusual occurrences resulted in the spread of contamination; and, areas where radioactive materials were buried or disposed. Areas immediately surrounding or adjacent to these locations are included in this classification due to the potential for inadvertent spread of contamination.
- 3.4 Ionizing Radiation – Radiation that has sufficient energy to remove electrons from atoms which produces ions. Examples include alpha, beta, gamma, and X-rays.

- 3.5 Minimum Detectable Concentration (MDC) – The net concentration that has a specified chance of being detected; it is an estimate of the detection capability of a measuring protocol and is calculated before measurements are taken. For purposes of this procedure, MDC for removable radioactive contamination is defined as the smallest amount of sample activity that will yield a net count, with a 95% confidence level, based upon the background count rate of the counting instrument used.
- 3.6 Sediment – According to MARSSIM, sediment includes soil and other solid material that has settled to the bottom of a liquid (e.g., water).
- 3.7 Site Safety and Health Plan (SSHP) – The SSHP provides evacuation routes for the site and its immediate area, as well as the names and telephone numbers of common emergency contact personnel for the worksite.
- 3.8 Subsurface Soil – According to MARSSIM, subsurface soil includes any soil not considered surface soil. It is typically anything greater than 15 centimeters (6 inches) below the ground surface.
- 3.9 Surface Soil – According to MARSSIM, surface soil includes the top layer of soil that is available for direct exposure, growing plants, re-suspension of particles for inhalation, and mixing from human disturbances. According to Title 40 of the Code of Federal Regulations, Part 192 (40 CFR 192), this layer is represented as the top 15 centimeters (6 inches) of soil.
- 3.10 Volumetric Sample – A sample of material taken to determine the radioactivity content in units of activity per unit volume or mass. It does **NOT** apply to loose surface material sampled using a cloth smear/wipe or to activity present only on the surface of solid materials.
- 3.11 Water Sample – A sample of surface water, groundwater, drinking water, or other hydrological system sampled to determine radioactivity content in units of activity per unit volume or unit mass.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- 4.1.1 Special situations will be evaluated and incorporated in site-specific work plans (e.g., evaluating trends for airborne deposition, determining contamination profiles via down-hole measurements, measuring non-radiological contaminants, etc.).
- 4.1.2 Personnel will not exceed the load ratings stamped on shipping containers to prevent container degradation during shipment. Prior to shipment, personnel will consult with the analytical laboratory for

approved packaging materials and shipping methods. Deviations from approved work plans will be brought to the attention of the Site Radiation Safety Lead.

- 4.1.3 Personnel will utilize a field-sampling logbook to document sampling information.
- 4.1.4 Samples that require alpha or beta spectroscopy or isotopic discrimination will be sent to an approved laboratory for analysis. If onsite gamma spectroscopy is utilized, quality control (QC) samples may be sent to an approved laboratory for analysis, in accordance with the approved site-specific work plan.
- 4.1.5 Individuals collecting volumetric and material samples will be familiar with the requirements set forth in the current, approved version of this procedure.
- 4.1.6 Personnel will decontaminate radiologically contaminated sampling equipment in accordance with *Decontamination of Equipment and Tools* (OP-018). Equipment that is contaminated with non-radiological waste will adhere to decontamination techniques discussed in *Field Equipment Decontamination* (OP-373).

4.2 Limitations

- 4.2.1 Sample media containing radiological contamination may also contain non-radiological contamination that will not affect the radiological components of a sample. Therefore, personnel will follow the stricter guidelines associated with non-radiological contamination, if present. If only radiological contamination is present, it is unnecessary to adhere to guidelines governing non-radiological contamination.
- 4.2.2 It may be necessary to place samples on ice should a non-radiological component be present. Most radiological samples are unaffected by and therefore **do not** need to be placed on ice. It is unnecessary for personnel to collect separate samples for radiological and non-radiological components.

Note: Samples containing tritium (^3H) or carbon-14 (^{14}C) contamination may convert to gaseous components resulting in sample loss from biological activity. Ice will always be used to preserve this type of radiological contamination. An exception is airborne ^3H sampling utilizing distilled water and bubbler collection equipment.

4.3 Requirements

- 4.3.1 Instrumentation used in surveys will be checked with standards daily and verified to have current valid calibration.

- 4.3.2 Personnel will perform direct surface radiation measurements prior to sampling at each location. They may identify gross contamination, which could require samples and sampling equipment to be treated as radioactive for transport purposes.
- 4.3.3 Personnel will utilize the following documentation when performing volumetric and material sampling:
- Record forms
 - Sample chain-of-custody (COC) forms
 - Field-sampling logbook
- 4.3.4 Records will be maintained in accordance with *Records Management* (OP-187).

5.0 EQUIPMENT

- 5.1 The following is a list of the minimum equipment required to perform field volumetric sampling under this procedure:
- A Lietz level log book 8152-50 or the equivalent
 - Survey form(s)
 - Chain-of-Custody forms
 - Sample containers
 - Indelible ink marker
 - Tap water
 - Clean paper towels
 - Brushes for decontamination, as needed
 - Sample location markers
 - Digging implement: garden trowel, shovel, spoons, post-hole digger, etc.
 - Applicable sampling equipment
 - Re-sealable plastic bags (approximately one-gallon capacity)
 - Twist-ties
 - Masking or duct tape
- 5.2 In addition to the above list, water sample collection may also require the following:
- Instrumentation to make water quality measurements that include: dissolved oxygen, pH, temperature, conductivity, and oxidation-reduction potential. This data may assist in the interpretation of analytical data and

the selection of sampling sites.

- Preservative(s), per analytical laboratory recommendations.

5.3 The following is a list of the minimum required equipment to perform sample packing and shipping under this procedure:

- Ludlum model 3 rate-meter with Ludlum model 44-9 G-M detection probe or equivalent
- Smears for removable activity and Ludlum 2929 smear counter or equivalent
- Micro Rem Ion chamber dose rate instrument or equivalent
- Boxes, coolers, or similar shipping containers for samples
- Clear packing tape
- Zipper-locking plastic bags
- Packaging material (e.g., plastic, vermiculite, preformed poly-foam liner, or equivalent)
- “Fragile” and “This Side Up” self-adhesive labels
- Mailing labels

5.4 The following is a list of sampling equipment that may be used for specific types of materials:

- Drains or pipes: plumber’s snake, swabs
- Residues: trowels, scoops
- Concrete or asphalt: core boxes, hammer, and chisel
- Metals: emery cloth or scraping tool
- Dusts: scraping tool and plastic bags

6.0 RESPONSIBILITIES

- 6.1 Corporate Radiation Safety Officer (RSO) – Will monitor compliance and ensure that personnel who collect volumetric and/or material samples are qualified by training and experience to perform this procedure.
- 6.2 Radiation Protection Technicians (RPT) – When collecting volumetric and/or material samples, are responsible for knowing and complying with this procedure.
- 6.3 Project Manager (PM) - Responsible for the radiological safety of all personnel on site, ensuring that if they collect volumetric and/or material samples, that

they are adequately trained, understand this procedure, and have access to a copy of procedures for reference.

- 6.4 Sample Collectors - Personnel who collect volumetric and material samples and are responsible for understanding and complying with this procedure.
- 6.5 Site Radiation Safety Lead (SRSL) – Acts as the RSO's duly authorized representative for radiological issues when the RSO and their duly authorized representative are not onsite. The SRSL will be onsite when work is in progress, will perform the requirements established in this procedure, and ensure that they are implemented during field assignments. The SRSL has the responsibility to stop work if: any unsafe condition exists in the work area, non-compliance with procedural requirements occurs, or if significant changes in radiological conditions occur.

7.0 PROCEDURE

7.1 General Volumetric and Material Sample Collection

This section is applicable to the collection of all volumetric and material samples.

- 7.1.1 Outside sample locations will be identified and documented with GPS data and survey maps, where practical. Survey maps will be used to document survey results related to the samples (e.g., loose surface activity of sample container or sampling equipment).
- 7.1.2 Personnel will use survey maps to clearly illustrate sample locations inside buildings.
- 7.1.3 Personnel will delineate sampling locations that need to be relocated with an appropriate marker (e.g., stake, pin flag, spray paint, etc.) and label them with a unique number.
- 7.1.4 Prior to collecting a sample, personnel will ensure that they have the correct container type and size by contacting the analytical laboratory for sample size requirements based on the desired detection sensitivity.
- 7.1.5 Personnel will adhere to the following techniques when collecting volumetric and material samples:
 - Perform loose surface activity surveys on sampling equipment that contacts sampling media to ensure no removable contamination exists. Document the results on the appropriate survey form.
 - Samples that can fit into a $\frac{1}{8}$ -inch by 2-inch planchette, and require gross alpha and/or beta/gamma results, may be counted in a Ludlum 2929 smear counter or equivalent. Ensure that minimum counting system sensitivity requirements are met by calculating MDC values for alpha and beta, as applicable.

- Place the sample into a planchette with the surface to be measured facing up.
- Count the sample for the appropriate length of time to meet MDC values described by work plans or other documents.
- Record count and counting time data, and calculate activity estimates on the appropriate survey form.
- If the collected sample is suspected to contain radioactivity above background levels, then survey sampling equipment for loose surface activity prior to collecting additional samples with the same equipment. Document the results on the appropriate survey form.
- Decontaminate sample equipment as necessary.

7.2 Surface and Subsurface Soil Sample Collection

Personnel will refer to *Surface Soil Sampling* and *Subsurface Soil Sampling* (OP-351 and OP-352, respectively) for more detailed techniques, as well as adhering to both Section 7.1 of this procedure and the following steps when sampling surface and subsurface soil:

- 7.2.1 Collect surface and subsurface soil samples by utilizing appropriate sampling equipment as detailed site work plans(e.g., spade, shovel, spatula, scoop, plastic or stainless steel spoons or split spoons, trowel, bucket auger, post-hole auger, etc.).
- 7.2.2 Carefully remove the soil layer correlating to the desired sample depth.
- 7.2.3 Place sample into the appropriate container and mix thoroughly to obtain a homogenous sample representative of the sampling interval. Remove large rocks, vegetation, and foreign objects which may be collected as separate samples. **Note:** It may be necessary to use a sieve or screen to remove them.
- 7.2.4 Fill sample container(s) to the top with sampling media.

7.3 Surface Water and Sediment Sample Collection

Personnel will refer to *Surface Water and Sediment Sampling* (OP-349) for more detailed techniques, as well as adhering to both Section 7.1 of this procedure and the following when sampling sediment and surface water:

- 7.3.1 Collect sediment and surface water samples by utilizing appropriate sampling equipment. When collecting sediment samples, personnel may utilize the following: spade, shovel, spatula, scoop, trowel, bucket auger, tube auger, sediment coring device, Ponar or Ekman dredge,

etc. When collecting surface water samples, personnel may utilize the following: ladle, scoop, pond sampler, funnel, etc.

Note: It is important to minimize disturbance of the sediment caused by sampling activities. Move slowly and approach sampling location(s) downstream for moving water and downwind for stationary water.

7.3.2 Continue with one the following steps depending on whether sediment or surface water is being collected:

- **Sediment:** Remove desired sediment thickness and volume slowly and gently from water using appropriate sampling equipment. Place sediment sample into appropriate container and mix thoroughly to obtain a homogenous sample representative for sampling interval. Decant surface water from sample or homogenization container prior to sealing or transfer. Use care to retain the fine sediment fraction during this procedure. Remove large rocks, vegetation, and foreign objects, all of which may be collected as separate samples. (**Note:** It may be necessary to use a sieve or screen to remove them.) Fill sample container(s) to the top with sediment.
- **Surface Water:** If surface water is deep enough, then it may be collected by dipping the sample container directly into the water. Fill sample container(s) to the top with surface water gently and slowly. While multi-parameter water quality measurements (i.e., dissolved O₂, pH, temperature, conductivity, oxidation-reduction potential, etc.) are not required for radiological analysis, they may assist in analytical data interpretation if non-radiological contaminants are present onsite. The PM will determine the necessity of these measurements.

7.4 Groundwater Sample Collection

Personnel will refer to “Groundwater Sampling” (OP-350) for more detailed techniques, as well as adhering to both Section 7.1 of this procedure and the following, when sampling groundwater:

Note: Low-flow sampling is a comprehensive technique that is not discussed within this procedure. Low-flow groundwater sampling will be conducted in accordance with *Low-Flow Groundwater Sampling Procedures* (OP-355).

7.4.1 Collect groundwater samples by utilizing appropriate sampling equipment (e.g., bailer, submersible pump, non-contact gas bladder pump, inertia pump, suction pump, etc.).

Note: It highly suggested to use dedicated sampling equipment (e.g., bailers) at each sampling location or well to prevent cross-contamination.

Note: It is important to minimize disturbance of the sediment caused by sampling activities. Lower all sampling equipment into the water column as slowly as practical, and **do not** allow the equipment to free-fall within the well.

7.4.2 When purging with a pump (not a bailer), the pump will be set at the screened interval. The sample will also be collected from the depth at which the pump was set.

7.4.3 All monitoring wells will be pumped prior to sampling. Purge water will be containerized onsite or handled as specified in the site work plan. Evacuation of a minimum of one (preferably three to five) volume(s) of water in the well casing is recommended for a representative sample. In a high-yielding groundwater formation that has no stagnant water above the screened section of the well, evacuation prior to sample withdrawal is not critical. Evacuation is, however, recommended when monitoring data will be used for enforcement actions.

7.4.4 Fill sample container(s) to top with water.

7.4.5 If non-radiological contaminants (i.e., metals) are present that require an acidified sample, then test the pH of the water sample. If the pH is greater than 2.0, add acid to reduce the pH to 2.0 or less. This should align it with the analytical laboratory protocols.

7.5 Material Sampling

Personnel will adhere to both Section 7.1 of this procedure and the following techniques when conducting material sampling:

7.5.1 Determine sample collection using sample media characteristics. Care will be taken to limit the potential for spreading contamination during sample collection. Determine sample quantities using the following criteria:

- Type of analyses required;
- Number of analyses requested;
- Detection sensitivity required of analytical result; and
- Estimated activity level of material.

7.5.2 Remove the material to be sampled by using the tools required and contamination control techniques to prevent loss of material from the sampled area.

7.6 Collection of Other Samples

- 7.6.1 For the purposes of this procedure, 'other' refers to any media type not previously defined in this document.
- 7.6.2 Prior to collecting the sample, consult with the analytical laboratory and SRS� for specific instructions on taking any 'other' sample types.
- 7.6.3 Removed foreign objects which are not representative of the desired sample matrix or which may affect the laboratory analysis.

7.7 Sample Packing and Shipping

- 7.7.1 The sample collector will use indelible ink in identifying sample media and location in assigning a unique number to the sample container label. Sample collectors are responsible for initiating the chain-of-custody form, in accordance with *Chain-of-Custody* (OP-008).
- 7.7.2 Personnel will adhere to the following techniques when labeling samples:
 - Label container(s).
 - Record sample identification, date, and time of sample collection on label.
 - If sample containers contain water or are preserved with ice, then place clear plastic tape around the label.
 - Wipe outside of sample container.
- 7.7.3 Personnel will adhere to the following techniques when preparing containers for shipment:
 - Tape container openings such as box seams and cooler drains (when used) shut.
 - Affix "This Side Up" labels on all four sides, and "Fragile" labels on a minimum of 2 sides of the container (e.g., box, cooler, etc.).
 - Place mailing label with laboratory address on container(s).
 - When shipping samples for analysis, line the shipping container(s) with plastic prior to placing samples inside. If shipping liquid samples, fill the bottom of the shipping container(s) with approximately 3 inches of an approved absorbent material (i.e., vermiculite, preformed poly-foam liner, etc.).
 - It may be necessary to preserve non-radiological samples at temperatures not exceeding 4°C. If ice is required for preservation, then it will be packaged within two zipper locking bags and placed on and around sample containers.
 - Arrange decontaminated sample containers in groups by sample

number.

- Arrange samples in shipping containers so that they do not touch and the potential for motion is minimized.
- Fill remaining spaces with absorbent material.
- Sign chain-of-custody form (or obtain signature) and indicate air bill number, if applicable. Seal the correct chain-of-custody copy in a zipper locking plastic bag and tape it to the inside of the shipping container top or lid.
- If a cooler serves as the shipping container, close the lid and secure latch. Tape the container shut on both ends, making several complete revolutions with packing tape.
- Use tamperproof seals provided by the analytical laboratory to securely seal shipping container and initial and date the seal.
- Conduct surface scan of shipping container. Record results on appropriate survey form and include a copy with the shipping label.
- Relinquish samples to the shipper and retain sample collection and shipment documentation for project file.

CAUTION: Shipments of samples containing potentially hazardous or radioactive materials may require specific packaging and shipping precautions not specified above. Consult the SRSL or analytical laboratory for instruction when shipping these samples.

Note: Do not exceed load rating for containers when shipping samples to prevent degradation of the container during shipping.

7.8 Sample Equipment Decontamination

Personnel will decontaminate sampling equipment to prevent cross-contamination between sample collections. The most common decontamination materials include: long-handled brushes, Masslinn cloth or similar wipes, tap water, paper towels, disposal container/bags.

Note: This procedure is not written in compliance with *Sampling Equipment Decontamination* (EPA SOP 2006). EPA's procedure pertains to the presence of chemical contamination, which may include volatile organic compounds. These can readily cross-contaminate sampling media. Radiological decontamination will therefore be in accordance with *Decontamination of Equipment and Tools* (OP-018).

7.9 Recordkeeping

7.9.1 Information will be documented clearly, neatly, accurately, and concisely, and prepared in dark, waterproof ink. Data will not be

obliterated by erasing, with whiteout, or by any other means. To make a correction, a single line will be struck through the error, and the corrector will initial and date the line.

7.9.2 The RPT, or designee, will review applicable forms for accuracy and completeness, and date and initial entries to validate the survey.

8.0 REFERENCES

- *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, DoD, DOE, EPA and NRC, Revision 1 (2000).
- Radiation Safety Program, Cabrera Services Inc., Manual
- AP-005, *ALARA*, Cabrera Services Inc., Operating Procedure
- OP-008, *Chain-of-Custody*, Cabrera Services Inc., Operating Procedure
- OP-018, *Decontamination of Equipment and Tools*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure
- OP-351, *Surface Soil Sampling*, Cabrera Services Inc., Operating Procedure
- OP-352, *Surface Soil Sampling*, Cabrera Services Inc., Operating Procedure
- OP-355, *Low-flow Groundwater Sampling Procedures*, Cabrera Services Inc., Operating Procedure

9.0 REQUIRED RECORDS

- Field-sampling logbooks
- Record forms
- Sample chain-of-custody (COC) forms
- Sample Status Log

10.0 ATTACHMENTS

There are no attachments associated with this procedure



CABRERA SERVICES

RADIOLOGICAL • ENVIRONMENTAL • REMEDIATION

RADIATION SAFETY PROCEDURE

FOR

CHAIN-OF-CUSTODY

OP-008

REVISION 1

Approved by: Henry Siegrist
Henry Siegrist, CHP, PE, Corporate Health Physicist

Date: 6/1/2006

Approved by: Dave Watters
Dave Watters, CHP, Senior Vice President, Operations

Date: 6/1/2006

1.0 PURPOSE

This procedure provides the methods Cabrera Services, Inc. (CABRERA) personnel shall utilize to transfer samples collected for characterization and/or final status surveys to a certified laboratory for analysis. Adherence to this procedure will provide assurance that appropriate analyses are requested, and that proper association between sample ID, sample location, and other pertinent sample parameters are documented and tracked by a known organization.

2.0 APPLICABILITY

This procedure will be used at all CABRERA work sites that require sample analysis to facilitate collection of data to be used in the official evaluation of the radionuclide or hazardous material content of the sample.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

- 3.1.1 Samples sent to an offsite analytical laboratory for analysis shall be returned to the site after processing for disposal if this is the condition of the laboratory contract. There may be occasions where the laboratory will hold and/or dispose of the samples.
- 3.1.2 Samples containing licensed radioactive material may only be sent to laboratories approved to handle such samples. Personnel shall use caution to assure sample radioactivity does not exceed the laboratory's license quantities.

3.2 Limitations

- 3.2.1 Personnel shall contact the contracted analytical laboratory to verify if they have their own required chain-of-custody. If the laboratory has its own, then personnel shall utilize their provided form, not the one used in this operating procedure.

3.3 Requirements

- 3.3.1 The chain-of-custody provided as an attachment to this procedure is based on an electronic CABRERA template. The version included in this procedure is provided as an example, not for use at a worksite. Personnel who use it shall ensure that they are using the most updated electronic template.

4.0 REFERENCES

- CABRERA Radiation Safety Program (RSP)
- AP-001 Record Retention

5.0 DEFINITIONS AND ABBREVIATIONS

- 5.1 Custody Seal - Custody seals are tamper-indicating devices. They record if access has occurred, they are not meant to resist it.

6.0 EQUIPMENT

Custody seals

7.0 RESPONSIBILITIES

- 7.1 Corporate Radiation Safety Officer/Health Physicist (RSO or Corp. HP) - The RSO or Corp. HP shall ensure that personnel who work with radioactive material are trained, and have an adequate understanding in the use of this procedure.
- 7.2 Health Physics Technicians (HPT) - The HPT are responsible for the control of radioactive material, coverage of radiation workers, and general safety protection. The HPT are responsible for knowing and complying with this procedure.
- 7.3 Project Manager (PM) - The PM is responsible for the radiological safety of all personnel onsite, ensuring that if they work in radiologically controlled areas, that they are familiar with this procedure, adequately trained in its use, and have access to a copy of procedures.
- 7.4 Sample Collector - Sample collectors are responsible for following the SRSO's instructions to ensure compliance with this procedure.
- 7.5 Site Radiation Safety Officer (SRSO) - The SRSO acts as the RSO's and Corp HP's duly authorized representative for radiological issues when neither are onsite. The SRSO shall be onsite when work is in progress and shall perform the requirements established in this procedure, and ensure that they are implemented during field assignments.

8.0 INSTRUCTIONS

8.1 General Instructions

- 8.1.1 The sample collector shall initiate a chain-of-custody form by filling in the requested information. Personnel may utilize the "Chain-of-Custody Checklist" (supplied in Attachment OP-008-01) to verify they

have completed CABRERA's chain-of-custody (supplied in Attachment OP-008-02) completely.

- 8.1.2 Proper chain-of-custody is maintained when the sample is controlled under the direct surveillance of an individual; in a controlled access facility, or the sample is in a tamper-resistant container.
- 8.1.3 If the sample is to be transported by any means other than hand delivered by the custodial individual, custody seals shall be used.
- 8.1.4 Upon transfer of the samples to another individual, that individual shall sign as recipient. A copy of the chain-of-custody form shall be maintained for record keeping purposes while the original will remain with the sample.
- 8.1.5 Upon arrival of the sample at the laboratory, the laboratory recipient shall inspect the sample for signs of tampering. If indication of tampering is noted, the laboratory shall notify site personnel who may need to collect another sample as conditions merit.
- 8.1.6 Once the sample is in the custody of the laboratory, it shall be maintained in accordance with the laboratory's chain-of-custody and quality assurance procedures.

8.2 Recordkeeping

- 8.2.1 Information shall be documented clearly, neatly, accurately, and concisely, and prepared in dark, waterproof ink. Data shall not be obliterated by erasing, with whiteout, or by any other means. To make a correction, a single line shall be struck through the error, and the corrector shall initial and date the line.
- 8.2.2 The HPT or designee shall review applicable forms for accuracy and completeness, and date and initial entries to validate the survey.
- 8.2.3 Records shall be maintained in accordance with "Record Retention" (AP-001).

9.0 ATTACHMENTS

- OP-008-01 CABRERA Chain-of-Custody Checklist
- OP-008-02 Chain-of-Custody/Analysis Record

OP-008-01 - CABRERA Chain-of-Custody Checklist

REQUIRED INFORMATION	DESCRIPTION AND INSTRUCTIONS	COMPLETED?
Page: of		
Project #:		
Lab Quote #:	Supplied by analytical laboratory	
COC #:		
PO #:		
Project/Site Name:		
Collected By:	Sample collectors	
Send Results to:	Project manager for site	
Custody Seal #:	As applicable, some laboratories do not require this	
Laboratory:	Complete analytical laboratory name, address, phone #, and fax #	
Should this sample be considered:	Check box to appropriate sample ID as to whether the sample should be considered radioactive and/or TSCA regulated	
Preservative Type:	Refer to footnote 5, and fill in appropriate information	
Sample Analysis Requested:	Refer to footnote 4 and fill in appropriate information, list the appropriate number of sample containers in the appropriate Sample ID row	
Sample ID	List each sample ID being shipped under this Chain-of-Custody	
Date Collected	Document date sample was collected in mm-dd-yy format	
Time Collected	Document time sample was collected in military time (hhmm)	
QC Code	Refer to footnote 1, and fill in appropriate information	
Field Filtered	Refer to footnote 2, and fill in appropriate information	
Matrix Code	Refer to footnote 3 , and fill in appropriate information	
Comments:	List any comments regarding samples	
Requested Turnaround Time:	Provided by project manager	
Fax Results:	Circle Yes or No	
Email Results, when available to:	Enter PM's email address	
Remarks:	List any remarks	
Chain-of-Custody Signatures	Sign under relinquished by and document date and time when relinquishing shipping container to shipper	
Sample Shipping and Delivery Details	Fill in the laboratory PM, method of shipment (i.e., FedEx, UPS, etc.), date shipped, and airbill #.	

CABRERA Chain-of-Custody and Analytical Request

Page 5 of 5



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

DECONTAMINATION OF RADIOACTIVITY FROM EQUIPMENT AND TOOLS

OP-018

REVISION 1.0

Reviewed by:

David Wunsch, Quality Assurance Manager

4/12/13

Date

Approved by:

Henry Siegrist
Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

This procedure establishes the requirements for decontamination of equipment, material, and tools used at Cabrera Services Inc., (CABRERA) field projects that become contaminated with radioactive material.

2.0 APPLICABILITY

This document applies to all CABRERA personnel involved in the decontamination. Each decontamination operation is unique; thus, this procedure provides general, effective decontamination techniques and guidelines to be used by CABRERA field personnel.

3.0 DEFINITIONS

- 3.1 Decontamination – The processes whereby contamination can be safely and effectively removed from equipment tools and materials.
- 3.2 Herculite – Herculite is a brand name plastic or polyethylene floor covering and containment material used for decontamination operations.
- 3.3 Material Safety Data Sheet (MSDS) – Sheets providing information and limitations about chemicals and products that is issued by the manufacturer.
- 3.4 Radiation Work Permit (RWP) – A document generated by Health Physics to provide:
 - A description and scope of the work to be performed;
 - Existing radiological conditions in the work area;
 - Limitations placed upon the scope of work;
 - Maximum radiological limits allowed;
 - Measures to be employed to protect the worker(s); and
 - Special instructions to workers and RPT personnel for the work to be performed.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- 4.1.1 Decontamination of contaminated tools or equipment will be performed under the direction of an RPT. The RPT will provide direction in accordance with this procedure, and the RWP.
- 4.1.2 Decontamination activities will be performed within a controlled area.
- 4.1.3 Controls to contain the spread of loose contamination, during the decontamination activity, will be planned and established prior to the decontamination of equipment, material, and tools.

4.2 Limitations

- 4.2.1 This procedure may not be applicable or readily applied to decontaminating surfaces composed of porous materials such as wood or concrete. It is therefore not the preferred operating procedure for decontaminating building surfaces.
- 4.2.2 Protective clothing worn, by the personnel involved in decontamination activities, will be determined in accordance with the RWP.
- 4.2.3 Decontamination cleaning solvent/solutions will only be used in accordance with the directions and limitations listed on the manufacturer supplied MSDS.
- 4.2.4 Respiratory protection devices, required by the RWP for decontamination operations, will be selected and used in accordance with the provisions of CABRERA procedure AP-006.

4.3 Requirements

- 4.3.1 Instrumentation used in the surveys will be checked with standards daily and verified to have current calibration records.
- 4.3.2 A pre-job briefing will be held to instruct RPTs and other personnel of the conditions of the RWP. All personnel performing work in the decontamination work area will sign the RWP prior to work.
- 4.3.3 Radiation and contamination surveys will be performed in accordance with the provisions of CABRERA procedure OP-001.
- 4.3.4 Release of equipment, materials, and tools from the decontamination work area will be performed in accordance with the provision of CABRERA procedure OP-004.
- 4.3.5 Operations conducted using this procedure will be reviewed for compliance at least annually.

5.0 EQUIPMENT

Appropriate Personal Protective Equipment (PPE) and decontamination equipment includes, but is not limited to:

- Herculite
- Decontamination rags
- Cleaning solutions

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – Ensures that personnel assigned the task of decontamination know and understand this procedure, are adequately trained in its use, and have access to a copy.

- 6.2 Radiation Safety Officer (RSO) – Training of personnel in the decontamination techniques and performing radiation surveys described in this procedure; and ensures that technicians are qualified by training and experience to perform the requirements of this procedure.
- 6.3 Site Radiation Safety Lead (SRSL) – During field assignments, ensures that this procedure is properly implemented. When the RSO is not on site, the SRSL will act as the RSO's duly authorized representative for radiological issues.
- 6.4 Radiation Protection Technologist(s) (RPT) – Performing the surveys of decontaminated items, and ensuring that radioactive material is not released to the public or the environment.

7.0 PROCEDURE

7.1 Pre-Decontamination Preparation

- 7.1.1 The SRSL will initiate decontamination work instructions.
- 7.1.2 A radiological survey will be performed by an RPT on any item or object that is to be removed from a controlled area.
- 7.1.3 If radiological survey results indicate that an RWP is required for decontamination, the RSO or duly authorized representative will write the RWP in accordance with CABRERA procedure AP-012.
- 7.1.4 If a survey indicates that decontamination is required, the item should be bagged, wrapped, or contained under the direction of health physics staff. The RPT will label the item with all pertinent information.
- 7.1.5 The SRSL will approve or disapprove the decontamination operation based on conditions of the RWP and the cost effectiveness of the operation versus disposal costs.

7.2 Establishment of the Decontamination Work Area

- 7.2.1 The RSO or duly authorized representative and the SRSL will determine a location for the decontamination area.
- 7.2.2 Once a location has been established, the decontamination area will be set-up, by the RPT, under the direction of the SRSL.
- 7.2.3 The decontamination area should consist of the following:
- Covered (or equivalent) floor surfaces. A double layer of Herculite (or equivalent) may be laid on the floor at the direction of Health Physics staff.
 - Covered (Herculite or equivalent) wall surfaces, if applicable.
 - Engineering controls (HEPA ventilation, vacuum cleaners,

containment tent walls glove bags, etc.), if applicable.

- Engineering controls will be determined on the basis of the ALARA consideration section of the RWP.

Note: All possible engineering controls will be utilized when feasible to minimize the need for respiratory protection equipment.

- Use of safe, sturdy workstations with contamination resistant surfaces and tables that will support decontamination attempts on heavy pieces of equipment.
- Adequate supply of overhead light, adequate electrical/compressed air supply for the operation of electrical/pneumatic driven decontamination equipment.
- Adequate supply of CABRERA approved cleaning solutions and solvents along with an adequate supply of decontamination equipment, such as:
 - Light duty decontamination equipment such as paper wipes, paper towels, masselin towels, etc.
 - Medium to heavy-duty decontamination equipment such as scrub pads, wire brushes steel wool, files, sandpaper, etc.
 - Fully stocked hand tool kit for disassembly of contaminated equipment.
 - Radioactive material storage bags, stickers, etc.
 - Buckets, barrels or drums for the storage of contaminated liquids, sludges, or slurries, if applicable.
 - Blotter paper or sorbent, if applicable.
 - Approved absorbent material such as oil dry, if applicable.
- Storage drums/bags for the storage of contaminated protective clothing under direction of Health Physics staff.
- Proper surveillance instruments (air monitor/sampler, contamination monitor, friskers, dose rate meter, etc.) in accordance with the RWP.
- Adequate supply of personal protective clothing gloves respiratory equipment, etc.
- Step-Off or Double Step-Off Pad, in accordance with the provision of the RWP.
- A designated area, within the decontamination area, for the segregation of radioactive waste.

7.2.4 Once the decontamination area has been established and stocked for operation, the bagged and/or wrapped contaminated or controlled

equipment should be placed in the decontamination work area by the technician, under the direction of the SRS and RPT. Contaminated or controlled items should always be escorted, under the direction of a RPT, to the decontamination area.

7.3 Decontamination

7.3.1 After the decontamination area has been posted, and area access controls established, all requirements of the RWP will be observed.

7.3.2 The preparation for decontamination of a particular tool, material, or piece of equipment will be performed, as follows:

- Position the wrapped item so that the written information on the label/wrapping is visible.

Note: Junior RPTs may operate survey instruments for decontamination monitoring purpose. RPTs will oversee Junior RPTs when survey instruments are in use.

CAUTION: Survey instruments to be used in a known or suspected contaminated area should be protected (wrapped in plastic, poly, etc.) against possible contamination before use.

- The RPTs will direct the removal of the item from the wrapping in such a manner (rolling plastic, poly, etc.) to control the spread of contamination.
- An item that is highly contaminated with loose contamination should be misted with an approved liquid such as demineralized water. The water vapor will wet down the particulate contamination and help prevent the possibility of generating airborne contamination.
- Once the item has been removed from the wrapping and has been properly positioned, discard the wrapping as radioactive waste.

7.3.3 The following decontamination techniques should be considered for the decontamination of equipment, materials, and tools:

- Any equipment with inaccessible areas will be dismantled so that all surfaces are accessible for decontamination and survey.
- Decontamination will be performed in a safe, effective manner.
- The RPT will be notified immediately if the job conditions change (e.g. suspected asbestos found, presence of mercury in a switch or a light bulb, a fluid leak, or any other special circumstances).
- An RPT (or qualified individual) will be assigned as a fire watch if any spark creating decontamination techniques (grinding, etc.) are used and there are combustible materials in the area. There will be

a dedicated fire extinguisher located within the decontamination work area.

- The decontamination area will remain organized and free of debris with the RPT enforcing the "clean-as-you-go" policy, whenever necessary.
- A HEPA vacuum cleaner may be used during the decontamination operation.

7.3.4 Smearable Contamination Removal

When the item is properly positioned for decontamination and the pre-survey has been completed, perform the following:

- Moisten the surface of the item with an approved liquid (e.g. demineralized water).
- Fold a paper or cloth wipe into sections, using one surface of the wipe gently wipe contamination off in one direction away from the user's body. This should reduce the possibility of personnel contamination.
- Re-fold the paper or cloth wipe so that a clean surface is available (this should prevent cross-contamination) and continue until item is ready for survey.
- For some materials, duct tape will effectively remove smearable contamination. Wrap the duct tape loosely around the gloved hand with the adhesive side out. Roll the tape over the contaminated area and re-survey.

7.3.5 Fixed Contamination Removal

There are many techniques that can be used to remove fixed contamination. The general idea is to remove the material, which is fixing the activity to the surface, or remove a very thin layer of the surface material. The techniques selected for a particular decontamination operation is at the discretion of the SRSL and the RPT. The techniques can be divided into the following categories:

- Light hand decontamination
- Abrasive hand decontamination
- Power tool decontamination
- Machine decontamination (use of abrasive bead blasters, grit blasters, high pressure water wash systems, etc.). The specific implementation of these techniques is not included within the scope of this procedure.
- Cleaning solutions/solvents (use of ultrasonic cleaners, acid baths,

electropolishing, etc.). The specific implementation of these techniques is not included within the scope of this procedure.

7.3.6 Light hand decontamination consists of using many of the same techniques as 7.3.4 of this procedure.

7.3.7 Abrasive hand decontamination will be performed in the following manner:

- Remove as much smearable contamination as possible.
- Moisten the surface of the item(s) to contain contamination.

CAUTION: Abrasive measure should only be applied to surfaces that are not critical for operation of devices, which must be restored to working condition. Abrasion of machined surfaces should be minimized if the device is intended to provide its designed operation.

- Use an abrasive cleaning tool (e.g. sandpaper, steel wool, steel brush, hand grinder, etc.) to loosen fixed contamination. Clean in one direction only and clean Away from the body to prevent personnel contamination.
- Continue to moisten the surface of the item(s) to contain contamination.
- Remove as much smearable contamination as possible.
- Re-survey.

7.3.8 Power tool decontamination will be performed in the following manner only as a last resort decontamination effort. The use of engineering controls must be used and must be under the guidance of the SRSL/RPT.

Note: When using power tools, always consider the potential of injury due to the hazards involved. Power tools will be used cautiously and in accordance with the manufacturer's recommendations.

Some of the electric power tools that can be used in decontamination operations are:

- Drills to drill out contaminated areas, to disassemble contaminated components and when used with grinding wheels or disks, may be used as an abrasive tool.
- Saws to separate contaminated pieces from clean pieces.
- Grinders to grind fixed contamination from surfaces.
- Electric screwdrivers used in the disassembly of component parts.

7.3.9 Power tool decontamination will be performed in the following manner:

- Using a spray bottle, moisten the surface of the item lightly to contain contamination.

CAUTION: Do not use electric power tools on a wet working surface. Keep liquids away from electric power tools.

- Whenever feasible a containment device (e.g. glove box or bag etc.) should be used to contain the spread of contamination when using power tools for decontamination operations.
- Use the power tool to remove fixed contamination. Clean in one direction only and clean away from the body to prevent personnel contamination.
- Re-survey.

7.4 Post-Decontamination

7.4.1 If the decontamination was successful, the technician will notify the RPT, who will perform a release survey in accordance with CABRERA procedure OP-004.

- If the item satisfies the criteria for release, as stated in OP-004, remove the item to a holding area for disposal and document results. When prepared for disposal, ensure compliance with the provisions of CABRERA procedures AP-014 and AP-013.
- If the item remains contaminated, attempt a second decontamination.
- If the item continues to be contaminated, attempt a third decontamination only at the direction of the RSO or duly authorized representative.

7.4.2 If an item cannot be effectively or economically decontaminated, the SRSL may direct the CABRERA work crew to volume-reduce (reduce to component parts) the equipment, material, or tools as much as possible. If the item is expendable, the individual parts may be surveyed and released in accordance with step 7.4.1.

7.4.3 If an item is volume-reduced to its component parts and decontamination is not feasible, and the item is not needed, the item parts will be considered radioactive waste. Radioactive waste is to be segregated into similar material for shipment purposes by the direction of the PM. The SRSL will direct the segregation of radioactive waste into the following categories:

- Steels, hard metals
- Wood

- Fiber products
- Paper
- Rubber
- Cloth (duct tape is considered a cloth)
- Aluminum, soft metals (brass)
- Glass
- Questionable items (e.g. light bulbs pipe with lead solder, electronic component parts) which could be considered mixed or hazardous waste.
- Other categories, if applicable.

7.4.4 After all decontamination operations have been completed, an RPT will perform a release survey of the decontamination area and de-post the area in accordance with CABRERA procedures OP-001 and OP-019.

8.0 REFERENCES

- Radiation Safety Program, Cabrera Services Inc., Manual
- AP-006, *Respiratory Protection Program*, Cabrera Services Inc., Operating Procedure
- AP-012, *Radiation Work Permits*, Cabrera Services Inc., Operating Procedure
- AP-013, *Packaging Radioactive Material*, Cabrera Services Inc., Operating Procedure
- AP-014, *Classifying Radioactive Waste*, Cabrera Services Inc., Operating Procedure
- OP-001, *Radiological Surveys*, Cabrera Services Inc., Operating Procedure
- OP-004, *Unconditional Release of Material from Radiological Control Areas*, Cabrera Services Inc., Operating Procedure
- OP-019, *Radiological Posting*, Cabrera Services Inc., Operating Procedure
- OP-020, *Operation of Contamination Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-021, *Operation of Alpha-Beta Sample Counting Instrumentation*, Cabrera Services Inc., Operating Procedure
- OP-023, *Operation of Micro-R Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure

9.0 REQUIRED RECORDS

The records generated by the use of this procedure are documented in accordance with the provisions of referenced CABRERA procedures. No new records are created.

10.0 ATTACHMENTS

None



CABRERA SERVICES

RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

OPERATION OF CONTAMINATION SURVEY METERS

OP-020

REVISION 1.0

Reviewed by:

David Wunsch, Quality Assurance Manager

4/112/13

Date

Approved by:

Henry Siegrist

Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

This procedure provides the methods for Cabrera Services Inc. (CABRERA) to use when operating alpha/beta survey meters in performing contamination surveys. Adherence to this procedure will provide a reasonable assurance that the surveys performed have reproducible results.

2.0 APPLICABILITY

This procedure will be used by CABRERA personnel to measure fixed and removable alpha and/or beta/gamma emitting radioactive material on facility surfaces, equipment, waste packages, personnel, personnel protective clothing, etc.

3.0 DEFINITIONS

- 3.1 Restricted Area – An area containing radioactive material(s) to which access is controlled, by the licensee, to protect individuals from exposure to ionizing radiation.
- 3.2 Alpha/Beta Contamination Survey – A survey technique used to determine fixed and removable alpha/beta contamination.
- 3.3 Acceptance Range – A range of values that describe an acceptable daily instrument source check result.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- 4.1.1 Ensure that thin Mylar or mica windows on the probe face are protected from punctures, during survey operations.
- 4.1.2 In the case of the 44-110 tritium windowless meter, very fragile anode wires are behind the screen. **Note:** Do not allow objects to pass beyond the protective wire screen as damage to the detector can occur.
- 4.1.3 If any instrument inconsistencies are observed (e.g., unusually high or low background readings, source checks outside the acceptable range, etc.), remove the instrument from use, label it "OUT OF SERVICE" and report the condition to the Radiation Safety Officer (RSO), Site Radiation Safety Lead (SRS�), or a duly authorized representative.

4.2 Limitations

Typical operating temperature ranges for detectors are -20 to 50 degrees Celsius (°C) [-4 to 122 degrees Fahrenheit (°F)].

4.3 Requirements

- 4.3.1 Calibration sources must be traceable to the National Institutes of Science and Technology.
- 4.3.2 A battery check, general observation of instrument condition, high voltage check, and source response check will be performed each day before instrument use. An end of daily work activities final verification of instrument operability may also be provided, as required by site work plans.
- 4.3.3 Survey instrument calibrations will be performed by a calibration facility licensed by the Nuclear Regulatory Commission or an Agreement State.
- 4.3.4 Instruments used to perform routine surveys will be used in accordance with the applicable CABRERA administrative and operational procedures. Authorized suppliers of properly calibrated and maintained equipment will supply/calibrate instruments.
- 4.3.5 Prior to field mobilization, project SRSL and identified radiological leads will review approved work plans to ensure identified survey equipment is appropriate. Where practical, equipment familiarization with expected ranges to be used, typical efficiency of detection, and templates to be used in the field with the particular instrument are desired.
- 4.3.6 Personnel performing the survey will ensure that this procedure is the most current and approved revision.
- 4.3.7 Personnel performing the survey will review QC records to ensure that the instrument passed the source-check prior to use.
- 4.3.8 The RSO or their duly authorized representative will review any applicable completed forms and templates for accuracy and completeness.
- 4.3.9 All entries documented on pertinent forms must be dated and initialed by personnel performing the survey to be valid.

5.0 EQUIPMENT

- 5.1 Equipment counting efficiencies should be determined by qualified CABRERA personnel to verify efficiencies of calibrated instruments prior to use. Routine survey equipment includes, but is not limited to:

- 5.1.1 Alpha Surveys – Ludlum Model 43-5 probe and Ludlum Model 3 survey meter or equivalent meter/probe combination.
- 5.1.2 Beta/Gamma Surveys – Ludlum Model 44-9 probe and Ludlum Model 3 survey meter or equivalent meter/probe combination.
- 5.2 Proportional meters may be advantageous for use in situations where the suspected contamination type is unknown or the contamination contains mixed alpha and beta/gamma components. Alpha and beta/gamma contamination can be detected simultaneously with proportional meters. Proportional meters that may be used for a contamination survey include, but are not limited to:
 - 5.2.1 Hand-held meters – Ludlum Model 43-93 probe coupled with a Ludlum Model 2360 meter or an equivalent meter/probe combination.
 - 5.2.2 Gas proportional floor meters – Ludlum Model 43-37 probe coupled with a Ludlum Model 2360 meter or an equivalent meter/probe combination.
 - 5.2.3 Radionuclide-specific meters – Includes meters such as a tritium contamination meter: Ludlum Model 44-110 probe coupled with a Ludlum Model 2221 meter or equivalent meter/probe combination.
- 5.3 Contamination survey meters will be selected based on job-specific requirements identified in site work plans.

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – Ensuring that personnel assigned the task of operating contamination survey meters know and understand this procedure, are adequately trained, and have access to a current copy.
- 6.2 Radiation Safety Officer (RSO) – Verifying that personnel comply with this procedure and are trained in the use of the contamination survey meters described in this procedure.
- 6.3 Site Radiation Safety Lead (SRSL) – During field assignments, the SRSL is responsible for ensuring that this procedure is properly implemented and will review approved work plans to ensure identified survey equipment is appropriate. When the RSO is not on site, the SRSL will act as the RSO's duly authorized representative for radiological issues.
- 6.4 Radiation Protection Technician (RPT) – The RPT operating contamination survey meters is responsible for knowing, understanding, and complying with this procedure and may be required to review approved work plans to ensure identified survey equipment is appropriate.

7.0 PROCEDURE

7.1 Instrument Inspection

7.1.1 Select the contamination survey meter and probe to be used in the survey.

7.1.2 Before each use, perform the following checks:

- Verify the probe/meter has a current calibration label.
- Visually inspect the probe/meter for physical damage or defects.
- Position the meter switch to “BAT” and check to see that the needle falls within the “Bat Test” checkband.
 - If the needle falls below the “Bat Test” checkband, install new battery(ies).
 - If the needle still falls outside the “Bat Test” checkband after the installation of new batteries, tag the instrument “OUT OF SERVICE” and notify the RSO or their duly authorized representative.
- Check alpha detectors for light leaks by pointing the Mylar window of the detector towards a light source (preferably sunlight) and observing for a change in the meter indication.

7.1.3 Remove and tag the instrument “OUT OF SERVICE” if it fails any of the criteria in steps 7.1.1 and 7.1.2 and notify the RSO or their duly authorized representative.

Note: Any defects, damages, or other physical abnormalities require that the instrument be removed from service and the RSO or their duly authorized representative be notified.

7.2 Initial Preparations

7.2.1 Assure that the necessary daily quality control (QC) checks have been performed prior to instrument use.

7.2.2 Obtain the necessary forms, smears, and protective clothing that will be used during the survey. This information can be obtained from the Radiation Work Permit (RWP) or the SRSL.

7.2.3 Position the meter fast/slow (“F/S”) switch to “S” as appropriate.

7.2.4 Position the meter switch to the appropriate range scale.

7.2.5 Ensure that the QC acceptance range has been calculated utilizing CABRERA count rate templates. Current templates can be obtained from the RSO and may be found in the CCDR.

7.3 Daily QC Check

- 7.3.1 Ensure both the source and detector are in documented, reproducible positions which will be used each time this check is performed.
- 7.3.2 Allow the instrument reading to stabilize (approximately 30 seconds) and place the QC source on its designated position, near the detector, and record the value on the QC template.
- 7.3.3 Compare the reading to the acceptance range and response check criteria on the count rate QC template. If the response reading falls outside of the acceptance range, tag the instrument "OUT OF SERVICE" and notify the RSO or their duly authorized representative.

7.4 Contamination Survey Techniques

CAUTION: The window area of the detectors is covered with either a very thin layer of aluminized Mylar or mica. In the case of the tritium windowless detector, small anode wires are present behind the protective screen. Windows and fragile anode wires can be easily punctured or broken when surveying areas that have protruding fragments. Ensure that care is used and that such potentially damaging fragments are removed, prior to performing surveys, or avoided.

Note: To maintain the calibrated detection efficiency, the detector must be held at the appropriate height when surveying, which is determined during calibration. For example, if a beta probe's efficiency was calculated at $\frac{1}{2}$ inch from the calibration source, the detector must be held at $\frac{1}{2}$ inch from the surface being surveyed to maintain calibrated detection efficiency.

Avoid contacting the detector probe to the area being surveyed. This potentially could contaminate the probe.

- 7.4.1 Initially, verify the instrument selector switch is in the x0.1 position or on the lowest scale. Scale settings may change during surveys.
- 7.4.2 For a stationary reading, place the detector over the area to be measured and allow the meter to stabilize. Record the average meter indication in either counts per minute (cpm) or total counts recorded on the ratemeter, in a set time interval, on the radiological survey form/template.
- 7.4.3 For a scan survey, move the detector slowly over the surface, at the rate described in the site work plan and record data, as described by the plan.

7.5 Final Verification

If required by the site work plan, upon completion of work activities, repeat steps 7.1.1 and 7.1.2 as a final verification that the instrument is working properly.

8.0 REFERENCES

- Radiation Safety Program, Cabrera Services Inc., Manual
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure
- OP-001, *Radiological Surveys*, Cabrera Services Inc., Operating Procedure
- OP-009, *Use and Control of Radioactive Sources*, Cabrera Services Inc., Operating Procedure

9.0 REQUIRED RECORDS

Results will be documented electronically in the “Alpha Beta Counting and Smear Worksheet” and Smear and/or Static worksheets should be printed out and filed along with the radiological Survey Form in Attachment B of OP-001. All records, including electronic records, must be managed in accordance with OP-187.

10.0 ATTACHMENTS

None



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

ALPHA-BETA COUNTING INSTRUMENTATION

OP-021

REVISION 1.0

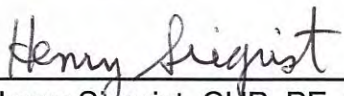
Reviewed by:

David Wunsch, Quality Assurance Manager

4/12/13

Date

Approved by:



Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

This procedure provides instruction on the operation and setup of an alpha/beta sample counter. Adherence to this procedure will provide a reasonable assurance that the surveys performed have reproducible results.

2.0 APPLICABILITY

This procedure will be used by Cabrera Services Inc., (CABRERA) personnel operating an alpha/beta sample counter during surveys. Types of surveys that may use an alpha/beta sample counter are:

- Smear surveys performed to determine the removal of alpha and beta contamination on facility surfaces, equipment, waste, source packages, etc.
- Air sample surveys performed in a worker's breathing zone, a work area, or around the perimeter of a work site to determine alpha and beta air concentrations.

3.0 DEFINITIONS

- 3.1 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.
- 3.2 Smear Sample Survey – A technique using a two-inch diameter filter paper to determine removable contamination of alpha and/or beta emitting radioactive material over a 100 cm² area.
- 3.3 Air Sample Survey – A technique where particulates are collected, from a known volume of air drawn through a filter paper, and the concentrations of airborne alpha and beta activity, associated with the particulates, are determined by sample counting.
- 3.4 Chi-Square Test – A statistical test used to evaluate the operation of a sample counter by determining how data fit a series of counts to a Poisson distribution.
- 3.5 Daily Calibration Check – A determination of alpha and beta sample counting efficiency by counting radioactive standards that are traceable to the National Institutes of Science and Technology.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

If any instrument inconsistencies are observed (e.g., unusually high or low background counts, source checks outside the tolerance range), remove the instrument from use and report the condition to the Site Radiation Safety Lead (SRSL) or other duly authorized representative.

4.2 Limitations

This instrumentation should be set up for use in a low background area, as determined by the SRSL or other duly authorized representative.

4.3 Requirements

- 4.3.1 Calibration sources will be traceable to the National Institutes of Science and Technology (NIST).
- 4.3.2 Survey instrument calibrations will be performed by a calibration facility licensed by the Nuclear Regulatory Commission or Agreement State.
- 4.3.3 A battery or power source check, general observation of instrument condition, background check, and source check will be performed each day before instrument use. A second daily quality check that includes all of the above can be performed at the end of daily work activities, if determined to be necessary on a project site.
- 4.3.4 The alpha/beta sample counter will be checked for proper calibration daily with a NIST-traceable source, when in use.
- 4.3.5 Chi-Square tests will be verified and noted as currently valid, when performed.
- 4.3.6 The Radiation Protection Technician (RPT) will ensure that the attachment forms are the most current and approved revisions.
- 4.3.7 The RPT will review completed forms for accuracy and completeness; all entries must be dated and initialed, by the RPT, to be valid.
- 4.3.8 The RSO or their duly authorized representative will review any applicable, completed forms for accuracy and completeness.

5.0 EQUIPMENT

Ludlum Model 2929 sample counter, or equivalent, coupled to a Ludlum Model 43-10-1 alpha/beta scintillation detector with sample tray. Equivalent instruments, based on project need, can be utilized (i.e. Ludlum Model 3030, Canberra Tennelec).

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – Ensuring that personnel assigned the task of operating alpha/beta sample counters know and understand this procedure, are adequately trained in its use, and have easy access to a copy.
- 6.2 Radiation Safety Officer (RSO) – Verifying that personnel comply with this procedure and are trained in the use of alpha/beta sample counters described in this procedure.

- 6.3 Site Radiation Safety Lead (SRSL) – During field assignments, the SRSL is responsible for ensuring that this procedure is properly implemented. When the RSO is not on site, the SRSL will act as the RSO's duly authorized representative for radiological issues.
- 6.4 Radiation Protection Technician (RPT) – The RPTs, using alpha/beta sample counters, are responsible for knowing and complying with this procedure.
- 6.5 CABRERA personnel – Individuals performing work with an alpha/beta counter will know and understand the requirements set forth in the current and approved version of this procedure.

7.0 PROCEDURE

7.1 Instrument Inspection

7.1.1 Before each use, perform the following checks:

- Verify that the instrument has a current calibration label.
- Visually inspect the instrument for physical damage and defects.
- Verify that the high voltage and high voltage potentiometer settings agree with the calibration sheet.

7.1.2 Remove and tag the instrument "OUT OF SERVICE" if it fails any of the above criteria and notify the SRSL or the duly authorized representative.

Note: Any defects, damages or other physical abnormalities require that the instrument be removed from service and the SRSL, or other duly authorized representative, be notified.

7.2 Chi-Square Test

Note: The Chi-Square Test is not always required, but is a good verification check on the instrument operability and count setup routines, at the beginning of a project. A Chi-Square Test is only required whenever significant changes have been made to the equipment, such as a detector tube (Model 43-10-1) change out and subsequent recalibration or decontamination of the equipment. Contact the SRSL for guidance.

7.2.1 Set up the instrument in a low background area.

7.2.2 Ensure the high voltage potentiometer is positioned according to the posted instrument label. Adjust if necessary.

7.2.3 Set the time multiplier switch to "x1".

7.2.4 Set the instrument-preset timer to one (1) minute.

7.2.5 Insert the alpha calibration standard into center of the sample tray, slide

the sample tray under the detector and depress the "COUNT" button to obtain a one minute count.

- 7.2.6 Upon completion of the count, record digital counts appearing in the alpha display in the "Xi" column on the Chi-Square Data Sheet (Attachment A).

Note: Approved electronic templates may be used in place of this form as long as the equivalent information is provided as described in this procedure.

- 7.2.7 Repeat counting sequence, ensuring that the count source is removed and repositioned within the count holder, thus ensuring count position variability consistent with actual use counting. No instrument settings can be changed during this count sequence. Continue until a total of 20 counts have been taken and recorded in the "Xi" column on the Chi-Square Data Sheet (Attachment A).
- 7.2.8 Add the 20 counts recorded in the "Xi" column and record in the "Sum" column. Then divide by 20 to obtain the mean number of counts (X_m) and record on the line " X_m ."
- 7.2.9 Calculate the individual count "Xi" difference from the mean (X_m) value and record in the " $(X_i - X_m)$ " column the Chi-Square Data Sheet for all 20 values.
- 7.2.10 Calculate $(X_i - X_m)^2$, sum the " $(X_i - X_m)^2$ " column, and record on the Chi-Square Data Sheet.
- 7.2.11 Calculate the value of Chi-Square using the following formula:

$$\chi^2 = \frac{\sum (X_i - X_m)^2}{X_m}$$

- 7.2.12 The value of Chi-Square should be between 8.91 and 32.8 (represents a probability between 0.025 and 0.975). Record this value at " χ^2 ." If the Chi-Square value falls outside this range, contact the SRSL or other duly authorized representative for further instructions.
- 7.2.13 Sign and date the Daily Calibration Check form (Attachment B) and forward the results to the SRSL or other duly authorized representative for review. Keep an electronic copy in the project files.
- 7.3 Initial Quality Control Check
- 7.3.1 Ensure the high voltage potentiometer is positioned according to the posted instrument label. Adjust slowly, if necessary.
- 7.3.2 Set time multiplier switch to "x1."
- 7.3.3 Set the instrument-preset timer to the pre-determined background count

time set by the SRSL. Counter MDAs need to be setup for 50% of the release limit for the given isotope.

- 7.3.4 Record the source type to be used and corresponding serial number on the proper line indicated on the Daily Calibration Check form. Use separate rows of the form for each source efficiency to be calculated.

Note: Approved electronic templates may be used in place of this form as long as the equivalent information is provided, as described in this procedure.

- 7.3.5 Insert a blank sample into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a background count.
- 7.3.6 Record the background count rate in the cell labeled "Bkg Count Time" on the Daily Calibration Check form.
- 7.3.7 Repeat the counting sequence until a total of 10 counts have been taken and recorded in the "Bkgd" row on the Daily Calibration Check form. Calculate the average of the 10 counts and the standard deviation (σ) for the average count.
- 7.3.8 Reset the instrument-preset timer to the pre-determined source count time set by the SRSL.
- 7.3.9 Remove the blank sample and insert the alpha or beta calibration standard into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a source count.

Note: Be sure to turn the source approximately 90 degrees with every count as this will give a wider range since not all sources are uniform in nature.

- 7.3.10 Record the source count rate in the columns labeled "Source #1 Count Time" and "Source #2 Count Time," respectively, on the Daily Calibration Check form
- 7.3.11 Repeat the counting sequence until a total of 10 counts have been taken and recorded for both alpha and beta check sources in the "Source #1" and "Source #2" rows on the Daily Calibration Check form. Calculate the average of the 10 counts for each source and (σ) for the average counts.
- 7.3.12 Remove calibration standards and place in source holders.
- 7.3.13 Initial and date the Daily Calibration Check form and forward the results to the SRSL, or other duly authorized representative, for review.

- 7.3.14 Record all data electronically in an alpha/beta counting spreadsheet and keep in project files. All records, including electronic records, must be managed in accordance with OP-187.

7.4 Daily Calibration Check

- 7.4.1 Ensure the high voltage potentiometer is positioned according to the posted instrument label. Adjust slowly, if necessary.
- 7.4.2 Set time multiplier switch to "x1".
- 7.4.3 Set the instrument-preset timer to the pre-determined background count time, set by the SRSL.
- 7.4.4 Record the source type to be used and corresponding serial number on the proper line indicated on the Daily Calibration Check form. Use separate rows of the form, for each source efficiency, to be calculated.
- 7.4.5 Insert a blank sample into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a background count.
- 7.4.6 Calculate and record the background total counts and count rate in the columns labeled "Bkgd" and "Bkg Count Time" respectively on the Daily Calibration Check form. The background count rate in CPM (counts per minute) can be calculated as follows:

$$CPM = \frac{Total\ Counts}{Total\ Time}$$

- 7.4.7 Remove the blank sample and insert the alpha or beta calibration standard into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a source count.
- 7.4.8 Upon completion of the measurement, calculate and record the total counts and count rate in the columns labeled "Total Counts" and "CPM" respectively, under 'Source' information on the Daily Calibration Check form. The count rate (CPM) can be calculated as listed in Step 7.4.6.
- 7.4.9 Calculate Net Source CPM, as below, and record on the Daily Calibration Check form under "Net CPM."

$$Net\ Source\ CPM = CPM - BKG\ CPM$$

Note: Obtain activity (DPM) value from the source certification paperwork. Decay correct activity, if needed.

- 7.4.10 Use the source disintegration per minute (DPM) to calculate the 4 pi efficiency, as shown below, and check against calibrated efficiency. This data can be recorded in the electronic template.

$$\% \text{ Efficiency} = \frac{\text{Net Source CPM}}{\text{DPM}} * 100$$

- 7.4.11 To calculate the efficiency, for the next source, remove the current source standard and insert a new source standard, then repeat steps 7.4.1 through 7.4.10, as necessary.
- 7.4.12 Remove calibration standards and place in source holders.
- 7.4.13 Generate an excel control chart tracking the daily efficiencies and notify the SRS or duly authorized representative if any point falls outside of 2σ variance.

Note: For the first day on the control chart, use five data points to begin the trend line.

8.0 REFERENCES

- Radiation Safety Program, Cabrera Services Inc., Manual
- AP-005, ALARA, Cabrera Services Inc., Operating Procedure
- OP-001, *Radiological Surveys*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure
- U.S. Nuclear Regulatory Commission, Consolidated Guidance About Material Licenses, Vol. 11 - *Program-Specific Guidance About Licenses of Broad Scope*, NUREG-1556, (1999).

9.0 REQUIRED RECORDS

The following records must be maintained whether paper or electronic:

- Chi-Square Data Sheet (when applicable)
- Daily Calibration Check
- Excel calibration records

10.0 ATTACHMENTS

Attachment A – Chi-Square Data Sheet

Attachment B – Daily Calibration Check

Attachment A

Chi-Square Data Sheet

Chi-Square Data SheetDate: _____ Instrument: _____ Serial Number: _____ χ^2 _____

Alpha Source No./Activity: _____ Beta Source No./Activity: _____

Count Number	X_i	$(X_i - X_m)$	$(X_i - X_m)^2$
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
Sum		////////////////////////////////////	
X_m		////////////////////////////////////	////////////////////////////////////

Prepared By: _____ Date: _____

Print/Sign

Reviewed By: _____ Date: _____

Print/Sign

Attachment B

Daily Calibration Check

Daily Calibration Check

[illegible]



CABRERA SERVICES

RADIOLOGICAL • ENVIRONMENTAL • REMEDIATION

OPERATING PROCEDURE

FOR

SAMPLE LABELING

OP-061

REVISION 0.1

Carl Young

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Approved By: _____ Date: _____

1.0 PURPOSE

This procedure provides the methods Cabrera Services, Inc. (CABRERA) personnel shall utilize when documenting field activities. Adherence to this procedure will provide assurance that the analyses performed have reproducible results.

2.0 APPLICABILITY

Personnel shall utilize this procedure to label environmental samples. Personnel must assure that the specifications of this SOP agree with the specifications listed in the Project Work Plans.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

Not applicable

3.2 Limitations

Not applicable.

3.3 Requirements

3.3.1 Sample names are unique identifiers. Sample codes must be assigned such that they discriminate a sample from any other samples.

3.3.2 Sample numbers must be recorded in at least four places:

- 1) On the sample container
- 2) On the Chain-of-Custody
- 3) On a Sample Control Log
- 4) In the field notebook.

3.3.3 Personnel using this procedure shall be familiar with the Project Work Plans.

3.3.4 Field Personnel shall discuss deviations to the Project Work Plans with the Project Manager. Any deviations, plus conversations with the PM shall be documented in the project field notebook.

4.0 REFERENCES

- none

5.0 DEFINITIONS

5.1 Project Management Plans. These plans usually consist of the following parts:

- Project Work Plan (PWP) - The project work plan includes project team members, roles, and responsibilities, project schedule and cost tracking mechanisms, quality assurance and quality control (QA/QC) measures,

particularly with respect to deliverables, project reporting, and project team communications.

- Field Sampling Plan (FSP) – The FSP provides specific directions for conducting each separate field sampling activity. For each field activity, the rationale and design for the work is presented and field procedures for that specific activity are described. Field Operations and Documentation are also described, including a discussion on field logbooks, photographic records, sample documentation, field analytical records, and documentation procedures for data management and retention.
- Quality Assurance Project Plan (QAPP) - The focus of the QAPP is primarily on the analytical methods and quality assurance/quality control (QA/QC) procedures that are used to analyze environmental samples and manage the data. The QAPP presents the project organization, objectives, procedures, functional activities, and specific QA/QC activities associated with the investigation.
- Site Safety and Health Plan (SSHP) - The SSHP provides evacuation routes for the site and immediate area; site-specific safety information; MSDS for any relevant chemicals of concern; and names and telephone numbers of common emergency contact personnel for the worksite.

5.2 Quality Assurance (QA) - All procedures, practices, records, and documentation required to provide confirmation that activities are compliant with regulations or specifications, or both.

5.3 Quality Control (QC) - Actions that control the attributes of the analytical process, standards, reagents, measurement equipment, components, system, or facility according to predetermined quality requirements.

6.0 EQUIPMENT

- none

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) - The PM is responsible for the contents of the Project Management Plans, and hence the design of the sample numbering system.

7.2 Field Site Manager (FSM) - The FSM is responsible for the execution of field activities, in discussion with the PM. The FSM is responsible for correctly applying the sample numbering system. The FSM is responsible for entering information into the field notebooks.

7.3 Personnel - Personnel include all CABRERA personnel who are responsible for reading, understanding, signing, and complying with the provisions of this procedure. Site workers should document that they have read this SOP by placing their signatures on the sign-off page(s) of the project work management plans.

8.0 INSTRUCTIONS

Sample labels provide specific information that is permanently affixed to the sample container using a water-proof label.

Sample labels are necessary to prevent misidentification of samples. Preprinted sample labels are to be used unless alternative labels are approved by the project manager. Where necessary, the label will be protected from water and solvents with clear covering of transparent tape. Each label will contain the following information:

- Name or initials of the collector
- Date, place, and time of collection
- Job name and number
- Sample number and/or boring number and depth
- Preservative (if required).

9.0 ATTACHMENTS

None



CABRERA SERVICES

RADIOLOGICAL • ENVIRONMENTAL • REMEDIATION

OPERATING PROCEDURE

FOR

SAMPLE HANDLING, PACKAGING & SHIPPING

OP-062

REVISION 0.1

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Date: 2007.09.18 09:37:52 -04'00' Date: _____

1.0 PURPOSE

This procedure provides the methods Cabrera Services, Inc. (CABRERA) personnel shall utilize when handling, packaging and shipping field samples. Adherence to this procedure will provide assurance that the analyses performed have reproducible results.

2.0 APPLICABILITY

Personnel shall utilize this procedure for all environmental field samples. Personnel must assure that the specifications of this SOP agree with the specifications listed in the Project Work Plans.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

Many environmental field samples are preserved using concentrated acids. These preservatives are typically placed in otherwise empty containers by the laboratory. Personnel must wear appropriate PPE and exercise appropriate care when handling sample containers. Preservative may leak from containers during shipment, or may be released into packaging from broken containers. Preservative can be splashed into the air when containers are opened.

USDOT and common carriers may levy severe penalties if fluids of any kind are found to be leaking from coolers.

3.2 Limitations

Not applicable.

3.3 Requirements

3.3.1 Sample names are unique identifiers. Sample codes must be assigned such that they discriminate a sample from any other samples.

3.3.2 Sample numbers must be recorded in at least four places:

- 1) On the sample container
- 2) On the Chain-of-Custody
- 3) On a Sample Control Log
- 4) In the field notebook.

3.3.3 Personnel using this procedure shall be familiar with the Project Work Plans.

3.3.4 Field Personnel shall discuss deviations to the Project Work Plans with the Project Manager. Any deviations, plus conversations with the PM shall be documented in the project field notebook.

4.0 REFERENCES

- none

5.0 DEFINITIONS

5.1 Project Management Plans. These plans usually consist of the following parts:

- Project Work Plan (PWP) - The project work plan includes project team members, roles, and responsibilities, project schedule and cost tracking mechanisms, quality assurance and quality control (QA/QC) measures, particularly with respect to deliverables, project reporting, and project team communications.
- Field Sampling Plan (FSP) – The FSP provides specific directions for conducting each separate field sampling activity. For each field activity, the rationale and design for the work is presented and field procedures for that specific activity are described. Field Operations and Documentation are also described, including a discussion on field logbooks, photographic records, sample documentation, field analytical records, and documentation procedures for data management and retention.
- Quality Assurance Project Plan (QAPP) - The focus of the QAPP is primarily on the analytical methods and quality assurance/quality control (QA/QC) procedures that are used to analyze environmental samples and manage the data. The QAPP presents the project organization, objectives, procedures, functional activities, and specific QA/QC activities associated with the investigation.
- Site Safety and Health Plan (SSHP) - The SSHP provides evacuation routes for the site and immediate area; site-specific safety information; MSDS for any relevant chemicals of concern; and names and telephone numbers of common emergency contact personnel for the worksite.

5.2 Quality Assurance (QA) - All procedures, practices, records, and documentation required to provide confirmation that activities are compliant with regulations or specifications, or both.

5.3 Quality Control (QC) - Actions that control the attributes of the analytical process, standards, reagents, measurement equipment, components, system, or facility according to predetermined quality requirements.

6.0 EQUIPMENT

- Either pre-printed or on-site printed sample labels
- Bubble wrap
- Ice
- Gallon-size water-tight freezer bags
- Trash bags

- Coolers
- Packing tape
- Anti-tamper custody seals
- Shipping labels

7.0 RESPONSIBILITIES

- 7.1 Project Manager (PM) - The PM is responsible for the contents of the Project Management Plans, and hence the design of the sample numbering system.
- 7.2 Field Site Manager (FSM) - The FSM is responsible for the execution of field activities, in discussion with the PM. The FSM is responsible for correctly applying the sample numbering system. The FSM is responsible for entering information into the field notebooks.
- 7.3 Personnel - Personnel include all CABRERA personnel who are responsible for reading, understanding, signing, and complying with the provisions of this procedure. Site workers should document that they have read this SOP by placing their signatures on the sign-off page(s) of the project work management plans.

8.0 INSTRUCTIONS

The procedures for sample handling, packaging, and shipment, when combined with the procedures for sample custody, containers, and preservation are the final steps in ensuring that representative samples are submitted to the laboratories for the appropriate chemical analyses. The Cabrera field representative is responsible for properly and safely following the procedures presented in this section so that holding times are not exceeded, proper preservation temperatures are maintained during shipment, and the samples are packaged so sample containers are not broken during transportation to the laboratory.

Cabrera's procedures for sample handling are as follows unless site-specific planning documents (such as a QAPP) require alternate procedures:

- All samples are to be handled by as few people as possible. If one person collects the samples and another delivers them to the laboratory, the chain of custody form must document the change of possession by the appropriate dated signatures.
- The Cabrera field representative who collects and/or processes the samples is responsible for the correct storage and preservation (usually coolers with blue ice) of the samples until they are delivered to the laboratories.
- The Cabrera field representative who delivers (or arranges delivery of) the samples to the laboratory is responsible for ensuring that sufficient preservation material (blue ice) is present in the shipment container so that the preservation temperature is maintained during transportation

to the laboratory. This is especially critical if the samples are being transported via overnight common courier (such as Federal Express) during the middle of the summer. Always err on the side of placing too much ice in the shipment container; re-sampling will always be more expensive than an extra bag of ice.

The procedures to be employed by the Cabrera field representative for sample packaging will vary based on the types of samples, containers, and method of shipment to the laboratory. Cabrera's procedures for sample packaging are as follows unless site-specific planning documents (such as a QAPP) require alternate procedures:

- For 40 ml volatile organic analysis (VOA) sample bottles, the Cabrera field representative should either have a foam block for the samples or sufficient plastic bags and shipping material (such as bubble wrap). The foam block is preferable for protecting the VOA bottles from breaking. Otherwise, the Cabrera field representative must wrap VOA bottles in bubble wrap and place a maximum of three wrapped VOA bottles into a plastic Ziploc bag. For each shipping container, sufficient cooling material is placed into the container (see next bullet), and the container is filled with Ziploc bags of samples. The chain of custody form is to be signed by the person delivering the samples to the laboratory and the form is sealed into a Ziploc bag and taped to the inside lid of the shipping container. Lastly, the container is taped shut and, if required, custody seals are placed on the container.
- If samples are to be shipped, it is extremely important that ice be packed in such a way the water from melting ice is prevented from leaking out of the coolers. Cooler drains shall be taped shut. A trash bag should be placed in the empty cooler before any samples or other packaging is used. Ice should be placed in a double layer of water-tight (e.g., Ziploc) bags.
- For other types of samples and containers, the process is generally the same except that each sample bottle should be wrapped in a protective layer of material and placed into separate, sealed plastic bags (Ziploc bags, if possible).
- If the samples are very high concentration (total chemical concentration greater than or equal to 15 percent) and are to be shipped by overnight common courier, the use of shipment cans and vermiculite is required for safe transportation. Also note that labeling of these types of high concentration samples (cans and coolers) must comply with Department of Transportation labeling requirements.
- The chain-of-custody should be placed in the cooler on top of any packaging. Protect the chain-of-custody inside a water-tight freezer bag. If the cooler has been scanned, smeared and cleared for potential radioactive contamination, place a copy of the survey in the bag with the chain-of-custody.

- Seal the cooler closed with packing tape. Apply two custody seals, intercalated within the layers of packing tape.

For shipment of samples, the most important consideration is making the arrangements for transporting the samples to the laboratory before starting any sampling episode. If the samples are to be sent by overnight common courier, the prior arrangements include obtaining pickup service or determining where and when the samples can be dropped off. It may also be necessary to modify the sampling schedule to match the latest pickup/drop off times for overnight delivery. For samples collected or shipped on Friday, Saturday, or Sunday, the Cabrera field representative should ensure that laboratory personnel will be present to accept the shipment. If sample coolers sit on a loading dock for a day or more sample integrity may be compromised as the ice or blue ice melts. The project manager and/or the Cabrera field representative should also check with the laboratory to be used for the project and determine if they have a dedicated courier service. While there may be a fee for this service, in some circumstances this service will be the most cost-effective method of shipment.

9.0 ATTACHMENTS

None



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

RECORDS MANAGEMENT

OP-187

Revision 0

Prepared by:

David Wunsch, Quality Assurance Manager

3/16/12

Date

Approved by:

Kim Nelson, PG. President/COO

Date

1.0 Purpose

The purpose of this procedure is to ensure that all required records are maintained in a consistent manner and compliant with quality and client requirements.

2.0 Applicability

This procedure applies to all CABRERA operating units and their methods to generate, identify, collect, index, access, file, store, maintain, and dispose of records unless specifically directed by contract or license requirements.

3.0 Definitions

3.1 Quality Records – Documents providing evidence that CABRERA quality management system (QMS) and client-related contractual quality requirements have been completed and are operating effectively. These documents would include the approval of required actions, client satisfaction surveys, the completion of required reviews or audit actions (re: OP-190), and the resolution of problems identified in nonconformity reports (re: OP-191). Quality records may be maintained in electronic or hard copy form.

3.2 Technical Records – Accumulations of data and information sufficient to form an audit trail which result from carrying out sampling and/or testing and indicate whether specified quality or process parameters are met. They may include forms, worksheets, workbooks, check sheets, work notes, control graphs, external or internal test reports, calibration certificates, and client feedback. Technical records may be maintained in electronic or hard copy form.

3.3 Master List of Quality Records – Identifies the quality records associated with the QMS. It includes the following information: record owner; format (electronic or paper); location of record; minimum retention period, indexing method, and disposition.

Note: Unless specifically defined as either quality or technical, the term *record* used throughout this procedure will refer to both record types.

4.0 Precautions, Limitations and Requirements

There are no special precautions, limitations or requirements associate with this procedure.

5.0 Equipment

There is no special equipment associated with this procedure.

6.0 Responsibilities

6.1 All CABRERA Staff – Ensure that quality and technical records, within their areas of responsibility, are maintained according to this procedure.

6.2 Quality Assurance Manager (QAM) – Ensures that CABRERA quality records are maintained according to this procedure. Establish, maintain and update

a Master List of Quality Records to meet the requirements of the ISO 9001 standard.

- 6.3 Program and Project Managers – Controlling project records to include: identifying records to be generated, maintaining custody, indexing, ensuring safe storage, and providing for maintenance, retention and, if required, their transfer or destruction.
- 6.4 Laboratory Quality Manager (LQM) – Ensures that technical records, associated with laboratory operations, are maintained according to this procedure and assists laboratory staff establish records control practices to comply with the ISO 17025 standard and/or other accreditation requirements.

7.0 Procedure

The following subsections describe the instructions to be followed and procedures to be implemented in the management and control of records.

7.1 Identification

7.1.1 All operating unit and QMS-related staff are to identify quality records within their areas of responsibility using the following criteria:

- Contractual and customer requirements documents (e.g., contracts, task orders).
- Documents that verify the conduct or report results of technical and editorial quality reviews (e.g., Independent Technical Review form).
- Documents that provide evidence of the quality of products or services either received by CABRERA or provided to customers (e.g., customer quality surveys).
- Documents that demonstrate conformance to effective operation of the QMS (e.g., Corrective Action Request).
- Quality record requirements specified by the ISO 9001 standards.

7.1.2 Quality records associated with the CABRERA QMS are identified in the Master List of Quality Records. The QAM is responsible for maintaining this list and updates it as needed. The master list includes the following information for each quality record: record owner (department or position); format of record (electronic or paper); location of record; retention period, indexing method, and disposition.

7.1.3 Technical records associated with CABRERA field and laboratory operations are either identified within corporate-wide and site-specific operating procedures or by the following criteria:

- Contractual and customer requirements documents (e.g., contracts, task orders).
- Documentation mandated by client referenced guides, manuals and/or standard laboratory and field methods.
- Any additional documentation of observations or derived data that ensures sample traceability or demonstrates that data quality objectives have been met.

7.2 Generation and Authentication

- 7.2.1 Records to be generated shall be specified in applicable documents, such as contracts, procurement documents, test methods, operating procedures or design specifications.
- 7.2.2 Records shall be traceable to associated equipment or activities and accurately reflect the work accomplished or information required.
- 7.2.3 Records will only be considered valid if stamped, initialed, or signed and dated, unless otherwise authenticated.
- 7.2.4 Electronic records will be authenticated with comparable information, as appropriate, with identification on the media; or with authentication information contained within or linked to the document itself.
- 7.2.5 When handwritten, records will be legible and written in permanent ink.
- 7.2.6 When mistakes occur in records, each mistake will be corrected by striking a single line through the entry and the correct entry made alongside. The record will not be erased, deleted or otherwise made illegible. All alterations to records will be signed/initialed and dated by the person making the correction. When corrections are made for other than transcription errors, the reason for the correction will be documented.

7.3 Collection, Filing and Indexing

- 7.3.1 All records will be collected, filed and indexed in a manner that ensures they are readily retrievable and auditable; and, with electronic project files organized as directed in OP-106, *Electronic File Structure*.
- 7.3.2 Quality records associated with the effectiveness of the QMS are collected by the QAM, and filed and indexed according to their associated QMS program.

7.3.3 Project/task records are collected by the project manager, filed in project-specific files (actual and electronic), and indexed in a manner consistent with the work plans and/or site operations.

7.3.4 Laboratory records are collected by laboratory staff, under the management of the laboratory director, and filed and indexed in a manner consistent with client/regulatory requirements and laboratory work flow.

7.4 Access

7.4.1 All records will be held in a secure manner and in confidence to the client. Therefore, access to the processing, storage, and retrieval of records is limited to the authorized personnel listed in Section 7.3, their designees, and CABRERA senior management.

7.4.2 All records will be made available to authorized client personnel, regulatory representatives, and auditing organizations, upon request

7.5 Maintenance and storage

7.5.1 Records will be maintained and stored in a manner that protects them from damage, deterioration, destruction, or loss (e.g., locked metal cabinets). In addition, records stored solely on electronic media will be supported by hardware and software that can ensure their retrieval.

7.5.2 Records generated by or stored on personal computers will have either a hard copy or write-protected backup copies.

7.5.3 Field and laboratory operations will develop and implement a management system for the control, maintenance and storage of notebooks, logbooks or other media used for collecting records while on site. This management system will be documented in project-specific work plans.

7.5.4 Once a project is closed, the project files, including all associated records, will be packed and shipped for the long-term storage in accordance with OP-183, *Document Archiving*. Retrieval of archival records will also follow processes defined in OP-183.

7.6 Retention and Disposal

7.6.1 The retention time for all corporate quality records associated with assessing the effectiveness of the QMS is 5 years.

7.6.2 All project-related records shall be retained for a minimum of 10 years from the date of project closure, except where the duration is specified in a contract or mandated by Federal or

State regulations, where applicable. Retention beyond 10 years will be reviewed on a project-by-project basis.

- 7.6.3 Records disposal will be implemented such that client or corporate confidentiality is maintained. This could involve either the transfer or destruction of these records, as required or instructed.

8.0 References

- ISO 9001 American National Standard (2008), Section 4.2.4, *Control of Records*
- ISO 17025 International Standard (2005), Section 4.13, *Control of Records*
- DoD Quality Systems Manual Version 4.2 (2010), Section 4.12, *Control of Records*
- ASME NQA-1 American National Standard (2008), Nonmandatory Appendix 17A-1, *Guidance on Quality Assurance Records*
- ASME NQA-1 American National Standard (2008), Nonmandatory Appendix 17A-2, *Guidance for Electronic Records*

9.0 Required Records

Master List of Quality Records – maintained electronically by the QAM on the CABRERA Intranet

10.0 Attachments

There are no attachments associated with this procedure.



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

WIPE SAMPLING PROCEDURE

OP- 312

Revision 0

Prepared by:

David Wunsch, Quality Assurance Manager

5/2/12

Date

Approved by:

Kim Nelson, PG, President/COO

5/3/12

Date

1.0 Purpose

This procedure provides the methods Cabrera Services, Inc. (CABRERA) personnel will use when conducting wipe sampling for laboratory analysis. Adherence to this procedure will help to provide assurance that the analyses performed have reproducible results.

2.0 Applicability

- 2.1 Wipe sampling techniques are used to assess contamination on hard surfaces such as stone, metal, concrete, brick, tile, and wood surfaces that are characteristically found in manmade structures.
- 2.2 Surface sampling techniques are not as reproducible as most other sampling techniques. Contaminant recovery may vary depending on the technique of the sampler and the texture of the surface.
- 2.3 An advantage of wipe samples is that they can be obtained quickly and easily without compromising the integrity of the area of surface under investigation.

3.0 Definitions

- 3.1 Wipe Sample – A sample taken over a known area (usually 10cm x 10cm) on a hard surface with a wiping of known size partially saturated with known solvent.
- 3.2 Template – An outline of the area to be sampled usually made of paper or other non-contaminating materials.

4.0 Precautions, Limitations and Requirements

4.1 Precautions

- 4.1.1 Excessive dust can interfere with wipe sampling by absorbing the solvent and preventing proper wetting of the surface. To reduce this problem, the filter may be held over the sample jar and carefully rinsed during the sampling process. Care should be taken when using the sampling area outline templates, especially in dusty areas, to avoid contaminating the sample field with falling dust.
- 4.1.2 Rough surfaces are very difficult to sample representatively. The texture of the sampled surface should always be noted in the field log. If cotton or gauze are used, care must be taken so that the material does not tear or shred and remains on the sampling surface.
- 4.1.3 Make sure that the template being used will not react with the sample material or solvent used and that the proper solvent is being used for the desired analyte (See Attachment A for solvent data).

- 4.2 There are no special limitations or requirements associate with this procedure.

5.0 Equipment

The following equipment is needed for proper wipe sampling:

- Non-powdered latex or nitrile sample gloves
- Teflon-coated forceps
- Templates (usually 10cm x 10cm)
- 11.0 cm diameter Whatman GF/A filter paper (glass microfibre)
- 8 ounce glass sample container with Teflon-lined bakelite cap
- Hexane (pesticide reagent grade) or other applicable and appropriate solvent
- Teflon squeeze bottles
- Sample labels
- Absorbent pads (spill diapers)
- Field log book
- Indelible ink markers
- Tape measures
- Garbage bags
- Blue ice for the cooler

6.0 Responsibilities

- 6.1 Project Manager (PM) – Sets the technical capability requirements and assessment criteria for site personnel and ensures that personnel assigned to perform building material sampling are properly qualified to perform wipe sampling.
- 6.2 Site Safety and Health Officer – Ensures that all site workers (Cabrera and subcontractors) have been adequately trained on the requirements of the Site Safety and Health Plan and that the applicable requirements of the plan are met during the conduct of all site activities.
- 6.3 Site Manager (SM) – Supervises daily activities by site personnel and, for this task, is responsible for:
- ensuring that the field personnel are briefed on conducting building material sampling in accordance with project requirements and this procedure.
 - assuring that all necessary equipment, including safety equipment, is available and functioning properly before project operations begin.
 - all task personnel are mobilized on time.
 - coordinating and consulting with the PM on decisions relating to unexpected issues and deviations from this SOP.
- 6.4 Field Personnel – Perform the wipe sampling activities and generating documentation, maps, sample point locations, chains-of-custody and related items.

7.0 Procedure

7.1 Preparation for Sampling

- 7.1.1 Either obtain measurements from fixed reference points (such as telephone poles, buildings, or benchmarks) to accurately establish the sampling point locations using three reference points per sample – or - set up a grid system to make and record measurements. These measurements will be recorded in the field notebook.
- 7.1.2 Determine the level of hazard for the sampling locations. If sampling is in Level D, then the only decontamination of reusable equipment will be necessary. If the sampling is in Level C environment or higher a decontamination area will be set up.

7.2 The steps to be followed in wipe sampling are:

- 7.2.1 Don a clean pair of disposable latex sample gloves.
- 7.2.2 Remove the lid of the sample jar and place it upside down on an absorbent pad.
- 7.2.3 Don a second clean pair of disposable latex sample gloves.
- 7.2.4 Remove one GF/A filter from the filter box and fold the GF/A filter paper in half three times.
- 7.2.5 Place solvent rinsed forceps onto the GF/A filter in such a manner that the forceps hold the filter paper approximately 1 cm away from, and parallel to, the triple-folded edge of the filter.
- 7.2.6 Saturate the filter paper as much as possible with the appropriate solvent from a Teflon squeeze bottle.
- 7.2.7 Carefully place the template on the area to be sampled.
- 7.2.8 Wipe the sample surface 10 times horizontally and 10 times vertically in two swaths each direction. Each swath is approximately 5.5 cm wide and approximately 9.5 cm long with an overlap of 0.5 cm on each pass. This provides for a consistent sample area of 100 cm².
- 7.2.9 Dab any fragments from the GF/A filter that may have been torn from the sample surface with the filter to prevent loss of recovery from the sample area.
- 7.2.10 Place the filter into an 8 ounce sample container.
- 7.2.11 Hold the forceps over the container and rinse with the appropriate solvent removing any residual surface contamination.

- 7.2.12 Replace the Teflon-lined lid on the sample container, and label and seal the sample properly.
- 7.2.13 Dispose of template.
- 7.2.14 Repeat steps 2 through 13 until all the samples have been collected.
- 7.2.15 Prepare shipping container for transportation in accordance with the referenced Cabrera procedures.
- 7.2.16 Complete the Chain-of-Custody and analysis request forms and release samples for shipment in accordance with the referenced Cabrera procedures.
- 7.2.17 Discard all disposables in appropriate container.

8.0 References

- Cabrera Procedure OP-008, *Chain of Custody*
- Cabrera Procedure OP-060, *Sample Numbering*
- Cabrera Procedure OP-061, *Sample Labeling*
- Cabrera Procedure OP-062, *Sample Handling, Packaging, and Shipping*

9.0 Required Records

- Field Notebook
- Chain-of –Custody form

10.0 Attachment

Attachment A – Solvent Selection

Attachment A
Solvent Selection

SOLVENT SELECTION	
ANALYTE	SOLVENT
Semi- and nonvolatile organics	Hexane
Metals - except Hexavalent Chromium	1:1 Water to Nitric Acid (10% HNO ₃)
Hexavalent Chromium (Cr ⁺⁶)	D.I. Water
Cyanide	1% Sodium Hydroxide (NaOH)



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

SURFACE SOIL SAMPLING

OP-351

Revision 0

Prepared by:

Carl Young, P.G., Senior Hydrogeologist

Date

Approved by:

Kim Nelson, PG, President/COO

5/17/12

Date

1.0 Purpose

This procedure provides the methods that personnel will use when sampling surface soil. Adherence to this procedure will provide assurance that the analyses performed have accurate and reproducible results.

2.0 Applicability

Personnel will utilize this procedure to sample surface soil for laboratory analysis unless otherwise directed by the project work plan.

3.0 Definitions

- 3.1 Bucket Auger – Bucket augers (Exhibit 1) consist of a stainless steel “T” handle, detachable handle extensions, and a bucket. They are an excellent choice for sample collection because they provide a relatively large sample volume in a short time and can sample discrete depth intervals. They are the recommended hand sampler for subsurface soil sampling beyond a depth of 6 inches to one foot.



Exhibit 1: Bucket Augers

- 3.2 Post-Hole Digger – Post-hole diggers (Exhibit 2) have limited utility for subsurface soil sample collection because they are designed to cut through fibrous, rooted, and rocky soils. They cannot be utilized below a depth of approximately three feet.



Exhibit 2: Post-Hole Digger

- 3.3 Sampling Station – The exact spot from where the sample will be collected.
- 3.4 Seven Sample Wheel Method – A composite sampling method designed to determine the average concentration representative of the soil at a specific location.
- 3.5 Surface Soil – The uppermost layer of unconsolidated material at the ground surface. Unconsolidated material that is normally under water is considered sediment rather than soil. Wetlands, which don't have water at the ground surface for most of the year, have hydric soil, while marshes, which do have surface water for most of the year, have sediment.

The thickness of the surface soil layer is typically designated by an applicable regulation. For example, in Pennsylvania and New York, surface soil extends from ground surface to two feet below ground surface. The Nuclear Regulatory Commission regards the upper 15 centimeters [6 inches] as the surface soil layer.

4.0 Precautions, Limitations and Requirements

4.1 Precautions

- 4.1.1 The potential exposure to contaminants should be addressed in a Site Specific Health and Safety Plan, specifically the sections concerning personal protective equipment and respiratory protection. At a minimum, an unused pair of nitrile gloves will be donned prior to sampling at each station.
- 4.1.2 Contact the State 'One Call' or 'Call-before-you-dig' service [dial 811 in most states] at least 48 hours in advance to have utilities marked. State regulations vary on the minimum excavation depth where prior notification is required, and site elevations can change over time, so locator services advise to contact them for line marking before any intrusive work regardless of depth. Use 'One Call' regardless of depth of sampling to limit liability.
- 4.1.3 Samples suspected of containing high volatile organic compound (VOC) concentrations will be collected, handled and stored separately.
- 4.1.4 Samplers must use new, verified/certified-clean disposable or non-disposable equipment cleaned according to procedures contained in OP-373 *Field Equipment Decontamination*, or otherwise as specified in the work plan.

4.2 Limitations

- 4.2.1 Certain options must be selected in advance. They include:
 - Specify the sample depth interval, which is typically from 0 to 6 inches but may vary to a maximum depth of one to two feet.
 - Will the station be sampled as a discrete (or 'grab') sample or as a composite, in which case the 'seven sample wheel' method should be used.
 - Will the sample be collected by spooning or by augering.
 - Will the sample depth interval be biased (based on field meter readings) or systematic (based on a pre-determined depth interval).
- 4.2.2 Determine whether there is conflicting client guidance with this method. Certain state regulations may prohibit the compositing of samples, while other state guidance has specific guidelines beyond the scope of this SOP. Federal guidelines for PCB sampling have specific requirements that are beyond the scope of this SOP.

4.3 Requirements

Review the project work plans (typically the Field Sampling Plan, Quality Assurance Project Plan, and Site Specific Health and Safety Plan). Equipment decontamination should be addressed in the work plans, which

may reference OP-373 *Field Equipment Decontamination*. Disposition of Investigation Derived Waste (IDW) must also be considered in the work plans, which may reference OP-336 *IDW Management*.

5.0 Equipment

Soil samples may be collected using a variety of methods and equipment. The methods and equipment used are dependent on the depth of the desired sample, the required sample type (disturbed vs. undisturbed), and the soil type. Near-surface soils may easily be sampled using a spade, trowel, or scoop. Sampling at greater depths may be performed using a hand auger, or by direct-push technology. Soil sampling equipment may include the following:

- Sampling plan
- Maps/plot plan
- PPE
- Survey equipment
- Tape measure
- Survey stakes or flags
- Camera and film
- Stainless steel bowls
- Sample containers (usually provided by the analytical lab)
- Ziploc plastic bags
- Logbook
- Labels
- Chain-of-custody form
- Field data sheets
- Cooler(s)
- Ice (for most non-radiological samples)
- Vermiculite and/or bubble wrap
- Decontamination supplies and equipment
- Plastic sheet
- Spade or shovel
- Spatula
- Scoop
- Plastic or stainless steel spoons
- Trowel
- Sampling wheel (see Figure 2-1)
- Bucket auger
- Post-hole digger

6.0 Responsibilities

- 6.1 Project Manager – The project manager is responsible for assuring that the field team understands the project objectives and has copies of the project work plans and that the field team has reviewed the plans and pertinent procedures before undertaking the work. The project manager is responsible for determining the sample design, including which of the options described in Section 4.2.1, are to be selected.
- 6.2 Field Site Manager – The field site manager is responsible for assuring that the necessary materials and equipment are available. The field site manager will verify that the field personnel have reviewed and understand this procedure.

- 6.3 **Sampler** – Usually a scientist or technician, this person is responsible for reading the work plans and procedures in advance of undertaking the work. The sampler will ask the field site manager or project manager about any details that do not seem clear. He/she should notify the field site manager and/or project manager about unusual conditions; especially conditions that would cause deviations from the work plans or this procedure. The sampler is responsible for documenting the sampling event.

7.0 Procedure

7.1 General Requirements

- 7.1.1 The work plans should specify which of the three following methods will be used to acquire surface soil samples.
- Spoon sampling is an efficient method for collecting loose soils from the upper six inches. Spoon sampling is not appropriate for sampling volatile organic compounds.
 - Auger sampling allows more precise collection of surface samples at greater depth and where soils are more consolidated.
 - The Seven Sample Wheel Method is preferable when contaminants are suspected of being heterogeneously distributed at the sample point.
- 7.1.2 Reused equipment must be decontaminated between each use. Determine in advance whether single-use or decontaminated equipment will be used.
- 7.1.3 Unused sample may be returned to the sample hole from which it came unless otherwise directed by the work plans.
- 7.1.4 Always proceed from the least contaminated to the most contaminated station when sampling surface soil to minimize the potential for cross-contamination.

7.2 Spoon Sampling

- 7.2.1 Place a sheet of plastic on the ground near the sample station to work on.
- 7.2.2 Remove vegetation at the sample station by cutting or scraping it away with a pre-cleaned stainless steel trowel.
- 7.2.3 Use a pre-cleaned stainless steel spoon, trowel to scoop out a cylindrical sample of the soil to a depth of 6 inches (or to the depth specified in the work plans).
- 7.2.4 If sampling for VOCs, take a field reading for VOCs, using a PID or FID, and collect 5 grams of soil using an Encore™ sampler.
- 7.2.5 For sampling all other analytes, place the soil sample into a plastic bowl (if dedicated) or stainless steel bowl (which must be cleaned between uses). Take readings from the sample using the field

meters specified in the work plans. Remove vegetation and stones larger than 1.25 inches (32 mm). If the sample consists of 30% or more of stones larger than this, consult with the PM. Do not sample surface cover materials, such as asphalt or concrete, unless directed.

- 7.2.6 Mix the soil thoroughly to obtain a homogeneous, representative sample.
- 7.2.7 Using pre-cleaned stainless steel equipment or a disposable scoop, fill sample container(s). Wipe soil away from the lip and threads of the container and secure the cap(s).
- 7.2.8 Label the container, prepare Chain-of-Custody form and document your observations in the field logbook.

7.3 Auger Sampling

- 7.3.1 Place a sheet of plastic on the ground next to the sampling station to work on.
- 7.3.2 Use a pre-cleaned bucket auger or post-hole digger to remove a cylindrical sample of the soil throughout the specified sample interval.
- 7.3.3 A VOC sample may be collected from the middle of the depth interval. Take a PID or FID reading and collect 5 grams of soil using an Encore™ sampler.
- 7.3.4 Place the soil sample into a plastic bowl (if dedicated) or stainless steel bowl (which must be cleaned between uses). Remove vegetation and stones larger than 1.25 inches (32 mm). If the sample consists of 30% or more of stones larger than this, consult with the PM. Do not sample surface cover materials such as asphalt or concrete unless directed.
- 7.3.5 Mix the soil thoroughly to obtain a homogeneous sample that represents the entire surface soil interval.
- 7.3.6 Using pre-cleaned stainless steel equipment or a disposable scoop, fill sample container(s). Wipe off the lip and threads of the container and secure the cap(s).
- 7.3.7 Label the container, prepare Chain-of-Custody form, and document your observations in the field logbook.

7.4 Seven Sample Wheel Method

- 7.4.1 Sampling wheels must be prepared in advance (Exhibit 3). These consist of templates cut from a plastic sheet or other impermeable material.
- 7.4.2 Place the sampling wheel over the sampling station so that the station aligns with the center hole of the wheel.

- 7.4.3 For VOC sampling, collect 5 grams of soil from each of the 7 substations of the sampling wheel using an Encore™ sampler. These subsamples must be mixed in the laboratory.

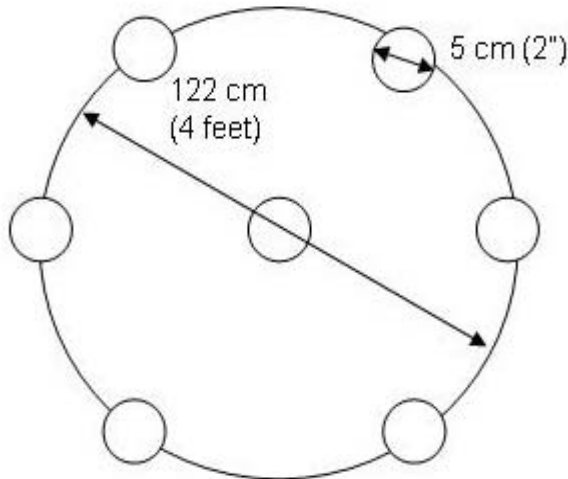


Exhibit 3: Sampling Wheel

- 7.4.4 Proceed with the steps for either spoon sampling or auger sampling, except that all aliquots from seven substations are placed into the bowl. Each aliquot must have the same volume.
- 7.4.5 Thoroughly mix the soil, removing vegetation and rocks larger than 1.25 inches. If the sample consists of 30% or more of stones larger than this, consult with the PM. Do not sample surface cover materials such as asphalt or concrete unless directed.
- 7.4.6 Using pre-cleaned stainless steel equipment or a disposable scoop, fill sample container(s). Wipe off the lip and threads of the container and secure the cap(s).
- 7.4.7 Label the container, prepare a Chain-of-Custody form, and document your observations in the field logbook.

8.0 References

- CABRERA Procedure OP-008, *Chain of Custody*
- CABRERA Procedure OP-059, *Field Activity Documentation*
- CABRERA Procedure OP-060, *Sample Numbering*
- CABRERA Procedure OP-061, *Sample Labeling*
- CABRERA Procedure OP-062, *Sample Handling, Packaging & Shipping*
- CABRERA Procedure OP-063, *Composite Soil Sampling*
- CABRERA Procedure OP-373, *Field Equipment Chemical Decontamination*
- USACE Cold Regions Research & Engineering Laboratory, 1996, Special Report (SR) 96-15, *Assessment of Sampling Error Associated*

with Collection and Analysis of Soil Samples at Explosives-Contaminated Sites.

- USEPA Environmental Response Team, 2000, *Soil Sampling Standard Operating Procedure*, SOP-2012, rev. 0.
- USEPA Method 5035, *Closed-System Purge-and-Trap and Extraction For Volatile Organics In Soil And Waste Samples*.
- USEPA Region 4 Science and Ecosystem Support Division, 2011, *Soil Sampling Operating Procedure*, SESCPROC-300-R2.
- USEPA, 1980, *Samplers and Sampling Procedures for Hazardous Waste Streams*, USEPA/600/2-80/018.
- USEPA, 1984, USEPA/600/4-84-076 *Characterization of Hazardous Waste Sites - A Methods Manual: Volume II*.
- USEPA, 1989, *Soil Sampling Quality Assurance User's Guide*, USEPA/600/8-89/046.
- USEPA, 1992, *Preparation of Soil Sampling Protocols: Techniques and Strategies*, USEPA/600/R-92/128.

9.0 Required Records

- Field Log Book
- Field Data Record – Surface/Subsurface Soil Sampling
- Chain-of-Custody forms

10.0 Attachments

Attachment A – Field Data Record Surface/Subsurface Soil Sampling

Attachment A

**Field Data Record
Surface/Subsurface Soil Sampling**



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**FIELD DATA RECORD
SURFACE / SUBSURFACE SOIL SAMPLING**

PROJECT _____		JOB NUMBER _____		DATE _____	
LOCATION ID _____		ACTIVITY TIME	START _____	END _____	CONTAINER TIME _____
FIELD SAMPLE ID _____			QC SAMPLES COLLECTED _____		

<p>SAMPLE DATA</p> <p>DEPTH OF SAMPLE _____ FT (BGS)</p> <p>TYPE OF SAMPLE: <input type="checkbox"/> DISCRETE <input type="checkbox"/> COMPOSITE</p> <p>LOCATION COORDINATES _____</p> <p>TYPE OF SOIL: <input type="checkbox"/> ORGANIC <input type="checkbox"/> SAND <input type="checkbox"/> GRAVEL <input type="checkbox"/> CLAY <input type="checkbox"/> OTHER</p>	<p>EQUIPMENT INFORMATION</p> <p>EQUIPMENT USED:</p> <p><input type="checkbox"/> HAND CORER / AUGER <input type="checkbox"/> DI WATER N2 PURGE</p> <p><input type="checkbox"/> S.S. SPOON <input type="checkbox"/> POTABLE WATER</p> <p><input type="checkbox"/> S.S. SHOVEL / TROWEL <input type="checkbox"/> LIQUINOX SOLUTION</p> <p><input type="checkbox"/> S.S. SPATULA <input type="checkbox"/> OTHER _____</p> <p><input type="checkbox"/> GEOPROBE</p> <p><input type="checkbox"/> OTHER _____ RINSATE BLANK ID _____</p>
--	--

RADIOLOGICAL MEASUREMENTS AT SAMPLE LOCATION			
BEFORE SAMPLE COLLECTION	AFTER SAMPLE COLLECTION	DETECTOR	METER
_____ cpm	_____ cpm	Type: _____	Type: _____
		Serial No.: _____	Serial No.: _____

SAMPLE OBSERVATIONS (e.g., location, texture, color, odor, etc.)

SAMPLE ANALYSES				
<u>PARAMETER</u>	<u>METHOD NUMBER</u>	<u>PRESERVATION METHOD</u>	<u>BOTTLE TYPE/ VOLUME REQUIRED</u>	<u>SAMPLE COLLECTED</u>
<input type="checkbox"/> DEPLETED URANIUM (GAMMA SPEC)	EPA 901.1M	None	1 @ 16 oz. plastic	<input type="checkbox"/>
<input type="checkbox"/>				<input type="checkbox"/>
<input type="checkbox"/>				<input type="checkbox"/>
<input type="checkbox"/>				<input type="checkbox"/>
<input type="checkbox"/>				<input type="checkbox"/>

NOTES

SAMPLED BY: _____

RECEIVED BY: _____



CABRERA SERVICES
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OPERATING PROCEDURE

FOR

FIELD ACTIVITY DOCUMENTATION

OP-359

Revision 1.0

Prepared/Reviewed by:

Carl Young, Senior Project Manager

Date

Approved by:

Chris Wright, Director of Applied Sciences

03/18/2014

Date

1.0 PURPOSE

This Operating Procedure (OP) provides the methods Cabrera Services, Inc. (Cabrera) personnel shall utilize when documenting field activities. Adherence to this procedure will assure that the field work is properly documented to meet the established project quality objectives by capturing field conditions, details regarding the work performed to include changes or variations to the planned SOW, and other pertinent details regarding the execution of the field effort. Additionally, this documentation will allow for an adequate description of the work performed in subsequent reports.

2.0 APPLICABILITY

Personnel shall utilize this procedure when conducting any field activity. Clear and complete written documentation of field activities is an essential part of a field project. Field notes will become a permanent part of the project records and should be regarded as a client-deliverable document. The keeping of field logs is a requirement under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (USEPA, 1988). Personnel should approach field documentation with the understanding that all of the field work should be able to be written into a report using the field notes alone, by an author who did not take part in field operations.

3.0 DEFINITIONS

- 3.1 Project Management Plans – A set of work plans usually consisting of a Project Work Plan (PWP), a Field Sampling Plan (FSP), and Quality Assurance Project Plan (QAPP). Other plans may be added to the Project Management Plans depending on the complexity of the project, client needs, and regulatory requirements.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

Field activities shall be documented in a project field notebook. The notebook must be bound, and entries must be made in ink. Pages must be sequentially numbered. An entry should be made for each day that activities occur at the field site, including mobilization days and demobilization days. Entries must be dated and initialed by the person making the entry. Blank pages should be lined out and initialed.

Any measurement that is not made on a field form should be entered in the field notebook. Consider making notebook entries that are redundant to field form entries for important measurements.

Field Personnel shall discuss deviations from the Project Work Plans with the Project Manager and receive approval prior to doing such. These actions shall be

documented in the project field notebook at a minimum.

5.0 EQUIPMENT

Field notebooks shall be water-resistant, with permanently-bound with consecutively-numbered pages (examples include Rite-in-the-Rain Part Numbers 350N, 353N or equivalent).

Although not required by this procedure, field forms may be produced on water-proof paper (Rite-in-the-Rain Part Number 8511 or equivalent).

Indelible ink pens with permanent, black or blue indelible ink, or permanent water-proof fine-point markers should be used.

6.0 RESPONSIBILITIES

- 6.1 Project manager (PM): The PM is responsible for ensuring that the assigned personnel are familiar with this procedure and that the required aspects of the field work are being properly documented.
- 6.2 Field Site Manager (FSM) - The FSM is responsible for ensuring that field personnel are entering information into the field notebooks for their assigned tasks. The FSM is responsible for custody of the field forms and field notebooks that are kept by the project team. This responsibility may be delegated to the Cabrera Quality Control System Manager (CQCSM) if that person is on-site.
- 6.3 Field Personnel - All field personnel who are responsible for reading and complying with the provisions of this procedure. All field personnel may make entries to field forms and field notebooks.

7.0 PROCEDURE

These procedures are to be used by the Cabrera field representative for all field investigations unless project-specific planning documents or other written, approved documents supersede. Should the Cabrera FSM be faced with a situation where alternative field procedures must be used because of site conditions, he/she should notify the PM of the conditions and the suggested alternative procedures.

7.1 Project Documentation

- 7.1.1 It is essential that all field work be documented completely and correctly because (1) a written record of events in the field is more reliable and accessible than personal memory and (2) field records could later be used as evidence for litigation. Field documentation is an important part of a project's permanent record, and it should be concise and factual.

Emotional, speculative, or humorous statements regarding events, subcontractors, clients, owners, or site visitors must not be included.

7.1.2 A project field logbook will be kept by the FSM (minimum), and by individual Field Personnel based on the project scope and tasks. The following information must be included in each day's entry:

- The project name, number, and site address will be recorded on the inside front cover of the field logbook.
- Each daily entry shall start at the top of a new page, and include the name of the person (FSM and/or Field Personnel) recording the information, date, time on-site, and the task being recorded.
- Notations in the field logbook will be made in logbook fashion, noting the time and date of all entries. All pertinent information regarding the site will be documented as near to real-time as possible using military-time format (for example, 1:15 pm becomes 1315 hrs).
- Weather conditions shall be noted in the morning and throughout the course of the day to reflect any changes.
- At the conclusion of each day, the person maintaining the field logbook will sign and date the day's documentation entries.
- No blank pages will be permitted. If a page is not completely filled in, a line will be drawn through the blank portion and initialed by the person making the entry.
- Information recorded on other project documentation (boring logs, well installation/development logs) does not need to be repeated in the field logbook at the same level of detail to avoid transcription errors; however, the supplemental log should be referenced in the field notes.
- All field logbooks will be kept in a secure place during the duration of the project.

7.1.3 Mistakes shall not be erased or obliterated. Instead, the mistake shall be crossed out with a single horizontal line and the initials of the reviewer should then be written in along with the date that the mistake was crossed out. Corrections or clarifications can be added to the notebook, but must also contain the initials of the reviewer and the date that the correction or clarification was made.

7.2 Data Collection Logs and Forms

7.2.1 Various OPs include forms and/or logs to be used for data collection for specific tasks. Where applicable, these forms should be used as the primary means to document an activity. Several examples include:

- Soil Boring Logs
- Well Construction Forms
- Well Development Forms
- Groundwater Sampling Forms
- Chain of Custody Sheets
- Sampling Data Sheets
- Survey Data Collection Forms
- Safety Inspection Forms
- Incident Reporting Forms

The field log book should contain a reference to the individual data collection logs and forms to ensure they can be tied to the work performed and provide clarity regarding the full level of detail collected from the field effort.

7.3 Daily Reports

7.3.1 The FSM must submit a daily report to the PM describing the day's events, subcontractor(s) time, site visitors, summary of field conditions, change conditions, etc. Based on project specific needs, the agreed upon format of the Daily Report may vary, but the minimum information required has been included in the attached Cabrera Daily Report (Attachment A).

The level of detail provided within this template will allow the project to accurately record information from the field effort to support any potential change order requests and justify any deviations to the work plans.

7.3.2 Subcontractors may supply field reports and receipts to the FSM. These must be organized by the FSM (or designee) and become part of the Daily Report.

8.0 REFERENCES

- USEPA, 1988, Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, EPA/540/G-89/004

9.0 REQUIRED RECORDS

- Data Collection Logs & Forms
- Field Logbook

10.0 ATTACHMENTS

Attachment A – Cabrera Daily Report

Attachment A
Cabrera Daily Report

OP 359, Field Activity Documentation



CABRERA SERVICES
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CABRERA DAILY REPORT

1. PROJECT INFORMATION

PROJECT NAME/LOCATION:		DATE:
		REPORT NO.
CONTRACT #:	CABRERA PROJECT #:	TASK #:
FIELD SITE MANAGER:		PROJECT MANAGER:

2. WEATHER

TEMPERATURE RANGE:		WIND SPEED/DIRECTION:	
PRECIPITATION LAST 24 HOURS:	<input type="checkbox"/> YES <input type="checkbox"/> NO	TYPE:	AMOUNT:
BAROMETRIC PRESSURE:	HUMIDITY:	HEAT INDEX RANGE:	
WEATHER DELAYS: <input type="checkbox"/> YES <input type="checkbox"/> NO		DELAY TIME (HOURS):	

3. SUMMARY OF WORK

--

4. MATERIALS & EQUIPMENT BROUGHT ON-SITE

--

Receipt inspection required & completed? ☐ Yes ☐ No

5. INSPECTIONS		
TYPE	DESCRIPTION	ACTION
PREPARATORY		
INITIAL		
FOLLOW-UP		
ARE ANY DEFICIENCIES NOTED IN FOLLOW-UP INSPECTIONS? <input type="checkbox"/> YES <input type="checkbox"/> NO – IF YES, EXPLAIN:		

6. DEFICIENCIES CORRECTED			
DEFICIENCY #	REPORT REFERENCE	DESCRIPTION	ACTION

7. TESTS PERFORMED		
SPECIFICATION REFERENCE	TYPE	TEST & RESULT
ARE TEST RESULTS ATTACHED? <input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA – IF NO, EXPLAIN:		

8. CABRERA PERSONNEL ON-SITE		
EMPLOYEE NAME	TITLE	TASK(S) PERFORMED

9. SUBCONTRACTOR PERSONNEL ON-SITE				
SUBCONTRACTOR NAME	JOB DUTY	TASK(S) PERFORMED	# OF PERSONNEL	MAN-HOURS
TOTALS				

10. EQUIPMENT & MATERIALS ON-SITE					
VENDOR	EQUIPMENT	SERIAL #.	ACTIVE OR IDLE	DATE RECEIVED	DATE RETURNED

11. MATERIAL GENERATED/STORED ON-SITE					
MATERIAL ID	SOLID, LIQUID, OR MIXED	DESCRIPTION OF MATERIAL	CONTAINER TYPE	DISPOSITION OR LOCATION OF MATERIAL	AMOUNT* (CY OR TONS)
Totals					
ATTACH SEPARATE PAGES AS NEEDED. SEPARATE PAGES INCLUDED? <input type="checkbox"/> Yes <input type="checkbox"/> No					

12. SAMPLE COLLECTION & ANALYSIS						
Sample ID	Media (Soil Water, Other)	Sampler Initials	On-Site or Off-Site Lab	Analyses / Type	Date Results Due	Freight Tracking #
ATTACH SEPARATE PAGES AS NEEDED. SEPARATE PAGES INCLUDED? <input type="checkbox"/> Yes <input type="checkbox"/> No						

13. CHANGES/DELAYS/CONFLICTSANY CHANGES IN SITE CONDITIONS OCCUR TODAY? ☐ Yes ☐ No

IF YES, EXPLAIN:

DID A DELAY OR WORK STOPPAGE OCCUR TODAY? ☐ Yes ☐ No

IF YES, EXPLAIN:

HAS ANYTHING DEVELOPED IN THE WORK WHICH MAY LEAD TO A CHANGE? ☐ Yes ☐ No

IF YES, EXPLAIN:

14. VERBAL INSTRUCTIONS RECEIVED:**15. HEALTH & SAFETY SUMMARY****SAFETY BRIEFINGS**WAS A SAFETY MEETING HELD? ☐ Yes ☐ No TOPIC DISCUSSED:**SAFETY INSPECTIONS**WAS A SAFETY INSPECTION CONDUCTED? ☐ Yes ☐ NoDEFICIENCIES NOTED: ☐ Yes ☐ No

DESCRIBE:

CORRECTIVE ACTIONS TAKEN: ☐ Yes ☐ No

DESCRIBE:

SUMMARY OF WORK PERFORMED

TYPE OF WORK:

CHEMICALS USED:

PPE LEVEL:

INCIDENT & NEAR MISS/OBSERVATION REPORTINGANY INCIDENTS ON-SITE TODAY? ☐ Yes ☐ No

DESCRIPTION:

CABRERA INCIDENT REPORTING FORM ATTACHED: <input type="checkbox"/> YES <input type="checkbox"/> NO	
CLIENT SPECIFIC INCIDENT REPORTING FORM ATTACHED: <input type="checkbox"/> YES <input type="checkbox"/> NO	
ANY NEAR MISSES/OBSERVATIONS ON-SITE TODAY? <input type="checkbox"/> YES <input type="checkbox"/> NO	DESCRIPTION:
H&S RECOMMENDATIONS	

16. REMARKS

17. VERIFICATION STATEMENT	
This report is complete and correct and all materials and equipment used and work performed during this reporting period are in compliance with the contract plans and specifications except as noted above.	
NAME/TITLE:	SIGNATURE:
DATE:	

18. PROJECT MANAGER REVIEW & ACCEPTANCE	
REMARKS AND/OR EXCEPTIONS TO REPORT:	
ACCEPTANCE	
NAME/TITLE:	SIGNATURE:
DATE:	



CABRERA SERVICES

RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

SAMPLE NUMBERING

OP-360

REVISION 1.0

Prepared by:

Carl Young, Project Manager

10-24-13

Date

Approved by:

David Wunsch, Quality Assurance Manager

10/24/13

Date

1.0 PURPOSE

This procedure provides the methods Cabrera Services Inc. (Cabrera) personnel will utilize to give unique numbers to environmental samples. Adherence to this procedure will provide consistency in sampling numbering across Cabrera projects and assurance that the results are traceable to a specific sample location, type and matrix.

2.0 APPLICABILITY

All Cabrera projects will utilize this procedure to number environmental samples unless formally directed, by the client, to use an alternate numbering scheme.

3.0 DEFINITIONS

- 3.1 Project Plans – For the purposes of this procedure, a generic term describing the project implementing plans that contain the information associated with the requirements for mandated sampling. These include, but are not necessarily limited to:
 - 3.1.1 Project Work Plan (PWP) – The over-arching project plan used to manage both project execution and project controls. A primary use is to document planning assumptions and decisions including quality assurance and quality control (QA/QC) measures regarding data gathering and deliverables.
 - 3.1.2 Field Sampling Plan – Provides specific directions for conducting each separate field sampling activity and presents the rationale and design, for the work, as well as the field procedures for each specific activity required. Field operations and documentation are also described and may include discussions on field logbooks, photographic records, sample documentation, field analytical records, and procedures for their management and retention.
 - 3.1.3 Quality Assurance Project Plan (QAPP) – Focuses primarily on the analytical methods and QA/QC procedures that are used to analyze and manage environmental samples and their resulting data. The QAPP also presents the project organization, objectives, procedures, functional activities, and specific QA/QC activities associated with sampling, data management and record retention.
 - 3.1.4 Site Safety and Health Plan (SSHP) – Provides evacuation routes for the site and immediate area; site-specific safety information; MSDS for any relevant chemicals of concern; and names and telephone numbers of common emergency contact personnel for the worksite. In addition, the SSHP may also contain sampling activities required to monitor worksite safety and health.
- 3.2 Quality Assurance (QA) - All procedures, practices, records, and other documentation required to provide confirmation that project activities are

completed in a manner compliant with regulations, specifications, and/or contract requirements.

- 3.3 Quality Control (QC) – For the purposes of this procedure, actions taken to control the variable attributes of the sampling and analytical processes to meet the data quality objectives described in the project plans.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

Personnel must assure that the specifications describe in this procedure are in agreement with the specifications listed in the project plans.

4.2 Limitations

There are no limitations associated with this procedure.

4.3 Requirements

- 4.3.1 Sample numbers are unique identifiers and must be assigned such that they discriminate each sample from any other sample.

- 4.3.2 Sample numbers must be recorded in at least four places:

- On the sample container;
- On the Chain-of-Custody;
- In the Sample Control Log; and
- In the field notebook.

- 4.3.3 Personnel using this procedure must be familiar with all the applicable project plans.

5.0 EQUIPMENT

None

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – The PM is responsible for implementing and ensuring compliance with the contents of the project plans, and hence the design of the sample numbering system. They also must ensure that project personnel have been trained and are qualified to implement this procedure.
- 6.2 Field Site Manager (FSM) – The FSM is responsible for: the execution of field activities in discussion with the PM; correctly applying the sample numbering system; and, entering information into the field notebooks.
- 6.3 Project Personnel – All Cabrera personnel are responsible for reading, understanding, and complying with the provisions of this procedure prior to engaging in sampling activities. In addition, site workers should discuss any deviations from the prescribed sampling protocols with the PM or FSM, and document that conversation in the project field notebook.

7.0 PROCEDURE

The sample numbering process consists of the assignment of a unique sample identification number, generation of sample labels or tags, and completion of a chain-of-custody form. In addition, sample documentation also requires entries into the field notebook and the Sample Control Log.

Primary samples and QC samples will each be assigned unique sample identification (ID) numbers. The sample ID will be composed of six components separated by dashes, as shown below:

[_] - [_] - [_] - [_] - [_] - [_]
1 2 3 4 5 6

7.1 **Component 1** – Defines the location or area of interest, as designated in the PWP. This component must be a small combination of letters and/or numbers (i.e., alphanumeric) without special characters. For example:

- If the site is divided into two “areas of concern,” you might use AOC1 and AOC2 as the location descriptors; or
- If the site contains 12 “survey units,” you might use SU01 – SU12 as the location descriptors.

Note: At a site with a single sampling area, this numbering component should be eliminated unless another unique discriminator is required. Do not use a site abbreviation as this is common to all samples collected.

7.2 **Component 2** – Defines the station type:

BF	=	Backfill
CPT	=	Cone Penetrometer
D	=	Drum
EXB	=	Excavation – bottom sample
EXE	=	Excavation – east sidewall sample
EXN	=	Excavation – north sidewall sample
EXS	=	Excavation – south sidewall sample
EXW	=	Excavation – west sidewall sample
MW	=	Monitor Well
P	=	Pipe
SB	=	Soil Boring (includes groundwater acquired from borings)
SP	=	Stockpile
T	=	Tank

7.3 **Component 3** – Identifies the station number in the area of interest. Number sequences start from 001 in each area [component 1].

7.4 **Component 4** – Defines the sample matrix using letters:

A	=	Air or soil gas
E	=	Effluent (waste water)
S	=	Soil sample in general or Subsurface Soil Sample
SS	=	Surface Soil Sample
SD	=	Sediment Sample
GF	=	Groundwater Sample – Filtered
GU	=	Groundwater Sample – Unfiltered
W	=	water sample in general or Surface Water Sample

7.5 **Component 5** – Defines either the primary or QC sample collected:

P	=	Primary Sample
MS	=	Matrix Spike
MSD	=	Matrix Spike Duplicate
DUP	=	Duplicate
EB	=	Equipment (Rinsate) Blank
TB	=	Trip Blank
FB	=	Field Blank
QA	=	QA Split

7.6 **Component 6** – Identifies the depth at which the sample was taken:

- For soil and sediment samples, it will designate the top of the sample interval, in feet.
- For groundwater samples, it will designate the depth below ground surface for the entry point of the sampling device (for example, the depth of tubing placement for a peristaltic pump).
- For surface water samples, it will designate the depth below water surface from which the sample was collected.

7.7 To maintain a unique sample ID, the sample database should be reviewed to identify the last sample number used for each station.

7.8 Sample Naming Convention Examples:

- The 16th primary soil sample collected at Building 23 from a soil boring and collected from a depth of 8 feet would be named 23-SB-16-S-P-08.
- The field duplicate, for the sample above, would be named 23-SB-16-S-DUP-08.
- The equipment blank, for the sample above, would be named 23-SB-16-W-EB-08.

8.0 REFERENCES

- None

9.0 REQUIRED RECORDS

- Chain-of-Custody forms
- Sample Control Log
- All field notebooks and/or sample documentation.

10.0 ATTACHMENTS

- None



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

GAMMA WALKOVER SURVEY

OP-387

Revision 0

Prepared/Reviewed by:

Stephan Owe, Scientist

March 7, 2014

Date

Approved by:

Michael Winters, CHP, HP Group Manager

March 7, 2014

Date

1.0 PURPOSE

This Operating Procedure (OP) provides the instructions for Cabrera Services Inc. (Cabrera) personnel conducting a Gamma Walkover Survey (GWS); correlated with global positioning system (GPS) coordinates. The process presented will guide Cabrera technical staff in conducting surveys, while maintaining high standards of quality and avoiding common errors.

2.0 APPLICABILITY

This procedure applies to all Cabrera personnel conducting a geospatially correlated GWS for the detection of radiological contamination/ radioactivity and contains a complete description of GWS operations.

This procedure may be modified to accommodate site-specific situations; however, modifications must be documented and approved, as outlined in OP-181, Document Control. In addition, any modifications must not compromise data quality or damage equipment.

3.0 DEFINITIONS

- 3.1 Gamma Walkover Survey (GWS) – Geospatially correlated radiological scanning survey, which typically uses a sodium iodide scintillation probe to detect gamma emitting radionuclides by holding the detector in close proximity to the ground and moving it in a serpentine pattern as the surveyor walks transects over a given area.
- 3.2 Global Positioning System (GPS) – Radio navigation system comprised of orbiting satellites and receivers that can provide users with positioning, navigation and timing information anywhere on earth. Although GPS is a United States owned utility, other countries have similar systems and modern GPS devices may be able to use foreign systems to aid in navigation.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- The GPS and radiological survey instruments should be operated in accordance with Cabrera operating procedures and manufacturers recommendations, and shall be in current calibration. Refer to OP 020, Operation of Contamination Survey Meters and OP 058, Health Physics Instrument General Quality Control Procedure and OP 051, Global Positioning Systems for guidance.
- Multiple detectors can be used for conducting GWS. The appropriate detector depends on factors such as potential nuclide present, investigation level, and/or other site conditions. Consult the work plan

or the project technical lead for the project specific detector that should be used to conduct the GWS.

- GWS scan rates can be adjusted depending on the expected detector response and the desired investigation level. A standard scan rate is presented in this procedure; however, consult the work plan or the project technical lead for the project specific scan rate that should be implemented.
- Covering or 'sleeving' the detector and probe in plastic is recommended to protect the instrumentation from cross-contamination or water during inclement weather, wet, dirty or muddy environments.

4.2 Limitations

- When conducting a GWS, radiological readings can only be correlated with a geospatial position when the GPS is receiving a satellite signal. Continually check the GPS during the GWS to ensure it is receiving a satellite signal.
- The preferred method of coupling the Ludlum 2221 to the GPS handheld is through a 9-pin serial cable, due to its durability. Some model 2221s are not equipped with this port, in which a RG-174 coaxial cable must be used.
- Positional accuracy during a GWS is affected by line of sight to orbiting satellites. Note that when conducting a GWS near buildings, trees or any elevated structure; the accuracy of the GPS can be reduced or positioning lost.

4.3 Requirements

- Qualified individuals shall perform surveys. Qualification will be determined by the PM, FSM, SRSL or duly authorized field representative. Qualification considers prior training, experience, and certifications.
- All radiological survey Instruments and the GPS Device used during a GWS must be operated in accordance with applicable operating procedures. Instruments used to perform GWS should be performance checked prior to and at the end of each day's use. Refer to OP 020, Operation of Contamination Survey Meters, OP 058, Health Physics Instrument General Quality Control Procedure and OP 051, Global Positioning Systems Device for guidance.

5.0 EQUIPMENT

GWS requires the use of both radiological instrumentation and a GPS device in order to combine radiological data with a highly accurate geospatial position.

5.1 Radiological Instrumentation

- Appropriate portable Scaler-Ratemeter (typically a Ludlum Model 2221) with RS-232 communications port (RG-174 coaxial port or a 9-pin serial port for some models) for linking to the GPS datalogger.
- Appropriate radiation detector, as specified by the Project HP or in established work plans.

5.2 GPS Equipment

Various GPS models exist that are compatible with the radiological survey instruments described above. Typical models used by Cabrera include the Trimble® Pathfinder® Pro XRT GPS receiver mated with a Trimble® Nomad® handheld data logger, or equivalent. GPS hardware and setup can vary slightly depending on the specific model, but the following hardware is typical of all GPS models. OP 051, Global Positioning Systems for guidance.

- Trimble® GPS Receiver/ Antenna/ Backpack
- Trimble® Handheld Datalogger with Terrasync™ software
- RG-174 coaxial cable to 9-pin serial cable (female) or
- 9-pin serial cable (male/female connection), depending on 2221 specifications
- PC with Trimble® Pathfinder® software for data transfer
- Micro-USB/USB cable (data transfer from datalogger to PC)

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – Responsible for ensuring that the assigned personnel know and understand this procedure and have access to a current copy.
- 6.2 Site Radiation Safety Lead (SRSL) - During field assignments, the SRSL is responsible for ensuring that this procedure is properly implemented. The SRSL is responsible for ensuring only properly trained operators use the GPS and GWS instrumentation, reviewing daily operational checks to ensure the unit is operating properly, backing up survey data and transmitting data to the Cabrera server, and communicating any issues to the SRSL. When the RSO

is not on site, the SRS will act as the RSO's duly authorized representative for all radiological matters. These responsibilities may be delegated to HP support staff with approval of the Corporate RSO.

- 6.3 Radiation Protection Technician (RPT) – Conduct GWS according to this procedure, project-specific work documents or, direction from the assigned Sr. HP assigned to a Project.

7.0 PROCEDURE

7.1 Connecting Hardware (Ludlum 2221 and GPS Unit)

- Complete Setup of the GPS Unit - GPS hardware can vary depending on the specific model being used. If using an external antenna, connect the GPS receiver to the antenna using the appropriate cable.

If necessary, check with manufacturers operating manual to complete setup.

- Turn on power switch to GPS receiver and GPS handheld datalogger.
- If connection between the GPS receiver/antenna and the GPS handheld datalogger requires Bluetooth, ensure the Bluetooth device is communicating properly. If necessary, check with manufacturers operating manual to complete setup.
- Connect the Ludlum Model 2221 to the Trimble® handheld datalogger using the RG-174 coaxial cable or a 9-pin serial cable. The 9-pin serial cable is preferred due to the durability, however not all Ludlum Model 2221 are equipped with this port. The RG-174 coaxial port is located below the handle in the center of the meter. If available, the 9-pin serial port is located on the side or front of the meter.
- Connect the 9-pin side of the coaxial cable to the serial port located on the GPS datalogger. If using a serial cable, connect the other end of the serial cable to the GPS datalogger serial port.
- Turn on power switch to the Ludlum Model 2221 and set to the following settings:
 - RESPONSE = F (Fast)
 - DIGITAL CONTROL = Dig. Rate
 - WIN = Out
 - Adjust the Volume dial to an audible level

7.2 GPS and Data Acquisition Software Setup (Terrasync™)

7.2.1 Coordinate System

- Within the Terrasync™ program settings, select the appropriate coordinate system. Consult with the GIS analyst assigned to the project to ensure the correct coordinate system is being used.
- Coordinate system settings can be modified by accessing the drop-down tab and selecting 'Setup', then 'Coordinate System' option.

7.2.2 Data Logging Settings

- Within the Terrasync™ program settings set the data logging interval setting to one (1) second for all data types (Point_generic, Line_generic, Area_generic). This will ensure that radiological measurements are recorded at a rate of one measurement per second.
- Data logging interval settings can be modified by accessing the drop-down tab and selecting 'Setup', then selecting 'Options' in the secondary drop-down, then selecting the 'Logging Settings' option.

7.2.3 External Sensor

- Within the Terrasync™ program settings ensure that the external sensor is activated and the appropriate settings have been entered.
- External Sensor settings can be modified by accessing the drop-down tab and selecting 'Setup', then selecting 'Options' in the secondary drop-down, then selecting the 'External Sensors' option. The external sensor can be activated by selecting the 'check box' next the sensor heading.
- The external sensor settings should already be entered, however for verification, the settings should be as follows:
 - Baud rate = 9600
 - No parity
 - 1 stop bit
 - 8 data bits

7.2.4 Connect GPS to Satellites

- Connect GPS to satellites by accessing the drop-down tab and selecting 'Setup', then selecting 'Options' in the secondary drop-down, then selecting the 'GNSS' button, which will begin the connection process to the GPS receiver.
- When connection is made, the status icon in the top portion of the screen will display an image of a satellite with a number, representing the number of satellites connected.
- It is important to note that if the number of satellites available drops below '5', GPS signal connection is lost and data will not be recorded. The 'satellite' icon will also disappear. Continually monitor the 'satellite' icon to ensure GPS connection. If the GPS signal is lost, wait for the GPS to regain connection. Move to an open area if necessary.

7.2.5 Create Data File

- Create data file by accessing the drop-down tab and selecting 'Data', then selecting 'New' in the secondary drop-down.
- Type a unique file name in the 'File Name:' dialog box that describes the survey you are about to conduct and the date of the survey. Consult the project work plan or SRSL for specific file name nomenclature.
- After you have entered the file name, select 'Create'. The program will prompt you to select a data type, select the 'Line_generic' for conducting GWS. Data will start to record immediately, the user can pause data collection by selecting the 'pause' button.
- To stop collecting data, select the 'Ok' button. Data is automatically saved.
- To begin a new survey, create a new data file as described above.

7.2.6 Check connection with Radiological Meter

- It is only possible to verify that the GPS system is receiving radiological count data from the Ludlum 2221 during data collection. After the user has created and begun logging in a file, as described above; access the drop-down tab and select 'Status', then select 'Sensor' from the secondary drop-down.

- If the GPS system is receiving radiological count data from the Ludlum 2221, the sensor data field will continually change value in accordance to the cpm digital count display located on the Ludlum 2221 meter.
- If the GPS system is registering the correct count values at a rate of one (1) value per second, the system is operating correctly and is ready to conduct the GWS.

7.3 Conduct GWS

7.3.1 Documenting the Survey Area

Before beginning the GWS, the following details about the survey area should be documented in the field log.

- Survey area size, shape and general elevation changes/ sloping
- Terrain cover (vegetation, grass, brush, soil, gravel, etc.)
- Obstructions that prevent survey coverage
- Debris (surface, buried or partially buried)
- Disturbances in terrain (mounding of soil, lack of vegetation growth, soil staining, etc.)

7.3.2 Perform GWS

- Perform Terrasync™ program setup and create data file as described in Section 7.2.
- Technicians should walk the survey area in parallel transects, one meter apart; while moving the detector in a serpentine (S-shaped) pattern with the detector held close to the ground surface (approximately 6 cm or 2.5 in., unless otherwise directed by a project-specific work plan or the Project Health Physicist)
- A scan rate of approximately 0.5 meters per second and a one second interval recording rate ensure that two (2) radiological measurements are collected per square meter. However, scan rates can be adjusted depending on the expected detector response and the desired investigation level. Consult the work plan or the SRSL for the project specific scan rate that should be used.

- Survey coverage should be conducted in accordance with the work plan. Consult the work plan, Sr. HP, or SRSL to determine the survey coverage when conducting a GWS. Absent specific work plan requirements or technical guidance from the Sr. HP assigned to the Project, the following guidelines should be utilized when conducting a GWS to ensure adequate survey coverage throughout the survey area.
 - 100% GWS Coverage – Transects should be 1 meter apart.
 - 50% GWS Coverage – Transects should be 2 meters apart.
 - 25% GWS Coverage – Transects should be 4 meters apart.
- To ensure adequate coverage when surveying large areas, markers should be used to delineate survey lanes. Pin-flags, cones, or similar items should be used as a visual guide to aid in walking straight, parallel transects. Background map files should also be loaded onto the datalogger for use as a guide if available. Background files could consist of property boundaries, survey boundaries, and roads (etc.); and be loaded to the datalogger using Trimble® Pathfinder® Office program. Consult with the GIS technician assigned to the project to create background files.

7.4 Transferring GWS Data from Datalogger to PC

7.4.1 Connect GPS Datalogger to PC

- Connect the GPS datalogger to a PC using the micro-USB-to-USB cable.
- Windows should automatically recognize the external device and establish connection using the 'Windows Mobile Device Center' program.

7.4.2 Transfer Data Files using Trimble® Pathfinder® Office

- Open the 'Trimble® Pathfinder® Office' program on a PC.
- The program will prompt you to select an existing 'Project' or to create a new 'Project'. Pathfinder® 'Projects' allow the user to organize GPS data files into site specific folders. A Pathfinder® 'Project' should be created for each field site.

- Open the 'Data Transfer' utility by selecting the 'Utilities' drop-down, located on the horizontal task bar at the top of the screen. Or by selecting the 'Data Transfer' icon on the left side of the screen.
- The 'Data Transfer' utility should automatically connect to the GPS handheld. The connection icon will alert you when connection to the GPS datalogger is complete.
- Ensure that the 'Receive' tab is selected (the 'Send' tab is used for sending data to the GPS datalogger).
- On the right side of the screen, select the 'Add' drop-down tab, then select 'Data File'.
- A dialog box will appear that contains all GPS data files stored on the GPS datalogger. Select those files in which you want to transfer.
- Select the 'Transfer All' button. A message will alert you if the data transfer was successful.
- GPS Data files are stored as '.SSF' and will be located on your PC in the designated project folder.

7.4.3 GIS Process & Mapping

Refer to OP 388, GWS, GIS Process & Mapping for guidance.

8.0 REFERENCES

- Cabrera OP 181, Document Control
- Cabrera Procedure OP-020, Operation of Contamination Survey Meters
- Cabrera Procedure OP-051, Global Positioning Systems
- Cabrera Procedure OP-058, Health Physics Instrument General Quality Control Procedure
- Cabrera OP 388, Gamma Walkover Surveys, GIS Procedures
- MARSSIM, NUREG-1575

9.0 REQUIRED RECORDS

- Annual Calibration Records for Radiological Instrument

- QA/QC Records (logs, notebooks, instrument background and source response check files)
- '.SSF' Data files associated with GWS data

10.0 ATTACHMENTS

None



**LABORATORY
ACCREDITATION
BUREAU**



Certificate of Accreditation

ISO/IEC 17025:2005

Certificate Number L2305

TestAmerica Laboratories

St. Louis Facility
13715 Rider Trail North
Earth City Missouri 63045

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation valid through: January 10, 2016

R. Douglas Leonard, Jr., President, COO
Laboratory Accreditation Bureau
Presented the 31st of May 2013

*See the laboratory's Scope of Accreditation for details of accredited parameters

**Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

Scope of Accreditation For TestAmerica Laboratories

St. Louis Facility
13715 Rider Trail North
Earth City, Missouri 63045
Marti Ward
314-298-8566

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.2) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to TestAmerica Laboratories, Inc. to perform the following tests:

Accreditation granted through: **January 10, 2016**

Testing - Environmental

Non-Potable Water		
Technology	Method	Analyte
ICP-AES	EPA 6010C	Aluminum
ICP-AES	EPA 6010C	Antimony
ICP-AES	EPA 6010C	Arsenic
ICP-AES	EPA 6010C	Barium
ICP-AES	EPA 6010C	Beryllium
ICP-AES	EPA 6010C	Bismuth
ICP-AES	EPA 6010C	Boron
ICP-AES	EPA 6010C	Cadmium
ICP-AES	EPA 6010C	Calcium
ICP-AES	EPA 6010C	Chromium
ICP-AES	EPA 6010C	Cobalt
ICP-AES	EPA 6010C	Copper
ICP-AES	EPA 6010C	Iron
ICP-AES	EPA 6010C	Lead
ICP-AES	EPA 6010C	Lithium
ICP-AES	EPA 6010C	Magnesium

Non-Potable Water		
Technology	Method	Analyte
ICP-AES	EPA 6010C	Manganese
ICP-AES	EPA 6010C	Molybdenum
ICP-AES	EPA 6010C	Nickel
ICP-AES	EPA 6010C	Phosphorus
ICP-AES	EPA 6010C	Potassium
ICP-AES	EPA 6010C	Selenium
ICP-AES	EPA 6010C	Silicon
ICP-AES	EPA 6010C	Silver
ICP-AES	EPA 6010C	Sodium
ICP-AES	EPA 6010C	Strontium
ICP-AES	EPA 6010C	Sulfur
ICP-AES	EPA 6010C	Thallium
ICP-AES	EPA 6010C	Thorium
ICP-AES	EPA 6010C	Tin
ICP-AES	EPA 6010C	Titanium
ICP-AES	EPA 6010C	Uranium
ICP-AES	EPA 6010C	Vanadium
ICP-AES	EPA 6010C	Zinc
GC/MS	EPA 8260C	Acetone
GC/MS	EPA 8260C	Acetonitrile
GC/MS	EPA 8260C	Acrolein
GC/MS	EPA 8260C	Acrylonitrile
GC/MS	EPA 8260C	Benzene
GC/MS	EPA 8260C	Benzyl chloride
GC/MS	EPA 8260C	Bromobenzene
GC/MS	EPA 8260C	Bromochloromethane
GC/MS	EPA 8260C	Bromodichloromethane
GC/MS	EPA 8260C	Bromoform
GC/MS	EPA 8260C	Bromomethane
GC/MS	EPA 8260C	n-Butanol
GC/MS	EPA 8260C	2-Butanone
GC/MS	EPA 8260C	n-Butylbenzene
GC/MS	EPA 8260C	sec-Butylbenzene
GC/MS	EPA 8260C	tert-Butylbenzene
GC/MS	EPA 8260C	Carbon disulfide

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260C	Carbon tetrachloride
GC/MS	EPA 8260C	Chlorobenzene
GC/MS	EPA 8260C	Chlorobromomethane
GC/MS	EPA 8260C	2-Chloro-1,3-butadiene
GC/MS	EPA 8260C	Chlorodibromomethane
GC/MS	EPA 8260C	Dibromochloromethane
GC/MS	EPA 8260C	Chloroethane
GC/MS	EPA 8260C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260C	Chloroform
GC/MS	EPA 8260C	Chloromethane
GC/MS	EPA 8260C	Allyl chloride
GC/MS	EPA 8260C	2-Chlorotoluene
GC/MS	EPA 8260C	4-Chlorotoluene
GC/MS	EPA 8260C	Cyclohexane
GC/MS	EPA 8260C	Cyclohexanone
GC/MS	EPA 8260C	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260C	1,2-Dibromoethane
GC/MS	EPA 8260C	Dibromomethane
GC/MS	EPA 8260C	1,2-Dichlorobenzene
GC/MS	EPA 8260C	1,3-Dichlorobenzene
GC/MS	EPA 8260C	1,4-Dichlorobenzene
GC/MS	EPA 8260C	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260C	Dichlorodifluoromethane
GC/MS	EPA 8260C	1,1-Dichloroethane
GC/MS	EPA 8260C	1,2-Dichloroethane
GC/MS	EPA 8260C	cis-1,2-Dichloroethene
GC/MS	EPA 8260C	trans-1,2-Dichloroethene
GC/MS	EPA 8260C	1,1-Dichloroethene
GC/MS	EPA 8260C	1,2-Dichloroethene (total)
GC/MS	EPA 8260C	1,2-Dichloropropane
GC/MS	EPA 8260C	1,3-Dichloropropane
GC/MS	EPA 8260C	2,2-Dichloropropane
GC/MS	EPA 8260C	cis-1,3-Dichloropropene
GC/MS	EPA 8260C	trans-1,3-Dichloropropene
GC/MS	EPA 8260C	1,1-Dichloropropene

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260C	1,2-Dichloro-1,1,2,2-tetrafluoroethane
GC/MS	EPA 8260C	Dimethyl disulfide
GC/MS	EPA 8260C	1,4-Dioxane
GC/MS	EPA 8260C	Ethyl acetate
GC/MS	EPA 8260C	Ethylbenzene
GC/MS	EPA 8260C	Ethyl ether
GC/MS	EPA 8260C	Diethyl ether
GC/MS	EPA 8260C	Ethyl methacrylate
GC/MS	EPA 8260C	Freon 113
GC/MS	EPA 8260C	Hexachlorobutadiene
GC/MS	EPA 8260C	n-Hexane
GC/MS	EPA 8260C	2-Hexanone
GC/MS	EPA 8260C	Iodomethane
GC/MS	EPA 8260C	Isobutanol
GC/MS	EPA 8260C	Isopropylbenzene
GC/MS	EPA 8260C	p-Isopropyltoluene
GC/MS	EPA 8260C	Methacrylonitrile
GC/MS	EPA 8260C	Methyl acetate
GC/MS	EPA 8260C	Methyl butyl ketone
GC/MS	EPA 8260C	Methylcyclohexane
GC/MS	EPA 8260C	Dichloromethane
GC/MS	EPA 8260C	Methylene chloride
GC/MS	EPA 8260C	Methyl methacrylate
GC/MS	EPA 8260C	4-Methyl-2-pentanone
GC/MS	EPA 8260C	MTBE
GC/MS	EPA 8260C	Naphthalene
GC/MS	EPA 8260C	2-Nitropropane
GC/MS	EPA 8260C	Nonanal
GC/MS	EPA 8260C	Pentachloroethane
GC/MS	EPA 8260C	Propionitrile
GC/MS	EPA 8260C	n-Propylbenzene
GC/MS	EPA 8260C	Styrene
GC/MS	EPA 8260C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260C	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260C	Tetrachloroethene

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260C	Tetrahydrofuran
GC/MS	EPA 8260C	Toluene
GC/MS	EPA 8260C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260C	1,2,3-Trichlorobenzene
GC/MS	EPA 8260C	1,2,4-Trichlorobenzene
GC/MS	EPA 8260C	1,1,1-Trichloroethane
GC/MS	EPA 8260C	1,1,2-Trichloroethane
GC/MS	EPA 8260C	Trichloroethene
GC/MS	EPA 8260C	Trichlorofluoromethane
GC/MS	EPA 8260C	1,2,3-Trichloropropane
GC/MS	EPA 8260C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260C	Trichlorotrifluoroethane
GC/MS	EPA 8260C	1,2,4-Trimethylbenzene
GC/MS	EPA 8260C	1,3,5-Trimethylbenzene
GC/MS	EPA 8260C	Vinyl acetate
GC/MS	EPA 8260C	Vinyl chloride
GC/MS	EPA 8260C	m-Xylene & p-Xylene
GC/MS	EPA 8260C	o-Xylene
GC/MS	EPA 8260C	Xylenes (total)
GC/MS SIM	EPA 8260 SIM	1,4-Dioxane
GC/MS	EPA 624	Acetone
GC/MS	EPA 624	Acetonitrile
GC/MS	EPA 624	Acrolein
GC/MS	EPA 624	Acrylonitrile
GC/MS	EPA 624	Benzene
GC/MS	EPA 624	Benzyl chloride
GC/MS	EPA 624	Bromobenzene
GC/MS	EPA 624	Bromochloromethane
GC/MS	EPA 624	Bromodichloromethane
GC/MS	EPA 624	Bromoform
GC/MS	EPA 624	Bromomethane
GC/MS	EPA 624	n-Butanol
GC/MS	EPA 624	2-Butanone
GC/MS	EPA 624	n-Butylbenzene
GC/MS	EPA 624	sec-Butylbenzene

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 624	tert-Butylbenzene
GC/MS	EPA 624	Carbon disulfide
GC/MS	EPA 624	Carbon tetrachloride
GC/MS	EPA 624	Chlorobenzene
GC/MS	EPA 624	Chlorobromomethane
GC/MS	EPA 624	2-Chloro-1,3-butadiene
GC/MS	EPA 624	Chlorodibromomethane
GC/MS	EPA 624	Dibromochloromethane
GC/MS	EPA 624	Chloroethane
GC/MS	EPA 624	2-Chloroethyl vinyl ether
GC/MS	EPA 624	Chloroform
GC/MS	EPA 624	Chloromethane
GC/MS	EPA 624	Allyl chloride
GC/MS	EPA 624	2-Chlorotoluene
GC/MS	EPA 624	4-Chlorotoluene
GC/MS	EPA 624	Cyclohexane
GC/MS	EPA 624	Cyclohexanone
GC/MS	EPA 624	1,2-Dibromo-3-chloropropane
GC/MS	EPA 624	1,2-Dibromoethane
GC/MS	EPA 624	Dibromomethane
GC/MS	EPA 624	1,2-Dichlorobenzene
GC/MS	EPA 624	1,3-Dichlorobenzene
GC/MS	EPA 624	1,4-Dichlorobenzene
GC/MS	EPA 624	trans-1,4-Dichloro-2-butene
GC/MS	EPA 624	Dichlorodifluoromethane
GC/MS	EPA 624	1,1-Dichloroethane
GC/MS	EPA 624	1,2-Dichloroethane
GC/MS	EPA 624	cis-1,2-Dichloroethene
GC/MS	EPA 624	trans-1,2-Dichloroethene
GC/MS	EPA 624	1,1-Dichloroethene
GC/MS	EPA 624	1,2-Dichloroethene (total)
GC/MS	EPA 624	1,2-Dichloropropane
GC/MS	EPA 624	1,3-Dichloropropane
GC/MS	EPA 624	2,2-Dichloropropane
GC/MS	EPA 624	cis-1,3-Dichloropropene

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 624	trans-1,3-Dichloropropene
GC/MS	EPA 624	1,1-Dichloropropene
GC/MS	EPA 624	1,2-Dichloro-1,1,2,2-tetrafluoroethane
GC/MS	EPA 624	Dimethyl disulfide
GC/MS	EPA 624	1,4-Dioxane
GC/MS	EPA 624	Ethyl acetate
GC/MS	EPA 624	Ethylbenzene
GC/MS	EPA 624	Ethyl ether
GC/MS	EPA 624	Diethyl ether
GC/MS	EPA 624	Ethyl methacrylate
GC/MS	EPA 624	Freon 113
GC/MS	EPA 624	Hexachlorobutadiene
GC/MS	EPA 624	n-Hexane
GC/MS	EPA 624	2-Hexanone
GC/MS	EPA 624	Iodomethane
GC/MS	EPA 624	Isobutanol
GC/MS	EPA 624	Isopropylbenzene
GC/MS	EPA 624	p-Isopropyltoluene
GC/MS	EPA 624	Methacrylonitrile
GC/MS	EPA 624	Methyl acetate
GC/MS	EPA 624	Methyl butyl ketone
GC/MS	EPA 624	Methylcyclohexane
GC/MS	EPA 624	Dichloromethane
GC/MS	EPA 624	Methylene chloride
GC/MS	EPA 624	Methyl methacrylate
GC/MS	EPA 624	4-Methyl-2-pentanone
GC/MS	EPA 624	MTBE
GC/MS	EPA 624	Naphthalene
GC/MS	EPA 624	2-Nitropropane
GC/MS	EPA 624	Nonanal
GC/MS	EPA 624	Pentachloroethane
GC/MS	EPA 624	Propionitrile
GC/MS	EPA 624	n-Propylbenzene
GC/MS	EPA 624	Styrene
GC/MS	EPA 624	1,1,1,2-Tetrachloroethane

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 624	1,1,2,2-Tetrachloroethane
GC/MS	EPA 624	Tetrachloroethene
GC/MS	EPA 624	Tetrahydrofuran
GC/MS	EPA 624	Toluene
GC/MS	EPA 624	1,3,5-Trichlorobenzene
GC/MS	EPA 624	1,2,3-Trichlorobenzene
GC/MS	EPA 624	1,2,4-Trichlorobenzene
GC/MS	EPA 624	1,1,1-Trichloroethane
GC/MS	EPA 624	1,1,2-Trichloroethane
GC/MS	EPA 624	Trichloroethene
GC/MS	EPA 624	Trichlorofluoromethane
GC/MS	EPA 624	1,2,3-Trichloropropane
GC/MS	EPA 624	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 624	Trichlorotrifluoroethane
GC/MS	EPA 624	1,2,4-Trimethylbenzene
GC/MS	EPA 624	1,3,5-Trimethylbenzene
GC/MS	EPA 624	Vinyl acetate
GC/MS	EPA 624	Vinyl chloride
GC/MS	EPA 624	m-Xylene & p-Xylene
GC/MS	EPA 624	o-Xylene
GC/MS	EPA 624	Xylenes (total)
GC/MS	EPA 8270D	Acenaphthene
GC/MS	EPA 8270D	Acenaphthylene
GC/MS	EPA 8270D	Acetophenone
GC/MS	EPA 8270D	2-Acetylaminofluorene
GC/MS	EPA 8270D	4-Aminobiphenyl
GC/MS	EPA 8270D	Aniline
GC/MS	EPA 8270D	Anthracene
GC/MS	EPA 8270D	Aramite (total)
GC/MS	EPA 8270D	Atrazine
GC/MS	EPA 8270D	Azobenzene
GC/MS	EPA 8270D	Benzaldehyde
GC/MS	EPA 8270D	Benzidine
GC/MS	EPA 8270D	Benzo(a)anthracene
GC/MS	EPA 8270D	Benzo(b)fluoranthene

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270D	Benzo(k)fluoranthene
GC/MS	EPA 8270D	Benzoic acid
GC/MS	EPA 8270D	Benzo(ghi)perylene
GC/MS	EPA 8270D	Benzo(a)pyrene
GC/MS	EPA 8270D	Benzyl alcohol
GC/MS	EPA 8270D	1,1'-Biphenyl
GC/MS	EPA 8270D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270D	bis(2-Chloroethyl) ether
GC/MS	EPA 8270D	bis(2-Chloroisopropyl) ether
GC/MS	EPA 8270D	bis(2-Ethylhexyl) phthalate
GC/MS	EPA 8270D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270D	n-Butylbenzenesulfonamide
GC/MS	EPA 8270D	Butyl benzyl phthalate
GC/MS	EPA 8270D	Caprolactam
GC/MS	EPA 8270D	Carbazole
GC/MS	EPA 8270D	4-Chloroaniline
GC/MS	EPA 8270D	Chlorobenzilate
GC/MS	EPA 8270D	p-Chlorobenzilate
GC/MS	EPA 8270D	4-Chloro-3-methylphenol
GC/MS	EPA 8270D	2-Chloronaphthalene
GC/MS	EPA 8270D	2-Chlorophenol
GC/MS	EPA 8270D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270D	Chrysene
GC/MS	EPA 8270D	Cresols (total)
GC/MS	EPA 8270D	Cyclohexanol
GC/MS	EPA 8270D	Diallate
GC/MS	EPA 8270D	Dibenz(a,h)anthracene
GC/MS	EPA 8270D	Dibenzo(a,h)anthracene
GC/MS	EPA 8270D	Dibenzofuran
GC/MS	EPA 8270D	Di-n-butyl phthalate
GC/MS	EPA 8270D	1,2-Dichlorobenzene
GC/MS	EPA 8270D	1,3-Dichlorobenzene
GC/MS	EPA 8270D	1,4-Dichlorobenzene
GC/MS	EPA 8270D	3,3'-Dichlorobenzidine
GC/MS	EPA 8270D	2,4-Dichlorophenol
GC/MS	EPA 8270D	2,6-Dichlorophenol

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270D	Diethyl phthalate
GC/MS	EPA 8270D	O,O-Diethyl-O-(2-pyrazinyl) phosphorothioate
GC/MS	EPA 8270D	Dimethoate
GC/MS	EPA 8270D	p-Dimethylaminoazobenzene
GC/MS	EPA 8270D	7,12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270D	3,3'-Dimethylbenzidine
GC/MS	EPA 8270D	Dimethylformamide
GC/MS	EPA 8270D	alpha,alpha-Dimethylphenethylamine
GC/MS	EPA 8270D	2,4-Dimethylphenol
GC/MS	EPA 8270D	Dimethyl phthalate
GC/MS	EPA 8270D	1,3-Dinitrobenzene
GC/MS	EPA 8270D	1,4-Dinitrobenzene
GC/MS	EPA 8270D	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270D	2,4-Dinitrophenol
GC/MS	EPA 8270D	2,4-Dinitrotoluene
GC/MS	EPA 8270D	2,6-Dinitrotoluene
GC/MS	EPA 8270D	2-sec-Butyl-4,6-dinitrophenol
GC/MS	EPA 8270D	Dinoseb
GC/MS	EPA 8270D	Di-n-octyl phthalate
GC/MS	EPA 8270D	1,4-Dioxane
GC/MS	EPA 8270D	1,2-Diphenylhydrazine (as Azobenzene)
GC/MS	EPA 8270D	Disulfoton
GC/MS	EPA 8270D	Ethyl methacrylate
GC/MS	EPA 8270D	Ethyl methanesulfonate
GC/MS	EPA 8270D	Famphur
GC/MS	EPA 8270D	Fluoranthene
GC/MS	EPA 8270D	Fluorene
GC/MS	EPA 8270D	Hexachlorobenzene
GC/MS	EPA 8270D	Hexachlorobutadiene
GC/MS	EPA 8270D	Hexachlorocyclopentadiene
GC/MS	EPA 8270D	Hexachloro-1,3-cyclopentadiene
GC/MS	EPA 8270D	Hexachloroethane
GC/MS	EPA 8270D	Hexachlorophene
GC/MS	EPA 8270D	Hexachloropropene
GC/MS	EPA 8270D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270D	Isodrin

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270D	Isophorone
GC/MS	EPA 8270D	Isosafrole
GC/MS	EPA 8270D	Kepone
GC/MS	EPA 8270D	Methapyrilene
GC/MS	EPA 8270D	2-Methylbenzenamine
GC/MS	EPA 8270D	3-Methylcholanthrene
GC/MS	EPA 8270D	4,4'-Methylenebis(2-chloroaniline)
GC/MS	EPA 8270D	Methyl methacrylate
GC/MS	EPA 8270D	Methyl methanesulfonate
GC/MS	EPA 8270D	2-Methylnaphthalene
GC/MS	EPA 8270D	Methyl parathion
GC/MS	EPA 8270D	2-Methylphenol
GC/MS	EPA 8270D	3-Methylphenol & 4-Methylphenol
GC/MS	EPA 8270D	2-Methylphenol, 3-methylphenol and 4-methylphenol
GC/MS	EPA 8270D	Methylphenols (total)
GC/MS	EPA 8270D	Naphthalene
GC/MS	EPA 8270D	1,4-Naphthoquinone
GC/MS	EPA 8270D	1-Naphthylamine
GC/MS	EPA 8270D	2-Naphthylamine
GC/MS	EPA 8270D	2-Nitroaniline
GC/MS	EPA 8270D	3-Nitroaniline
GC/MS	EPA 8270D	4-Nitroaniline
GC/MS	EPA 8270D	Nitrobenzene
GC/MS	EPA 8270D	2-Nitrophenol
GC/MS	EPA 8270D	4-Nitrophenol
GC/MS	EPA 8270D	4-Nitroquinoline-1-oxide
GC/MS	EPA 8270D	N-Nitrosodi-n-butylamine
GC/MS	EPA 8270D	N-Nitrosodiethylamine
GC/MS	EPA 8270D	N-Nitrosodimethylamine
GC/MS	EPA 8270D	N-Nitrosodiphenylamine
GC/MS	EPA 8270D	N-Nitrosodi-n-propylamine
GC/MS	EPA 8270D	N-Nitrosomethylethylamine
GC/MS	EPA 8270D	N-Nitrosomorpholine
GC/MS	EPA 8270D	N-Nitrosopiperidine
GC/MS	EPA 8270D	N-Nitrosopyrrolidine
GC/MS	EPA 8270D	5-Nitro-o-toluidine

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270D	2,2'-oxybis(1-Chloropropane)
GC/MS	EPA 8270D	Parathion
GC/MS	EPA 8270D	Pentachlorobenzene
GC/MS	EPA 8270D	Pentachloroethane
GC/MS	EPA 8270D	Pentachloronitrobenzene
GC/MS	EPA 8270D	Pentachlorophenol
GC/MS	EPA 8270D	Phenacetin
GC/MS	EPA 8270D	Phenanthrene
GC/MS	EPA 8270D	Phenol
GC/MS	EPA 8270D	p-Phenylene diamine
GC/MS	EPA 8270D	Phorate
GC/MS	EPA 8270D	2-Picoline
GC/MS	EPA 8270D	Pronamide
GC/MS	EPA 8270D	Pyrene
GC/MS	EPA 8270D	Pyridine
GC/MS	EPA 8270D	Safrole
GC/MS	EPA 8270D	Sulfotepp
GC/MS	EPA 8270D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270D	Tetraethyldithiopyrophosphate (Sulfotepp)
GC/MS	EPA 8270D	Thionazin
GC/MS	EPA 8270D	o-Toluidine
GC/MS	EPA 8270D	Tributyl phosphate
GC/MS	EPA 8270D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270D	2,4,5-Trichlorophenol
GC/MS	EPA 8270D	2,4,6-Trichlorophenol
GC/MS	EPA 8270D	O,O,O-Triethyl phosphorothioate
GC/MS	EPA 8270D	1,3,5-Trinitrobenzene
GC/MS	EPA 8270D	Tris(2-chloroethyl)phosphate
GC/MS	EPA 8270D	1-Methyl naphthalene
GC/MS	EPA 625	Acenaphthene
GC/MS	EPA 625	Acenaphthylene
GC/MS	EPA 625	Acetophenone
GC/MS	EPA 625	2-Acetylaminofluorene
GC/MS	EPA 625	4-Aminobiphenyl
GC/MS	EPA 625	Aniline

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 625	Anthracene
GC/MS	EPA 625	Aramite (total)
GC/MS	EPA 625	Atrazine
GC/MS	EPA 625	Azobenzene
GC/MS	EPA 625	Benzaldehyde
GC/MS	EPA 625	Benzidine
GC/MS	EPA 625	Benzo(a)anthracene
GC/MS	EPA 625	Benzo(b)fluoranthene
GC/MS	EPA 625	Benzo(k)fluoranthene
GC/MS	EPA 625	Benzoic acid
GC/MS	EPA 625	Benzo(ghi)perylene
GC/MS	EPA 625	Benzo(a)pyrene
GC/MS	EPA 625	Benzyl alcohol
GC/MS	EPA 625	1,1'-Biphenyl
GC/MS	EPA 625	bis(2-Chloroethoxy)methane
GC/MS	EPA 625	bis(2-Chloroethyl) ether
GC/MS	EPA 625	bis(2-Chloroisopropyl) ether
GC/MS	EPA 625	bis(2-Ethylhexyl) phthalate
GC/MS	EPA 625	4-Bromophenyl phenyl ether
GC/MS	EPA 625	n-Butylbenzenesulfonamide
GC/MS	EPA 625	Butyl benzyl phthalate
GC/MS	EPA 625	Caprolactam
GC/MS	EPA 625	Carbazole
GC/MS	EPA 625	4-Chloroaniline
GC/MS	EPA 625	Chlorobenzilate
GC/MS	EPA 625	p-Chlorobenzilate
GC/MS	EPA 625	4-Chloro-3-methylphenol
GC/MS	EPA 625	2-Chloronaphthalene
GC/MS	EPA 625	2-Chlorophenol
GC/MS	EPA 625	4-Chlorophenyl phenyl ether
GC/MS	EPA 625	Chrysene
GC/MS	EPA 625	Cresols (total)
GC/MS	EPA 625	Cyclohexanol
GC/MS	EPA 625	Diallate
GC/MS	EPA 625	Dibenz(a,h)anthracene
GC/MS	EPA 625	Dibenzo(a,h)anthracene
GC/MS	EPA 625	Dibenzofuran
GC/MS	EPA 625	Di-n-butyl phthalate

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 625	1,2-Dichlorobenzene
GC/MS	EPA 625	1,3-Dichlorobenzene
GC/MS	EPA 625	1,4-Dichlorobenzene
GC/MS	EPA 625	3,3'-Dichlorobenzidine
GC/MS	EPA 625	2,4-Dichlorophenol
GC/MS	EPA 625	2,6-Dichlorophenol
GC/MS	EPA 625	Diethyl phthalate
GC/MS	EPA 625	O,O-Diethyl-O-(2-pyrazinyl) phosphorothioate
GC/MS	EPA 625	Dimethoate
GC/MS	EPA 625	p-Dimethylaminoazobenzene
GC/MS	EPA 625	7,12-Dimethylbenz(a)anthracene
GC/MS	EPA 625	3,3'-Dimethylbenzidine
GC/MS	EPA 625	Dimethylformamide
GC/MS	EPA 625	alpha,alpha-Dimethylphenethylamine
GC/MS	EPA 625	2,4-Dimethylphenol
GC/MS	EPA 625	Dimethyl phthalate
GC/MS	EPA 625	1,3-Dinitrobenzene
GC/MS	EPA 625	1,4-Dinitrobenzene
GC/MS	EPA 625	4,6-Dinitro-2-methylphenol
GC/MS	EPA 625	2,4-Dinitrophenol
GC/MS	EPA 625	2,4-Dinitrotoluene
GC/MS	EPA 625	2,6-Dinitrotoluene
GC/MS	EPA 625	2-sec-Butyl-4,6-dinitrophenol
GC/MS	EPA 625	Dinoseb
GC/MS	EPA 625	Di-n-octyl phthalate
GC/MS	EPA 625	1,4-Dioxane
GC/MS	EPA 625	1,2-Diphenylhydrazine (as Azobenzene)
GC/MS	EPA 625	Disulfoton
GC/MS	EPA 625	Ethyl methacrylate
GC/MS	EPA 625	Ethyl methanesulfonate
GC/MS	EPA 625	Famphur
GC/MS	EPA 625	Fluoranthene
GC/MS	EPA 625	Fluorene
GC/MS	EPA 625	Hexachlorobenzene
GC/MS	EPA 625	Hexachlorobutadiene
GC/MS	EPA 625	Hexachlorocyclopentadiene
GC/MS	EPA 625	Hexachloro-1,3-cyclopentadiene
GC/MS	EPA 625	Hexachloroethane

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 625	Hexachlorophene
GC/MS	EPA 625	Hexachloropropene
GC/MS	EPA 625	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 625	Isodrin
GC/MS	EPA 625	Isophorone
GC/MS	EPA 625	Isosafrole
GC/MS	EPA 625	Kepone
GC/MS	EPA 625	Methapyrilene
GC/MS	EPA 625	2-Methylbenzenamine
GC/MS	EPA 625	3-Methylcholanthrene
GC/MS	EPA 625	4,4'-Methylenebis(2-chloroaniline)
GC/MS	EPA 625	Methyl methacrylate
GC/MS	EPA 625	Methyl methanesulfonate
GC/MS	EPA 625	2-Methylnaphthalene
GC/MS	EPA 625	Methyl parathion
GC/MS	EPA 625	2-Methylphenol
GC/MS	EPA 625	3-Methylphenol & 4-Methylphenol
GC/MS	EPA 625	2-Methylphenol, 3-methylphenol and 4-methylphenol
GC/MS	EPA 625	Methylphenols (total)
GC/MS	EPA 625	Naphthalene
GC/MS	EPA 625	1,4-Naphthoquinone
GC/MS	EPA 625	1-Naphthylamine
GC/MS	EPA 625	2-Naphthylamine
GC/MS	EPA 625	2-Nitroaniline
GC/MS	EPA 625	3-Nitroaniline
GC/MS	EPA 625	4-Nitroaniline
GC/MS	EPA 625	Nitrobenzene
GC/MS	EPA 625	2-Nitrophenol
GC/MS	EPA 625	4-Nitrophenol
GC/MS	EPA 625	4-Nitroquinoline-1-oxide
GC/MS	EPA 625	N-Nitrosodi-n-butylamine
GC/MS	EPA 625	N-Nitrosodiethylamine
GC/MS	EPA 625	N-Nitrosodimethylamine
GC/MS	EPA 625	N-Nitrosodiphenylamine
GC/MS	EPA 625	N-Nitrosodi-n-propylamine
GC/MS	EPA 625	N-Nitrosomethylethylamine
GC/MS	EPA 625	N-Nitrosomorpholine
GC/MS	EPA 625	N-Nitrosopiperidine

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 625	N-Nitrosopyrrolidine
GC/MS	EPA 625	5-Nitro-o-toluidine
GC/MS	EPA 625	2,2'-oxybis(1-Chloropropane)
GC/MS	EPA 625	Parathion
GC/MS	EPA 625	Pentachlorobenzene
GC/MS	EPA 625	Pentachloroethane
GC/MS	EPA 625	Pentachloronitrobenzene
GC/MS	EPA 625	Pentachlorophenol
GC/MS	EPA 625	Phenacetin
GC/MS	EPA 625	Phenanthrene
GC/MS	EPA 625	Phenol
GC/MS	EPA 625	p-Phenylene diamine
GC/MS	EPA 625	Phorate
GC/MS	EPA 625	2-Picoline
GC/MS	EPA 625	Pronamide
GC/MS	EPA 625	Pyrene
GC/MS	EPA 625	Pyridine
GC/MS	EPA 625	Safrole
GC/MS	EPA 625	Sulfotepp
GC/MS	EPA 625	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 625	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 625	Tetraethyldithiopyrophosphate (Sulfotepp)
GC/MS	EPA 625	Thionazin
GC/MS	EPA 625	o-Toluidine
GC/MS	EPA 625	Tributyl phosphate
GC/MS	EPA 625	1,2,4-Trichlorobenzene
GC/MS	EPA 625	2,4,5-Trichlorophenol
GC/MS	EPA 625	2,4,6-Trichlorophenol
GC/MS	EPA 625	O,O,O-Triethyl phosphorothioate
GC/MS	EPA 625	1,3,5-Trinitrobenzene
GC/MS	EPA 625	Tris(2-chloroethyl)phosphate
GC/MS	EPA 625	1-Methyl naphthalene
GC-ECD	EPA 8081B	Aldrin
GC-ECD	EPA 8081B	alpha-BHC
GC-ECD	EPA 8081B	beta-BHC
GC-ECD	EPA 8081B	delta-BHC
GC-ECD	EPA 8081B	gamma-BHC (Lindane)
GC-ECD	EPA 8081B	alpha-Chlordane

Non-Potable Water		
Technology	Method	Analyte
GC-ECD	EPA 8081B	gamma-Chlordane
GC-ECD	EPA 8081B	Chlordane (technical)
GC-ECD	EPA 8081B	4,4'-DDD
GC-ECD	EPA 8081B	2,4'-DDD
GC-ECD	EPA 8081B	4,4'-DDE
GC-ECD	EPA 8081B	2,4'-DDE
GC-ECD	EPA 8081B	4,4'-DDT
GC-ECD	EPA 8081B	2,4'-DDT
GC-ECD	EPA 8081B	Dieldrin
GC-ECD	EPA 8081B	Endosulfan I
GC-ECD	EPA 8081B	Endosulfan II
GC-ECD	EPA 8081B	Endosulfan sulfate
GC-ECD	EPA 8081B	Endrin
GC-ECD	EPA 8081B	Endrin aldehyde
GC-ECD	EPA 8081B	Endrin ketone
GC-ECD	EPA 8081B	Heptachlor
GC-ECD	EPA 8081B	Heptachlor epoxide
GC-ECD	EPA 8081B	Methoxychlor
GC-ECD	EPA 8081B	Toxaphene
GC-ECD	EPA 608	Aldrin
GC-ECD	EPA 608	alpha-BHC
GC-ECD	EPA 608	beta-BHC
GC-ECD	EPA 608	delta-BHC
GC-ECD	EPA 608	gamma-BHC (Lindane)
GC-ECD	EPA 608	alpha-Chlordane
GC-ECD	EPA 608	gamma-Chlordane
GC-ECD	EPA 608	Chlordane (technical)
GC-ECD	EPA 608	4,4'-DDD
GC-ECD	EPA 608	2,4'-DDD
GC-ECD	EPA 608	4,4'-DDE
GC-ECD	EPA 608	2,4'-DDE
GC-ECD	EPA 608	4,4'-DDT
GC-ECD	EPA 608	2,4'-DDT
GC-ECD	EPA 608	Dieldrin
GC-ECD	EPA 608	Endosulfan I
GC-ECD	EPA 608	Endosulfan II

Non-Potable Water		
Technology	Method	Analyte
GC-ECD	EPA 608	Endosulfan sulfate
GC-ECD	EPA 608	Endrin
GC-ECD	EPA 608	Endrin aldehyde
GC-ECD	EPA 608	Endrin ketone
GC-ECD	EPA 608	Heptachlor
GC-ECD	EPA 608	Heptachlor epoxide
GC-ECD	EPA 608	Methoxychlor
GC-ECD	EPA 608	Toxaphene
GC-ECD	EPA 608	Aroclor 1016
GC-ECD	EPA 608	Aroclor 1221
GC-ECD	EPA 608	Aroclor 1232
GC-ECD	EPA 608	Aroclor 1242
GC-ECD	EPA 608	Aroclor 1248
GC-ECD	EPA 608	Aroclor 1254
GC-ECD	EPA 608	Aroclor 1260
GC-ECD	EPA 608	Aroclor 1262
GC-ECD	EPA 608	Aroclor 1268
GC-ECD	EPA 8082A	Aroclor 1016
GC-ECD	EPA 8082A	Aroclor 1221
GC-ECD	EPA 8082A	Aroclor 1232
GC-ECD	EPA 8082A	Aroclor 1242
GC-ECD	EPA 8082A	Aroclor 1248
GC-ECD	EPA 8082A	Aroclor 1254
GC-ECD	EPA 8082A	Aroclor 1260
GC-ECD	EPA 8082A	Aroclor 1262
GC-ECD	EPA 8082A	Aroclor 1268
GC-ECD	EPA 8151A	2,4-D
GC-ECD	EPA 8151A	Dalapon
GC-ECD	EPA 8151A	2,4-DB
GC-ECD	EPA 8151A	Dicamba
GC-ECD	EPA 8151A	Dichlorprop
GC-ECD	EPA 8151A	Dinoseb
GC-ECD	EPA 8151A	MCPA
GC-ECD	EPA 8151A	MCPP
GC-ECD	EPA 8151A	4-Nitrophenol
GC-ECD	EPA 8151A	Pentachlorophenol

Non-Potable Water		
Technology	Method	Analyte
GC-ECD	EPA 8151A	2,4,5-TP (Silvex)
GC-ECD	EPA 8151A	2,4,5-T
GC-FID	RSK-175	Methane
GC-FID	RSK-175	Ethane
GC-FID	RSK-175	Ethene
GC-FID	RSK-175	Acetylene
GC-FID	EPA 8015B	Ethanol
GC-FID	EPA 8015B	Methanol
GC-FID	EPA 8015B	Ethylene glycol
GC-FID	EPA 8015B	Propylene glycol
GC-FID	EPA 8015B	Diesel Range Organics
GC-FID	EPA 8015B	Motor Oil Range Organics
GC-FID	EPA 8015B	TPH (as Diesel)
GC-FID	EPA 8015B	Gasoline Range Organics
LC/MS/MS	EPA 8321A	2-Amino-4,6-dinitrotoluene
LC/MS/MS	EPA 8321A	4-Amino-2,6-dinitrotoluene
LC/MS/MS	EPA 8321A	3,5-Dinitroaniline
LC/MS/MS	EPA 8321A	1,3-Dinitrobenzene
LC/MS/MS	EPA 8321A	2,4-Dinitrotoluene
LC/MS/MS	EPA 8321A	2,6-Dinitrotoluene
LC/MS/MS	EPA 8321A	DNX
LC/MS/MS	EPA 8321A	HMX
LC/MS/MS	EPA 8321A	HNAB
LC/MS/MS	EPA 8321A	HNS
LC/MS/MS	EPA 8321A	MXN
LC/MS/MS	EPA 8321A	Nitrobenzene
LC/MS/MS	EPA 8321A	Nitroglycerin
LC/MS/MS	EPA 8321A	4-Nitrotoluene
LC/MS/MS	EPA 8321A	3-Nitrotoluene
LC/MS/MS	EPA 8321A	2-Nitrotoluene
LC/MS/MS	EPA 8321A	PETN
LC/MS/MS	EPA 8321A	RDX
LC/MS/MS	EPA 8321A	TATB
LC/MS/MS	EPA 8321A	Tetryl
LC/MS/MS	EPA 8321A	TNX
LC/MS/MS	EPA 8321A	1,3,5-Trinitrobenzene

Non-Potable Water		
Technology	Method	Analyte
LC/MS/MS	EPA 8321A	2,4,6-Trinitrotoluene
LC/MS/MS	EPA 8321A	Tris (o-cresyl) Phosphate
LC/MS/MS	EPA 8321A	2,4-diamino-6-nitrotoluene
LC/MS/MS	EPA 8321A	2,6-diamino-4-nitrotoluene
HPLC	EPA 8330B	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330B	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330B	1,3-Dinitrobenzene
HPLC	EPA 8330B	2,4-Dinitrotoluene
HPLC	EPA 8330B	2,6-Dinitrotoluene
HPLC	EPA 8330B	HMX
HPLC	EPA 8330B	HNAB
HPLC	EPA 8330B	HNS
HPLC	EPA 8330B	Nitrobenzene
HPLC	EPA 8330B	Nitroglycerin
HPLC	EPA 8330B	2-Nitrotoluene
HPLC	EPA 8330B	3-Nitrotoluene
HPLC	EPA 8330B	4-Nitrotoluene
HPLC	EPA 8330B	PETN
HPLC	EPA 8330B	RDX
HPLC	EPA 8330B	TATB
HPLC	EPA 8330B	Tetryl
HPLC	EPA 8330B	MXN
HPLC	EPA 8330B	DNX
HPLC	EPA 8330B	TNX
HPLC	EPA 8330B	1,3,5-Trinitrobenzene
HPLC	EPA 8330B	2,4,6-Trinitrotoluene
HPLC	EPA 8310	Acenaphthene
HPLC	EPA 8310	Acenaphthylene
HPLC	EPA 8310	Anthracene
HPLC	EPA 8310	Benzo(a)anthracene
HPLC	EPA 8310	Benzo(b)fluoranthene
HPLC	EPA 8310	Benzo(k)fluoranthene
HPLC	EPA 8310	Benzo(ghi)perylene
HPLC	EPA 8310	Benzo(a)pyrene
HPLC	EPA 8310	Chrysene
HPLC	EPA 8310	Dibenz(a,h)anthracene

Non-Potable Water		
Technology	Method	Analyte
HPLC	EPA 8310	Fluoranthene
HPLC	EPA 8310	Fluorene
HPLC	EPA 8310	Indeno(1,2,3-cd)pyrene
HPLC	EPA 8310	Naphthalene
HPLC	EPA 8310	Phenanthrene
HPLC	EPA 8310	Pyrene
GC/MS SIM	EPA 8270D SIM	Acenaphthene
GC/MS SIM	EPA 8270D SIM	Acenaphthylene
GC/MS SIM	EPA 8270D SIM	Anthracene
GC/MS SIM	EPA 8270D SIM	Benzo(a)anthracene
GC/MS SIM	EPA 8270D SIM	Benzo(b)fluoranthene
GC/MS SIM	EPA 8270D SIM	Benzo(k)fluoranthene
GC/MS SIM	EPA 8270D SIM	Benzo(ghi)perylene
GC/MS SIM	EPA 8270D SIM	Benzo(a)pyrene
GC/MS SIM	EPA 8270D SIM	Chrysene
GC/MS SIM	EPA 8270D SIM	Dibenz(a,h)anthracene
GC/MS SIM	EPA 8270D SIM	Fluoranthene
GC/MS SIM	EPA 8270D SIM	Fluorene
GC/MS SIM	EPA 8270D SIM	Indeno(1,2,3-cd)pyrene
GC/MS SIM	EPA 8270D SIM	Naphthalene
GC/MS SIM	EPA 8270D SIM	Phenanthrene
GC/MS SIM	EPA 8270D SIM	Pyrene
LC/MS/MS	EPA 6850	Perchlorate
ICP-MS	EPA 6020A	Aluminum
ICP-MS	EPA 6020A	Antimony
ICP-MS	EPA 6020A	Arsenic
ICP-MS	EPA 6020A	Barium
ICP-MS	EPA 6020A	Beryllium
ICP-MS	EPA 6020A	Bismuth
ICP-MS	EPA 6020A	Boron
ICP-MS	EPA 6020A	Cadmium
ICP-MS	EPA 6020A	Calcium
ICP-MS	EPA 6020A	Cerium
ICP-MS	EPA 6020A	Cesium
ICP-MS	EPA 6020A	Chromium
ICP-MS	EPA 6020A	Cobalt

Non-Potable Water		
Technology	Method	Analyte
ICP-MS	EPA 6020A	Copper
ICP-MS	EPA 6020A	Hafnium
ICP-MS	EPA 6020A	Iron
ICP-MS	EPA 6020A	Lanthanum
ICP-MS	EPA 6020A	Lead
ICP-MS	EPA 6020A	Lithium
ICP-MS	EPA 6020A	Magnesium
ICP-MS	EPA 6020A	Manganese
ICP-MS	EPA 6020A	Molybdenum
ICP-MS	EPA 6020A	Neodymium
ICP-MS	EPA 6020A	Nickel
ICP-MS	EPA 6020A	Niobium
ICP-MS	EPA 6020A	Palladium
ICP-MS	EPA 6020A	Phosphorus
ICP-MS	EPA 6020A	Platinum
ICP-MS	EPA 6020A	Potassium
ICP-MS	EPA 6020A	Praseodymium
ICP-MS	EPA 6020A	Rhodium
ICP-MS	EPA 6020A	Ruthenium
ICP-MS	EPA 6020A	Samarium
ICP-MS	EPA 6020A	Selenium
ICP-MS	EPA 6020A	Silicon
ICP-MS	EPA 6020A	Silver
ICP-MS	EPA 6020A	Sodium
ICP-MS	EPA 6020A	Strontium
ICP-MS	EPA 6020A	Sulfur
ICP-MS	EPA 6020A	Tantalum
ICP-MS	EPA 6020A	Technetium-99
ICP-MS	EPA 6020A	Tellurium
ICP-MS	EPA 6020A	Thallium
ICP-MS	EPA 6020A	Thorium
ICP-MS	EPA 6020A	Tin
ICP-MS	EPA 6020A	Titanium
ICP-MS	EPA 6020A	Tungsten
ICP-MS	EPA 6020A	Uranium
ICP-MS	EPA 6020A	Uranium 233

Non-Potable Water		
Technology	Method	Analyte
ICP-MS	EPA 6020A	Uranium 234
ICP-MS	EPA 6020A	Uranium 235
ICP-MS	EPA 6020A	Uranium 236
ICP-MS	EPA 6020A	Uranium 238
ICP-MS	EPA 6020A	Vanadium
ICP-MS	EPA 6020A	Yttrium
ICP-MS	EPA 6020A	Zinc
ICP-MS	EPA 6020A	Zirconium
ICP-MS	EPA 200.8	Aluminum
ICP-MS	EPA 200.8	Antimony
ICP-MS	EPA 200.8	Arsenic
ICP-MS	EPA 200.8	Barium
ICP-MS	EPA 200.8	Beryllium
ICP-MS	EPA 200.8	Bismuth
ICP-MS	EPA 200.8	Boron
ICP-MS	EPA 200.8	Cadmium
ICP-MS	EPA 200.8	Calcium
ICP-MS	EPA 200.8	Cerium
ICP-MS	EPA 200.8	Cesium
ICP-MS	EPA 200.8	Chromium
ICP-MS	EPA 200.8	Cobalt
ICP-MS	EPA 200.8	Copper
ICP-MS	EPA 200.8	Hafnium
ICP-MS	EPA 200.8	Iron
ICP-MS	EPA 200.8	Lanthanum
ICP-MS	EPA 200.8	Lead
ICP-MS	EPA 200.8	Lithium
ICP-MS	EPA 200.8	Magnesium
ICP-MS	EPA 200.8	Manganese
ICP-MS	EPA 200.8	Molybdenum
ICP-MS	EPA 200.8	Neodymium
ICP-MS	EPA 200.8	Nickel
ICP-MS	EPA 200.8	Niobium
ICP-MS	EPA 200.8	Palladium
ICP-MS	EPA 200.8	Phosphorus
ICP-MS	EPA 200.8	Platinum

Non-Potable Water		
Technology	Method	Analyte
ICP-MS	EPA 200.8	Potassium
ICP-MS	EPA 200.8	Praseodymium
ICP-MS	EPA 200.8	Rhodium
ICP-MS	EPA 200.8	Ruthenium
ICP-MS	EPA 200.8	Samarium
ICP-MS	EPA 200.8	Selenium
ICP-MS	EPA 200.8	Silicon
ICP-MS	EPA 200.8	Silver
ICP-MS	EPA 200.8	Sodium
ICP-MS	EPA 200.8	Strontium
ICP-MS	EPA 200.8	Sulfur
ICP-MS	EPA 200.8	Tantalum
ICP-MS	EPA 200.8	Tellurium
ICP-MS	EPA 200.8	Thallium
ICP-MS	EPA 200.8	Thorium
ICP-MS	EPA 200.8	Tin
ICP-MS	EPA 200.8	Titanium
ICP-MS	EPA 200.8	Tungsten
ICP-MS	EPA 200.8	Uranium
ICP-MS	EPA 200.8	Vanadium
ICP-MS	EPA 200.8	Yttrium
ICP-MS	EPA 200.8	Zinc
ICP-MS	EPA 200.8	Zirconium
ICP-AES	EPA 200.7	Aluminum
ICP-AES	EPA 200.7	Antimony
ICP-AES	EPA 200.7	Arsenic
ICP-AES	EPA 200.7	Barium
ICP-AES	EPA 200.7	Beryllium
ICP-AES	EPA 200.7	Bismuth
ICP-AES	EPA 200.7	Boron
ICP-AES	EPA 200.7	Cadmium
ICP-AES	EPA 200.7	Calcium
ICP-AES	EPA 200.7	Chromium
ICP-AES	EPA 200.7	Cobalt
ICP-AES	EPA 200.7	Copper
ICP-AES	EPA 200.7	Iron

Non-Potable Water		
Technology	Method	Analyte
ICP-AES	EPA 200.7	Lead
ICP-AES	EPA 200.7	Lithium
ICP-AES	EPA 200.7	Magnesium
ICP-AES	EPA 200.7	Manganese
ICP-AES	EPA 200.7	Molybdenum
ICP-AES	EPA 200.7	Nickel
ICP-AES	EPA 200.7	Phosphorus
ICP-AES	EPA 200.7	Potassium
ICP-AES	EPA 200.7	Selenium
ICP-AES	EPA 200.7	Silicon
ICP-AES	EPA 200.7	Silver
ICP-AES	EPA 200.7	Sodium
ICP-AES	EPA 200.7	Strontium
ICP-AES	EPA 200.7	Sulfur
ICP-AES	EPA 200.7	Thallium
ICP-AES	EPA 200.7	Thorium
ICP-AES	EPA 200.7	Tin
ICP-AES	EPA 200.7	Titanium
ICP-AES	EPA 200.7	Uranium
ICP-AES	EPA 200.7	Vanadium
ICP-AES	EPA 200.7	Zinc
CVAA	EPA 7470A	Mercury
Colormetric	EPA 9010C EPA 9012B	Cyanide
Ion Chromatography	EPA 300.0/9056A	Bromide
Ion Chromatography	EPA 300.0/9056A	Chloride
Ion Chromatography	EPA 300.0/9056A	Fluoride
Ion Chromatography	EPA 300.0/9056A	Nitrate
Ion Chromatography	EPA 300.0/9056A	Nitrite
Ion Chromatography	EPA 300.0/9056A	Sulfate
Ion Chromatography	EPA 300.0/9056A	Ortho-phosph
Ion Chromatography	EPA 300.0/9056A	Iodide
Ion Chromatography	EPA 314.0	Perchlorate

Non-Potable Water		
Technology	Method	Analyte
Gravimetric	EPA 2540B EPA 2540C EPA 2540D	Solids
Probe	EPA 9040C EPA 9045D EPA 150.1	pH
Titration	SM 2320B EPA 310.1	Alkalinity
Titration	EPA 9030	Sulfide
Penske-Martin	EPA 1010A	Ignitability
Colormetric	EPA 353.1	nitrate/Nitrite
Colormetric	EPA 365.2	Total phosph
Colormetric	EPA 350.1	Ammonia
Colormetric	EPA 351.2	TKN
TOC Analyzer	EPA 9060	TOC
Titrimetric	EPA 9020	TOX
Colormetric	EPA 7196A	Hex Chromium
Gravimetric	EPA 1664A	Oil & Grease
Gravimetric	EPA 1664A	TPH
Probe	EPA 9050A	Conductivity
Probe	SM 5210B EPA 405.1	BOD/CBOD
Gas Flow Proportional Counter	EPA 900.0 EPA 9310	gross alpha/beta
Gas Flow Proportional Counter	EPA 903.0 EPA 9315	Radium-226
Gas Flow Proportional Counter	EPA 903.0 EPA 9315	total radium
Gas Flow Proportional Counter	EPA 904.0 EPA 9320	Radium-228
Gas Flow Proportional Counter	EPA 905.0 / DOE HASL 300 Sr-02	Strontium-90
Liquid Scintillation Counter	EPA 906.0	Tritium
Liquid Scintillation Counter	Eichrom Technologies TCW01/TCS01	Tecnetium-99
Liquid Scintillation Counter	EERF C-01-C14	Carbon-14

Non-Potable Water		
Technology	Method	Analyte
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Gamma Emitters:
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 227 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Americium 241
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 124
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 125
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium-137
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium/Lanthanum-140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 133
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Beryllium 7
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 211 eq Th-227
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 207
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth-210M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 212
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Calcium-45
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 141
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 139
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 134
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 137

Non-Potable Water		
Technology	Method	Analyte
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 57
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 58
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 60
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 152
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 154
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 155
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Hafnium 181
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iodine 131
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iridium 192
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iron 59
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lanthanum 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 210
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 211
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 212
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese-56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese 54
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Mercury 203
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 237
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 239
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 83

Non-Potable Water		
Technology	Method	Analyte
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 94
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 95
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Potassium 40
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 146
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 147
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 231
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium (226)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 223 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 224
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Ruthenium 106
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Scandium 46
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 22
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 24
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Strontium 85
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thallium 208
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 227
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 230

Non-Potable Water		
Technology	Method	Analyte
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 231
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 232
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 234
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Tin 113
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 235
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 238
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Vanadium-48
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Yttrium 88
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zinc 65
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zirconium 95
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Alpha spec analysis:
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Uranium
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Thorium
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Americium
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Plutonium
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Neptunium
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Curium
Liquid Scintillation Counter	Eichrom Technologies OTW01, OTS01	Lead-210
Alpha Spectroscopy	Laboratory SOP ST-RC-0210	Polonium-210
Liquid Scintillation Counter	Eichrom Technologies FEW01	Iron-55
Liquid Scintillation Counter	DOE RP-300	Nickel 59/63

Non-Potable Water		
Technology	Method	Analyte
Liquid Scintillation Counter	SM 7500-IB	Iodine-129
Preparation	Method	Type
Organic Extraction & Sample Prep	EPA 3500C	Organic Extraction & Sample Prep
Volatile Prep	EPA 5000	Sample Preparation for Volatile Organic Compounds
Organic Cleanup	EPA 3600A	Cleanup for Organic extracts
Organic prep/analysis	EPA 8000C	Determinative Chromatographic Separations
Acid Digestion (Aqueous samples)	EPA 3010A	Acid Digestion for Metals (Aqueous samples)
Purge & Trap	EPA 5030B	Purge & Trap for Aqueous Volatile Samples
Sep Funnel Liquid-Liquid Extraction	EPA 3510C	Sep Funnel Liquid-Liquid Extraction
Continuous Liquid-Liquid Extraction	EPA 3520C	Continuous Liquid-Liquid Extraction
Organic Cleanup	EPA 3600A	Cleanup for Organic extracts
Florisil Cleanup	EPA 3620C	Florisil Cleanup
Sulfur Cleanup	EPA 3660B	Sulfur Cleanup
TCLP Extraction	EPA 1311	TCLP Extraction
SPLP Extraction	EPA 1312	SPLP Extraction
CWET Extraction	CA Title 22	CWET Extraction
Solid Phase Extraction	EPA 3535A	Solid Phase Extraction

Drinking Water		
Technology	Method	Analyte
Gas Flow Proportional Counter	EPA 900.0 EPA 9310	gross alpha/beta
Gas Flow Proportional Counter	EPA 903.0 EPA 9315	Radium-226

Drinking Water		
Technology	Method	Analyte
Gas Flow Proportional Counter	EPA 904.0 EPA 9320	Radium-228
Gas Flow Proportional Counter	EPA 905.0 / DOE HASL 300 Sr-02	Strontium-90
Liquid Scintillation Counter	EPA 906.0	Tritium
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Gamma Emitters:
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 227 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Americium 241
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 124
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 125
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium-137
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium/Lanthanum-140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 133
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Beryllium 7
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 211 eq Th-227
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 207
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth-210M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 212
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Calcium-45

Drinking Water		
Technology	Method	Analyte
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 141
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 139
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 134
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 137
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 57
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 58
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 60
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 152
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 154
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 155
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Hafnium 181
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iodine 131
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iridium 192
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iron 59
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lanthanum 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 210
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 211
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 212

Drinking Water		
Technology	Method	Analyte
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese-56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese 54
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Mercury 203
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 237
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 239
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 83
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 94
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 95
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Potassium 40
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 146
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 147
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 231
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium (226)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 223 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 224

Drinking Water		
Technology	Method	Analyte
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Ruthenium 106
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Scandium 46
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 22
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 24
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Strontium 85
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thallium 208
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 227
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 230
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 231
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 232
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 234
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Tin 113
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 235
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 238
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Vanadium-48
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Yttrium 88
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zinc 65
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zirconium 95

Solid and Chemical Materials		
Technology	Method	Analyte
ICP-AES	EPA 6010C	Aluminum
ICP-AES	EPA 6010C	Antimony
ICP-AES	EPA 6010C	Arsenic
ICP-AES	EPA 6010C	Barium
ICP-AES	EPA 6010C	Beryllium
ICP-AES	EPA 6010C	Bismuth
ICP-AES	EPA 6010C	Boron
ICP-AES	EPA 6010C	Cadmium
ICP-AES	EPA 6010C	Calcium
ICP-AES	EPA 6010C	Chromium
ICP-AES	EPA 6010C	Cobalt
ICP-AES	EPA 6010C	Copper
ICP-AES	EPA 6010C	Iron
ICP-AES	EPA 6010C	Lead
ICP-AES	EPA 6010C	Lithium
ICP-AES	EPA 6010C	Magnesium
ICP-AES	EPA 6010C	Manganese
ICP-AES	EPA 6010C	Molybdenum
ICP-AES	EPA 6010C	Nickel
ICP-AES	EPA 6010C	Phosphorus
ICP-AES	EPA 6010C	Potassium
ICP-AES	EPA 6010C	Selenium
ICP-AES	EPA 6010C	Silicon
ICP-AES	EPA 6010C	Silver
ICP-AES	EPA 6010C	Sodium
ICP-AES	EPA 6010C	Strontium
ICP-AES	EPA 6010C	Sulfur
ICP-AES	EPA 6010C	Thallium
ICP-AES	EPA 6010C	Thorium
ICP-AES	EPA 6010C	Tin
ICP-AES	EPA 6010C	Titanium
ICP-AES	EPA 6010C	Uranium
ICP-AES	EPA 6010C	Vanadium
ICP-AES	EPA 6010C	Zinc
GC/MS	EPA 8260C	Acetone
GC/MS	EPA 8260C	Acetonitrile

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260C	Acrolein
GC/MS	EPA 8260C	Acrylonitrile
GC/MS	EPA 8260C	Benzene
GC/MS	EPA 8260C	Benzyl chloride
GC/MS	EPA 8260C	Bromobenzene
GC/MS	EPA 8260C	Bromochloromethane
GC/MS	EPA 8260C	Bromodichloromethane
GC/MS	EPA 8260C	Bromoform
GC/MS	EPA 8260C	Bromomethane
GC/MS	EPA 8260C	n-Butanol
GC/MS	EPA 8260C	2-Butanone
GC/MS	EPA 8260C	n-Butylbenzene
GC/MS	EPA 8260C	sec-Butylbenzene
GC/MS	EPA 8260C	tert-Butylbenzene
GC/MS	EPA 8260C	Carbon disulfide
GC/MS	EPA 8260C	Carbon tetrachloride
GC/MS	EPA 8260C	Chlorobenzene
GC/MS	EPA 8260C	Chlorobromomethane
GC/MS	EPA 8260C	2-Chloro-1,3-butadiene
GC/MS	EPA 8260C	Chlorodibromomethane
GC/MS	EPA 8260C	Dibromochloromethane
GC/MS	EPA 8260C	Chloroethane
GC/MS	EPA 8260C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260C	Chloroform
GC/MS	EPA 8260C	Chloromethane
GC/MS	EPA 8260C	Allyl chloride
GC/MS	EPA 8260C	2-Chlorotoluene
GC/MS	EPA 8260C	4-Chlorotoluene
GC/MS	EPA 8260C	Cyclohexane
GC/MS	EPA 8260C	Cyclohexanone
GC/MS	EPA 8260C	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260C	1,2-Dibromoethane
GC/MS	EPA 8260C	Dibromomethane
GC/MS	EPA 8260C	1,2-Dichlorobenzene
GC/MS	EPA 8260C	1,3-Dichlorobenzene
GC/MS	EPA 8260C	1,4-Dichlorobenzene

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260C	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260C	Dichlorodifluoromethane
GC/MS	EPA 8260C	1,1-Dichloroethane
GC/MS	EPA 8260C	1,2-Dichloroethane
GC/MS	EPA 8260C	cis-1,2-Dichloroethene
GC/MS	EPA 8260C	trans-1,2-Dichloroethene
GC/MS	EPA 8260C	1,1-Dichloroethene
GC/MS	EPA 8260C	1,2-Dichloroethene (total)
GC/MS	EPA 8260C	1,2-Dichloropropane
GC/MS	EPA 8260C	1,3-Dichloropropane
GC/MS	EPA 8260C	2,2-Dichloropropane
GC/MS	EPA 8260C	cis-1,3-Dichloropropene
GC/MS	EPA 8260C	trans-1,3-Dichloropropene
GC/MS	EPA 8260C	1,1-Dichloropropene
GC/MS	EPA 8260C	1,2-Dichloro-1,1,2,2-tetrafluoroethane
GC/MS	EPA 8260C	Dimethyl disulfide
GC/MS	EPA 8260C	1,4-Dioxane
GC/MS	EPA 8260C	Ethyl acetate
GC/MS	EPA 8260C	Ethylbenzene
GC/MS	EPA 8260C	Ethyl ether
GC/MS	EPA 8260C	Diethyl ether
GC/MS	EPA 8260C	Ethyl methacrylate
GC/MS	EPA 8260C	Freon 113
GC/MS	EPA 8260C	Hexachlorobutadiene
GC/MS	EPA 8260C	n-Hexane
GC/MS	EPA 8260C	2-Hexanone
GC/MS	EPA 8260C	Iodomethane
GC/MS	EPA 8260C	Isobutanol
GC/MS	EPA 8260C	Isopropylbenzene
GC/MS	EPA 8260C	p-Isopropyltoluene
GC/MS	EPA 8260C	Methacrylonitrile
GC/MS	EPA 8260C	Methyl acetate
GC/MS	EPA 8260C	Methyl butyl ketone
GC/MS	EPA 8260C	Methylcyclohexane
GC/MS	EPA 8260C	Dichloromethane
GC/MS	EPA 8260C	Methylene chloride

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260C	Methyl methacrylate
GC/MS	EPA 8260C	4-Methyl-2-pentanone
GC/MS	EPA 8260C	MTBE
GC/MS	EPA 8260C	Naphthalene
GC/MS	EPA 8260C	2-Nitropropane
GC/MS	EPA 8260C	Nonanal
GC/MS	EPA 8260C	Pentachloroethane
GC/MS	EPA 8260C	Propionitrile
GC/MS	EPA 8260C	n-Propylbenzene
GC/MS	EPA 8260C	Styrene
GC/MS	EPA 8260C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260C	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260C	Tetrachloroethene
GC/MS	EPA 8260C	Tetrahydrofuran
GC/MS	EPA 8260C	Toluene
GC/MS	EPA 8260C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260C	1,2,3-Trichlorobenzene
GC/MS	EPA 8260C	1,2,4-Trichlorobenzene
GC/MS	EPA 8260C	1,1,1-Trichloroethane
GC/MS	EPA 8260C	1,1,2-Trichloroethane
GC/MS	EPA 8260C	Trichloroethene
GC/MS	EPA 8260C	Trichlorofluoromethane
GC/MS	EPA 8260C	1,2,3-Trichloropropane
GC/MS	EPA 8260C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260C	Trichlorotrifluoroethane
GC/MS	EPA 8260C	1,2,4-Trimethylbenzene
GC/MS	EPA 8260C	1,3,5-Trimethylbenzene
GC/MS	EPA 8260C	Vinyl acetate
GC/MS	EPA 8260C	Vinyl chloride
GC/MS	EPA 8260C	m-Xylene & p-Xylene
GC/MS	EPA 8260C	o-Xylene
GC/MS	EPA 8260C	Xylenes (total)
GC/MS	EPA 8270D	Acenaphthene
GC/MS	EPA 8270D	Acenaphthylene
GC/MS	EPA 8270D	Acetophenone
GC/MS	EPA 8270D	2-Acetylaminofluorene

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270D	4-Aminobiphenyl
GC/MS	EPA 8270D	Aniline
GC/MS	EPA 8270D	Anthracene
GC/MS	EPA 8270D	Aramite (total)
GC/MS	EPA 8270D	Atrazine
GC/MS	EPA 8270D	Azobenzene
GC/MS	EPA 8270D	Benzaldehyde
GC/MS	EPA 8270D	Benzidine
GC/MS	EPA 8270D	Benzo(a)anthracene
GC/MS	EPA 8270D	Benzo(b)fluoranthene
GC/MS	EPA 8270D	Benzo(k)fluoranthene
GC/MS	EPA 8270D	Benzoic acid
GC/MS	EPA 8270D	Benzo(ghi)perylene
GC/MS	EPA 8270D	Benzo(a)pyrene
GC/MS	EPA 8270D	Benzyl alcohol
GC/MS	EPA 8270D	1,1'-Biphenyl
GC/MS	EPA 8270D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270D	bis(2-Chloroethyl) ether
GC/MS	EPA 8270D	bis(2-Chloroisopropyl) ether
GC/MS	EPA 8270D	bis(2-Ethylhexyl) phthalate
GC/MS	EPA 8270D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270D	n-Butylbenzenesulfonamide
GC/MS	EPA 8270D	Butyl benzyl phthalate
GC/MS	EPA 8270D	Caprolactam
GC/MS	EPA 8270D	Carbazole
GC/MS	EPA 8270D	4-Chloroaniline
GC/MS	EPA 8270D	Chlorobenzilate
GC/MS	EPA 8270D	p-Chlorobenzilate
GC/MS	EPA 8270D	4-Chloro-3-methylphenol
GC/MS	EPA 8270D	2-Chloronaphthalene
GC/MS	EPA 8270D	2-Chlorophenol
GC/MS	EPA 8270D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270D	Chrysene
GC/MS	EPA 8270D	Cresols (total)
GC/MS	EPA 8270D	Cyclohexanol
GC/MS	EPA 8270D	Diallate

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270D	Dibenz(a,h)anthracene
GC/MS	EPA 8270D	Dibenzo(a,h)anthracene
GC/MS	EPA 8270D	Dibenzofuran
GC/MS	EPA 8270D	Di-n-butyl phthalate
GC/MS	EPA 8270D	1,2-Dichlorobenzene
GC/MS	EPA 8270D	1,3-Dichlorobenzene
GC/MS	EPA 8270D	1,4-Dichlorobenzene
GC/MS	EPA 8270D	3,3'-Dichlorobenzidine
GC/MS	EPA 8270D	2,4-Dichlorophenol
GC/MS	EPA 8270D	2,6-Dichlorophenol
GC/MS	EPA 8270D	Diethyl phthalate
GC/MS	EPA 8270D	O,O-Diethyl-O-(2-pyrazinyl) phosphorothioate
GC/MS	EPA 8270D	Dimethoate
GC/MS	EPA 8270D	p-Dimethylaminoazobenzene
GC/MS	EPA 8270D	7,12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270D	3,3'-Dimethylbenzidine
GC/MS	EPA 8270D	Dimethylformamide
GC/MS	EPA 8270D	alpha,alpha-Dimethylphenethylamine
GC/MS	EPA 8270D	2,4-Dimethylphenol
GC/MS	EPA 8270D	Dimethyl phthalate
GC/MS	EPA 8270D	1,3-Dinitrobenzene
GC/MS	EPA 8270D	1,4-Dinitrobenzene
GC/MS	EPA 8270D	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270D	2,4-Dinitrophenol
GC/MS	EPA 8270D	2,4-Dinitrotoluene
GC/MS	EPA 8270D	2,6-Dinitrotoluene
GC/MS	EPA 8270D	2-sec-Butyl-4,6-dinitrophenol
GC/MS	EPA 8270D	Dinoseb
GC/MS	EPA 8270D	Di-n-octyl phthalate
GC/MS	EPA 8270D	1,4-Dioxane
GC/MS	EPA 8270D	1,2-Diphenylhydrazine (as Azobenzene)
GC/MS	EPA 8270D	Disulfoton
GC/MS	EPA 8270D	Ethyl methacrylate
GC/MS	EPA 8270D	Ethyl methanesulfonate
GC/MS	EPA 8270D	Famphur
GC/MS	EPA 8270D	Fluoranthene

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270D	Fluorene
GC/MS	EPA 8270D	Hexachlorobenzene
GC/MS	EPA 8270D	Hexachlorobutadiene
GC/MS	EPA 8270D	Hexachlorocyclopentadiene
GC/MS	EPA 8270D	Hexachloro-1,3-cyclopentadiene
GC/MS	EPA 8270D	Hexachloroethane
GC/MS	EPA 8270D	Hexachlorophene
GC/MS	EPA 8270D	Hexachloropropene
GC/MS	EPA 8270D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270D	Isodrin
GC/MS	EPA 8270D	Isophorone
GC/MS	EPA 8270D	Isosafrole
GC/MS	EPA 8270D	Kepone
GC/MS	EPA 8270D	Methapyrilene
GC/MS	EPA 8270D	2-Methylbenzenamine
GC/MS	EPA 8270D	3-Methylcholanthrene
GC/MS	EPA 8270D	4,4'-Methylenebis(2-chloroaniline)
GC/MS	EPA 8270D	Methyl methacrylate
GC/MS	EPA 8270D	Methyl methanesulfonate
GC/MS	EPA 8270D	2-Methylnaphthalene
GC/MS	EPA 8270D	Methyl parathion
GC/MS	EPA 8270D	2-Methylphenol
GC/MS	EPA 8270D	3-Methylphenol & 4-Methylphenol
GC/MS	EPA 8270D	2-Methylphenol, 3-methylphenol and 4-methylphenol
GC/MS	EPA 8270D	Methylphenols (total)
GC/MS	EPA 8270D	Naphthalene
GC/MS	EPA 8270D	1,4-Naphthoquinone
GC/MS	EPA 8270D	1-Naphthylamine
GC/MS	EPA 8270D	2-Naphthylamine
GC/MS	EPA 8270D	2-Nitroaniline
GC/MS	EPA 8270D	3-Nitroaniline
GC/MS	EPA 8270D	4-Nitroaniline
GC/MS	EPA 8270D	Nitrobenzene
GC/MS	EPA 8270D	2-Nitrophenol
GC/MS	EPA 8270D	4-Nitrophenol
GC/MS	EPA 8270D	4-Nitroquinoline-1-oxide

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270D	N-Nitrosodi-n-butylamine
GC/MS	EPA 8270D	N-Nitrosodiethylamine
GC/MS	EPA 8270D	N-Nitrosodimethylamine
GC/MS	EPA 8270D	N-Nitrosodiphenylamine
GC/MS	EPA 8270D	N-Nitrosodi-n-propylamine
GC/MS	EPA 8270D	N-Nitrosomethylethylamine
GC/MS	EPA 8270D	N-Nitrosomorpholine
GC/MS	EPA 8270D	N-Nitrosopiperidine
GC/MS	EPA 8270D	N-Nitrosopyrrolidine
GC/MS	EPA 8270D	5-Nitro-o-toluidine
GC/MS	EPA 8270D	2,2'-oxybis(1-Chloropropane)
GC/MS	EPA 8270D	Parathion
GC/MS	EPA 8270D	Pentachlorobenzene
GC/MS	EPA 8270D	Pentachloroethane
GC/MS	EPA 8270D	Pentachloronitrobenzene
GC/MS	EPA 8270D	Pentachlorophenol
GC/MS	EPA 8270D	Phenacetin
GC/MS	EPA 8270D	Phenanthrene
GC/MS	EPA 8270D	Phenol
GC/MS	EPA 8270D	p-Phenylene diamine
GC/MS	EPA 8270D	Phorate
GC/MS	EPA 8270D	2-Picoline
GC/MS	EPA 8270D	Pronamide
GC/MS	EPA 8270D	Pyrene
GC/MS	EPA 8270D	Pyridine
GC/MS	EPA 8270D	Safrole
GC/MS	EPA 8270D	Sulfotepp
GC/MS	EPA 8270D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270D	Tetraethyldithiopyrophosphate (Sulfotepp)
GC/MS	EPA 8270D	Thionazin
GC/MS	EPA 8270D	o-Toluidine
GC/MS	EPA 8270D	Tributyl phosphate
GC/MS	EPA 8270D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270D	2,4,5-Trichlorophenol
GC/MS	EPA 8270D	2,4,6-Trichlorophenol

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270D	O,O,O-Triethyl phosphorothioate
GC/MS	EPA 8270D	1,3,5-Trinitrobenzene
GC/MS	EPA 8270D	Tris(2-chloroethyl)phosphate
GC/MS	EPA 8270D	1-Methyl naphthalene
GC-ECD	EPA 8081B	Aldrin
GC-ECD	EPA 8081B	alpha-BHC
GC-ECD	EPA 8081B	beta-BHC
GC-ECD	EPA 8081B	delta-BHC
GC-ECD	EPA 8081B	gamma-BHC (Lindane)
GC-ECD	EPA 8081B	alpha-Chlordane
GC-ECD	EPA 8081B	gamma-Chlordane
GC-ECD	EPA 8081B	Chlordane (technical)
GC-ECD	EPA 8081B	4,4'-DDD
GC-ECD	EPA 8081B	2,4'-DDD
GC-ECD	EPA 8081B	4,4'-DDE
GC-ECD	EPA 8081B	2,4'-DDE
GC-ECD	EPA 8081B	4,4'-DDT
GC-ECD	EPA 8081B	2,4'-DDT
GC-ECD	EPA 8081B	Dieldrin
GC-ECD	EPA 8081B	Endosulfan I
GC-ECD	EPA 8081B	Endosulfan II
GC-ECD	EPA 8081B	Endosulfan sulfate
GC-ECD	EPA 8081B	Endrin
GC-ECD	EPA 8081B	Endrin aldehyde
GC-ECD	EPA 8081B	Endrin ketone
GC-ECD	EPA 8081B	Heptachlor
GC-ECD	EPA 8081B	Heptachlor epoxide
GC-ECD	EPA 8081B	Methoxychlor
GC-ECD	EPA 8081B	Toxaphene
GC-ECD	EPA 8082A	Aroclor 1016
GC-ECD	EPA 8082A	Aroclor 1221
GC-ECD	EPA 8082A	Aroclor 1232
GC-ECD	EPA 8082A	Aroclor 1242
GC-ECD	EPA 8082A	Aroclor 1248
GC-ECD	EPA 8082A	Aroclor 1254
GC-ECD	EPA 8082A	Aroclor 1260

Solid and Chemical Materials		
Technology	Method	Analyte
GC-ECD	EPA 8082A	Aroclor 1262
GC-ECD	EPA 8082A	Aroclor 1268
GC-ECD	EPA 8151A	2,4-D
GC-ECD	EPA 8151A	Dalapon
GC-ECD	EPA 8151A	2,4-DB
GC-ECD	EPA 8151A	Dicamba
GC-ECD	EPA 8151A	Dichlorprop
GC-ECD	EPA 8151A	Dinoseb
GC-ECD	EPA 8151A	MCPA
GC-ECD	EPA 8151A	MCPP
GC-ECD	EPA 8151A	4-Nitrophenol
GC-ECD	EPA 8151A	Pentachlorophenol
GC-ECD	EPA 8151A	2,4,5-TP (Silvex)
GC-ECD	EPA 8151A	2,4,5-T
LC/MS/MS	EPA 8321A	2-Amino-4,6-dinitrotoluene
LC/MS/MS	EPA 8321A	4-Amino-2,6-dinitrotoluene
LC/MS/MS	EPA 8321A	3,5-Dinitroaniline
LC/MS/MS	EPA 8321A	1,3-Dinitrobenzene
LC/MS/MS	EPA 8321A	2,4-Dinitrotoluene
LC/MS/MS	EPA 8321A	2,6-Dinitrotoluene
LC/MS/MS	EPA 8321A	DNX
LC/MS/MS	EPA 8321A	HMX
LC/MS/MS	EPA 8321A	HNAB
LC/MS/MS	EPA 8321A	HNS
LC/MS/MS	EPA 8321A	MXN
LC/MS/MS	EPA 8321A	Nitrobenzene
LC/MS/MS	EPA 8321A	Nitroglycerin
LC/MS/MS	EPA 8321A	4-Nitrotoluene
LC/MS/MS	EPA 8321A	3-Nitrotoluene
LC/MS/MS	EPA 8321A	2-Nitrotoluene
LC/MS/MS	EPA 8321A	PETN
LC/MS/MS	EPA 8321A	RDX
LC/MS/MS	EPA 8321A	TATB
LC/MS/MS	EPA 8321A	Tetryl
LC/MS/MS	EPA 8321A	TNX
LC/MS/MS	EPA 8321A	1,3,5-Trinitrobenzene

Solid and Chemical Materials		
Technology	Method	Analyte
LC/MS/MS	EPA 8321A	2,4,6-Trinitrotoluene
LC/MS/MS	EPA 8321A	Tris (o-cresyl) Phosphate
LC/MS/MS	EPA 8321A	2,4-diamino-6-nitrotoluene
LC/MS/MS	EPA 8321A	2,6-diamino-4-nitrotoluene
HPLC	EPA 8330B	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330B	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330B	1,3-Dinitrobenzene
HPLC	EPA 8330B	2,4-Dinitrotoluene
HPLC	EPA 8330B	2,6-Dinitrotoluene
HPLC	EPA 8330B	HMX
HPLC	EPA 8330B	HNAB
HPLC	EPA 8330B	HNS
HPLC	EPA 8330B	Nitrobenzene
HPLC	EPA 8330B	Nitroglycerin
HPLC	EPA 8330B	2-Nitrotoluene
HPLC	EPA 8330B	3-Nitrotoluene
HPLC	EPA 8330B	4-Nitrotoluene
HPLC	EPA 8330B	PETN
HPLC	EPA 8330B	RDX
HPLC	EPA 8330B	TATB
HPLC	EPA 8330B	Tetryl
HPLC	EPA 8330B	MXN
HPLC	EPA 8330B	DNX
HPLC	EPA 8330B	TNX
HPLC	EPA 8330B	1,3,5-Trinitrobenzene
HPLC	EPA 8330B	2,4,6-Trinitrotoluene
HPLC	EPA 8310	Acenaphthene
HPLC	EPA 8310	Acenaphthylene
HPLC	EPA 8310	Anthracene
HPLC	EPA 8310	Benzo(a)anthracene
HPLC	EPA 8310	Benzo(b)fluoranthene
HPLC	EPA 8310	Benzo(k)fluoranthene
HPLC	EPA 8310	Benzo(ghi)perylene
HPLC	EPA 8310	Benzo(a)pyrene
HPLC	EPA 8310	Chrysene
HPLC	EPA 8310	Dibenz(a,h)anthracene

Solid and Chemical Materials		
Technology	Method	Analyte
HPLC	EPA 8310	Fluoranthene
HPLC	EPA 8310	Fluorene
HPLC	EPA 8310	Indeno(1,2,3-cd)pyrene
HPLC	EPA 8310	Naphthalene
HPLC	EPA 8310	Phenanthrene
HPLC	EPA 8310	Pyrene
GC/MS SIM	EPA 8270D	Acenaphthene
GC/MS SIM	EPA 8270D	Acenaphthylene
GC/MS SIM	EPA 8270D	Anthracene
GC/MS SIM	EPA 8270D	Benzo(a)anthracene
GC/MS SIM	EPA 8270D	Benzo(b)fluoranthene
GC/MS SIM	EPA 8270D	Benzo(k)fluoranthene
GC/MS SIM	EPA 8270D	Benzo(ghi)perylene
GC/MS SIM	EPA 8270D	Benzo(a)pyrene
GC/MS SIM	EPA 8270D	Chrysene
GC/MS SIM	EPA 8270D	Dibenz(a,h)anthracene
GC/MS SIM	EPA 8270D	Fluoranthene
GC/MS SIM	EPA 8270D	Fluorene
GC/MS SIM	EPA 8270D	Indeno(1,2,3-cd)pyrene
GC/MS SIM	EPA 8270D	Naphthalene
GC/MS SIM	EPA 8270D	Phenanthrene
GC/MS SIM	EPA 8270D	Pyrene
GC/MS SIM	EPA 8260C	1,4- dioxane
GC-FID	EPA 8015B	Diesel Range Organics
GC-FID	EPA 8015B	Motor Oil Range Organics
GC-FID	EPA 8015B	TPH (as Diesel)
GC-FID	EPA 8015B	Gasoline Range Organics
GC-FID	EPA 8015B	Ethanol
GC-FID	EPA 8015B	Methanol
GC-FID	EPA 8015B	Ethylene glycol
GC-FID	EPA 8015B	Propylene glycol
LC/MS/MS	EPA 6850	Perchlorate
ICP-MS	EPA 6020A	Aluminum
ICP-MS	EPA 6020A	Antimony
ICP-MS	EPA 6020A	Arsenic
ICP-MS	EPA 6020A	Barium

Solid and Chemical Materials		
Technology	Method	Analyte
ICP-MS	EPA 6020A	Beryllium
ICP-MS	EPA 6020A	Bismuth
ICP-MS	EPA 6020A	Boron
ICP-MS	EPA 6020A	Cadmium
ICP-MS	EPA 6020A	Calcium
ICP-MS	EPA 6020A	Cerium
ICP-MS	EPA 6020A	Cesium
ICP-MS	EPA 6020A	Chromium
ICP-MS	EPA 6020A	Cobalt
ICP-MS	EPA 6020A	Copper
ICP-MS	EPA 6020A	Hafnium
ICP-MS	EPA 6020A	Iron
ICP-MS	EPA 6020A	Lanthanum
ICP-MS	EPA 6020A	Lead
ICP-MS	EPA 6020A	Lithium
ICP-MS	EPA 6020A	Magnesium
ICP-MS	EPA 6020A	Manganese
ICP-MS	EPA 6020A	Molybdenum
ICP-MS	EPA 6020A	Neodymium
ICP-MS	EPA 6020A	Nickel
ICP-MS	EPA 6020A	Niobium
ICP-MS	EPA 6020A	Palladium
ICP-MS	EPA 6020A	Phosphorus
ICP-MS	EPA 6020A	Platinum
ICP-MS	EPA 6020A	Potassium
ICP-MS	EPA 6020A	Praseodymium
ICP-MS	EPA 6020A	Rhodium
ICP-MS	EPA 6020A	Ruthenium
ICP-MS	EPA 6020A	Samarium
ICP-MS	EPA 6020A	Selenium
ICP-MS	EPA 6020A	Silicon
ICP-MS	EPA 6020A	Silver
ICP-MS	EPA 6020A	Sodium
ICP-MS	EPA 6020A	Strontium
ICP-MS	EPA 6020A	Sulfur
ICP-MS	EPA 6020A	Tantalum

Solid and Chemical Materials		
Technology	Method	Analyte
ICP-MS	EPA 6020A	Technetium-99
ICP-MS	EPA 6020A	Tellurium
ICP-MS	EPA 6020A	Thallium
ICP-MS	EPA 6020A	Thorium
ICP-MS	EPA 6020A	Tin
ICP-MS	EPA 6020A	Titanium
ICP-MS	EPA 6020A	Tungsten
ICP-MS	EPA 6020A	Uranium
ICP-MS	EPA 6020A	Uranium 233
ICP-MS	EPA 6020A	Uranium 234
ICP-MS	EPA 6020A	Uranium 235
ICP-MS	EPA 6020A	Uranium 236
ICP-MS	EPA 6020A	Uranium 238
ICP-MS	EPA 6020A	Vanadium
ICP-MS	EPA 6020A	Yttrium
ICP-MS	EPA 6020A	Zinc
ICP-MS	EPA 6020A	Zirconium
CVAA	EPA 7471B	Mercury
Colormetric	EPA 9010C EPA 9012B	Cyanide
Ion Chromatography	EPA 300.0 EPA 9056A	Bromide
Ion Chromatography	EPA 300.0 EPA 9056A	Chloride
Ion Chromatography	EPA 300.0 EPA 9056A	Fluoride
Ion Chromatography	EPA 300.0 EPA 9056A	Nitrate
Ion Chromatography	EPA 300.0 EPA 9056A	Nitrite
Ion Chromatography	EPA 300.0 EPA 9056A	Sulfate
Ion Chromatography	EPA 300.0 EPA 9056A	Ortho-phosph
Ion Chromatography	EPA 300.0 EPA 9056A	Iodide
Ion Chromatography	EPA 314.0	Perchlorate
Gravimetric	EPA 2540B EPA 2540C EPA 2540D	Solids

Solid and Chemical Materials		
Technology	Method	Analyte
Probe	EPA 9040C EPA 9045D EPA 150.1	pH
Titration	SM 2320B EPA 310.1	Alkalinity
Titration	EPA 9030	Sulfide
Penske-Martin	EPA1010A	Ignitability
Colormetric	EPA 353.1	nitrate/Nitrite
Colormetric	EPA 350.1	Ammonia
Colormetric	EPA 351.2	TKN
TOC Analyzer	EPA 9060	TOC
Titrimetric	EPA 9020	TOX
Colormetric	EPA 7196A	Hex Chromium
Gravimetric	EPA 1664A	Oil & Grease
Gravimetric	EPA 1664A	TPH
Probe	EPA 9050A	Conductivity
Probe	SM 5210B EPA 405.1	BOD/CBOD
Gas Flow Proportional Counter	EPA 900.0 EPA 9310	gross alpha/beta
Gas Flow Proportional Counter	EPA 903.0 EPA 9315	Radium-226
Gas Flow Proportional Counter	EPA 903.0 EPA 9315	total radium
Gas Flow Proportional Counter	EPA 904.0 EPA 9320	Radium-228
Gas Flow Proportional Counter	EPA 905.0 / DOE HASL 300 Sr-02	Strontium-90
Liquid Scintillation Counter	EPA 906.0	Tritium
Liquid Scintillation Counter	Eichrom Technologies TCW01/TCS01	Tecnetium-99
Liquid Scintillation Counter	EERF C-01-C14	Carbon-14
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Gamma Emitters:
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 227 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Actinium 228

Solid and Chemical Materials		
Technology	Method	Analyte
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Americium 241
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 124
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Antimony 125
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium-137
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium/Lanthanum-140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 133
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Barium 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Beryllium 7
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 211 eq Th-227
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 207
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth-210M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 212
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Bismuth 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Calcium-45
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 141
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 139
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cerium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 134
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cesium 137
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 57
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 58

Solid and Chemical Materials		
Technology	Method	Analyte
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Cobalt 60
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 152
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 154
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Europium 155
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Hafnium 181
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iodine 131
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iridium 192
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Iron 59
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lanthanum 140
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 210
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 211
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 212
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Lead 214
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese-56
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Manganese 54
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Mercury 203
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 237
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Neptunium 239
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 83
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 94
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Niobium 95
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Potassium 40

Solid and Chemical Materials		
Technology	Method	Analyte
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 144
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 146
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Promethium 147
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234M
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 231
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Protactinium 234
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium (226)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 223 (assumes equilibrium w/ Th-227)
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Radium 224
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Ruthenium 106
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Scandium 46
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 22
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Sodium 24
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Strontium 85
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thallium 208
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 227
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 228
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 230
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 231
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 232
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Thorium 234

Solid and Chemical Materials		
Technology	Method	Analyte
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Tin 113
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 235
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Uranium 238
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Vanadium-48
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Yttrium 88
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zinc 65
Gamma Spectroscopy	EPA 901.1 / DOE HASL 300 Ga-01-R	Zirconium 95
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Alpha spec analysis:
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Uranium
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Thorium
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Americium
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Plutonium
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Neptunium
Alpha Spectroscopy	DOE HASL 300 A- 01-R	Isotopic Curium
Liquid Scintillation Counter	Eichrom Technologies OTW01, OTS01	Lead-210
Alpha Spectroscopy	Laboratory SOP ST-RC-0210	Polonium-210
Liquid Scintillation Counter	Eichrom Technologies FEW01	Iron-55
Liquid Scintillation Counter	DOE RP-300	Nickel 59/63
Liquid Scintillation Counter	SM 7500-IB	Iodine-129

Preparation	Method	Type
Organic Extraction & Sample Prep	EPA 3500C	Organic Extraction & Sample Prep
Volatile Prep	EPA 5000	Sample Preparation for Volatile Organic Compounds
Organic Cleanup	EPA 3600A	Cleanup for Organic extracts
Organic prep/analysis	EPA 8000C	Determinative Chromatographic Separations
Acid Digestion (Aqueous samples)	EPA 3010A	Acid Digestion for Metals (Aqueous samples)
Acid Digestion (solids)	EPA 3050B	Acid Digestion for Metals of Sediment/Soils
Purge & Trap	EPA 5030B	Purge & Trap for Aqueous Volatile Samples
Closed System Purge & Trap and Extraction for Volatiles	EPA 5035	Closed System Purge & Trap and Extraction for Volatiles
Sep Funnel Liquid-Liquid Extraction	EPA 3510C	Sep Funnel Liquid-Liquid Extraction
Ultrasonic Extraction	EPA 3550C	Ultrasonic Extraction Organic Soils
Continuous Liquid-Liquid Extraction	EPA 3520C	Continuous Liquid-Liquid Extraction
Solid Phase Extraction	EPA 3535A	Solid Phase Extraction
Florisil Cleanup	EPA 3620C	Florisil Cleanup
Sulfur Cleanup	EPA 3660B	Sulfur Cleanup
Waste Dilution	EPA 3585	Waste Dilution Volatile Organics
Waste Dilution	EPA 3580A	Waste Dilution SemiVolatile Organics
TCLP Extraction	EPA 1311	TCLP Extraction
SPLP Extraction	EPA 1312	SPLP Extraction
CWET Extraction	CA Title 22	CWET Extraction
Alkaline Digestion	EPA 3060A	Alkaline Digestion for Hexavalent Chromium

Notes:

- 1) This laboratory offers commercial testing service.

Approved by:


 R. Douglas Leonard
 Chief Technical Officer

 Date: May 31, 2013

ReIssued: 5/31/13

State of Utah
Department of Health
Environmental Laboratory Certification Program
Certification is hereby granted to

TestAmerica St. Louis

13715 Rider Trail North
Earth City, MO 63045

*Has conformed with the
2009 TNI Standard
Scope of accreditation is limited to the
State of Utah Accredited Fields of Accreditation
Which accompanies this Certificate*

EPA Number: MO00054
Expiration Date: 7/31/2014
Certificate Number: MO000542013-5



Robyn M. Atkinson, Ph.D, HCLD
Director, Utah Public Health Laboratory



Continued accredited status depends on successful ongoing participation in the program.





State of Utah
Gary R Herbert
Governor
Gregory S Bell
Lieutenant Governor

Utah Department of Health

W. David Patton Ph.D

Executive Director

Disease Control and Prevention

Robyn M. Atkinson, Ph.D, HCLD

Director, Utah Public Health Laboratory

Bureau of Laboratory Improvement



EPA Number: MO00054

Attachment to Certificate Number: MO000542013-5

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TestAmerica St. Louis

Start Date Expires AB

Program/Matrix: CWA (Non Potable Water)

Method EPA 120.1

Conductivity

7/1/2013 7/31/2014 LA-
DE
Q

Method EPA 130.2

Total hardness as CaCO₃

7/1/2013 7/31/2014 LA-
DE
Q

Method EPA 150.1

pH

7/1/2013 7/31/2014 LA-
DE
Q

Method EPA 160.1

Residue-filterable (TDS)

7/1/2013 7/31/2014 LA-
DE
Q

Method EPA 160.2

Residue-nonfilterable (TSS)

7/1/2013 7/31/2014 LA-
DE
Q

Method EPA 160.3

Residue-total

7/1/2013 7/31/2014 LA-
DE
Q

Method EPA 1664A (HEM)

Oil & Grease

7/1/2013 7/31/2014 LA-
DE
Q

Method EPA 200.7

Aluminum

7/1/2013 7/31/2014 LA-
DE
Q

Antimony

7/1/2013 7/31/2014 LA-
DE
Q

Arsenic

7/1/2013 7/31/2014 LA-
DE
Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: CWA (Non Potable Water)

Barium	7/1/2013	7/31/2014	LA-DE Q
Beryllium	7/1/2013	7/31/2014	LA-DE Q
Boron	7/1/2013	7/31/2014	LA-DE Q
Cadmium	7/1/2013	7/31/2014	LA-DE Q
Calcium	7/1/2013	7/31/2014	LA-DE Q
Chromium	7/1/2013	7/31/2014	LA-DE Q
Cobalt	7/1/2013	7/31/2014	LA-DE Q
Copper	7/1/2013	7/31/2014	LA-DE Q
Iron	7/1/2013	7/31/2014	LA-DE Q
Lead	7/1/2013	7/31/2014	LA-DE Q
Magnesium	7/1/2013	7/31/2014	LA-DE Q
Manganese	7/1/2013	7/31/2014	LA-DE Q
Molybdenum	7/1/2013	7/31/2014	LA-DE Q
Nickel	7/1/2013	7/31/2014	LA-DE Q
Potassium	7/1/2013	7/31/2014	LA-DE Q
Selenium	7/1/2013	7/31/2014	LA-DE Q
Silver	7/1/2013	7/31/2014	LA-DE Q
Sodium	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: CWA (Non Potable Water)			
Strontium	7/1/2013	7/31/2014	LA-DE Q
Thallium	7/1/2013	7/31/2014	LA-DE Q
Tin	7/1/2013	7/31/2014	LA-DE Q
Titanium	7/1/2013	7/31/2014	LA-DE Q
Vanadium	7/1/2013	7/31/2014	LA-DE Q
Zinc	7/1/2013	7/31/2014	LA-DE Q
Method EPA 200.8			
Aluminum	7/1/2013	7/31/2014	LA-DE Q
Antimony	7/1/2013	7/31/2014	LA-DE Q
Arsenic	7/1/2013	7/31/2014	LA-DE Q
Barium	7/1/2013	7/31/2014	LA-DE Q
Beryllium	7/1/2013	7/31/2014	LA-DE Q
Cadmium	7/1/2013	7/31/2014	LA-DE Q
Chromium	7/1/2013	7/31/2014	LA-DE Q
Cobalt	7/1/2013	7/31/2014	LA-DE Q
Copper	7/1/2013	7/31/2014	LA-DE Q
Lead	7/1/2013	7/31/2014	LA-DE Q
Magnesium	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: <i>CWA (Non Potable Water)</i>			
Manganese	7/1/2013	7/31/2014	LA-DE Q
Molybdenum	7/1/2013	7/31/2014	LA-DE Q
Nickel	7/1/2013	7/31/2014	LA-DE Q
Selenium	7/1/2013	7/31/2014	LA-DE Q
Silver	7/1/2013	7/31/2014	LA-DE Q
Thallium	7/1/2013	7/31/2014	LA-DE Q
Uranium	7/1/2013	7/31/2014	LA-DE Q
Vanadium	7/1/2013	7/31/2014	LA-DE Q
Zinc	7/1/2013	7/31/2014	LA-DE Q
Method EPA 245.1			
Mercury	7/1/2013	7/31/2014	LA-DE Q
Method EPA 300.0			
Bromide	7/1/2013	7/31/2014	LA-DE Q
Chloride	7/1/2013	7/31/2014	LA-DE Q
Fluoride	7/1/2013	7/31/2014	LA-DE Q
Nitrate as N	7/1/2013	7/31/2014	LA-DE Q
Nitrite as N	7/1/2013	7/31/2014	LA-DE Q
Orthophosphate as P	7/1/2013	7/31/2014	LA-DE Q
Sulfate	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: CWA (Non Potable Water)**Method EPA 310.1**

Alkalinity as CaCO3

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 314

Perchlorate

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 350.1

Ammonia as N

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 376.1

Sulfide

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 405.1

Biochemical oxygen demand

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 410.4

Chemical oxygen demand

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 415.1

Total organic carbon

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 608

4,4'-DDD

7/1/2013	7/31/2014	LA-DE Q
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4,4'-DDE

7/1/2013	7/31/2014	LA-DE Q
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4,4'-DDT

7/1/2013	7/31/2014	LA-DE Q
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Aldrin

7/1/2013	7/31/2014	LA-DE Q
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alpha-BHC (alpha-Hexachlorocyclohexane)

7/1/2013	7/31/2014	LA-DE Q
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Aroclor-1016 (PCB-1016)

7/1/2013	7/31/2014	LA-DE Q
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Aroclor-1221 (PCB-1221)

7/1/2013	7/31/2014	LA-DE Q
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TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: CWA (Non Potable Water)			
Aroclor-1232 (PCB-1232)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1242 (PCB-1242)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1248 (PCB-1248)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1254 (PCB-1254)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1260 (PCB-1260)	7/1/2013	7/31/2014	LA-DE Q
beta-BHC (beta-Hexachlorocyclohexane)	7/1/2013	7/31/2014	LA-DE Q
Chlordane (tech.)	7/1/2013	7/31/2014	LA-DE Q
delta-BHC	7/1/2013	7/31/2014	LA-DE Q
Dieldrin	7/1/2013	7/31/2014	LA-DE Q
Endosulfan I	7/1/2013	7/31/2014	LA-DE Q
Endosulfan II	7/1/2013	7/31/2014	LA-DE Q
Endosulfan sulfate	7/1/2013	7/31/2014	LA-DE Q
Endrin	7/1/2013	7/31/2014	LA-DE Q
Endrin aldehyde	7/1/2013	7/31/2014	LA-DE Q
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	7/1/2013	7/31/2014	LA-DE Q
Heptachlor	7/1/2013	7/31/2014	LA-DE Q
Heptachlor epoxide	7/1/2013	7/31/2014	LA-DE Q
Toxaphene (Chlorinated camphene)	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: CWA (Non Potable Water)**Method EPA 624**

1,1,1-Trichloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1,2,2-Tetrachloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1,2-Trichloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1-Dichloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1-Dichloroethylene	7/1/2013	7/31/2014	LA-DE Q
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2013	7/31/2014	LA-DE Q
1,2-Dichloroethane (Ethylene dichloride)	7/1/2013	7/31/2014	LA-DE Q
1,2-Dichloropropane	7/1/2013	7/31/2014	LA-DE Q
1,3-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,4-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
2-Chloroethyl vinyl ether	7/1/2013	7/31/2014	LA-DE Q
Acrolein (Propenal)	7/1/2013	7/31/2014	LA-DE Q
Acrylonitrile	7/1/2013	7/31/2014	LA-DE Q
Benzene	7/1/2013	7/31/2014	LA-DE Q
Bromodichloromethane	7/1/2013	7/31/2014	LA-DE Q
Bromoform	7/1/2013	7/31/2014	LA-DE Q
Carbon tetrachloride	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: CWA (Non Potable Water)			
Chlorobenzene	7/1/2013	7/31/2014	LA-DE Q
Chlorodibromomethane	7/1/2013	7/31/2014	LA-DE Q
Chloroethane (Ethyl chloride)	7/1/2013	7/31/2014	LA-DE Q
Chloroform	7/1/2013	7/31/2014	LA-DE Q
cis-1,3-Dichloropropene	7/1/2013	7/31/2014	LA-DE Q
Ethylbenzene	7/1/2013	7/31/2014	LA-DE Q
Methyl bromide (Bromomethane)	7/1/2013	7/31/2014	LA-DE Q
Methyl chloride (Chloromethane)	7/1/2013	7/31/2014	LA-DE Q
Methylene chloride (Dichloromethane)	7/1/2013	7/31/2014	LA-DE Q
Tetrachloroethylene (Perchloroethylene)	7/1/2013	7/31/2014	LA-DE Q
Toluene	7/1/2013	7/31/2014	LA-DE Q
trans-1,2-Dichloroethylene	7/1/2013	7/31/2014	LA-DE Q
trans-1,3-Dichloropropylene	7/1/2013	7/31/2014	LA-DE Q
Trichloroethene (Trichloroethylene)	7/1/2013	7/31/2014	LA-DE Q
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	7/1/2013	7/31/2014	LA-DE Q
Vinyl chloride	7/1/2013	7/31/2014	LA-DE Q
Xylene (total)	7/1/2013	7/31/2014	LA-DE Q

Method **EPA 625**

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: CWA (Non Potable Water)

1,2,4-Trichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2013	7/31/2014	LA-DE Q
1,3-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,4-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
2,4,6-Trichlorophenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dichlorophenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dimethylphenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dinitrophenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dinitrotoluene (2,4-DNT)	7/1/2013	7/31/2014	LA-DE Q
2,6-Dinitrotoluene (2,6-DNT)	7/1/2013	7/31/2014	LA-DE Q
2-Chloronaphthalene	7/1/2013	7/31/2014	LA-DE Q
2-Chlorophenol	7/1/2013	7/31/2014	LA-DE Q
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	7/1/2013	7/31/2014	LA-DE Q
2-Nitrophenol	7/1/2013	7/31/2014	LA-DE Q
3,3'-Dichlorobenzidine	7/1/2013	7/31/2014	LA-DE Q
4-Bromophenyl phenyl ether	7/1/2013	7/31/2014	LA-DE Q
4-Chloro-3-methylphenol	7/1/2013	7/31/2014	LA-DE Q
4-Chlorophenyl phenylether	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date

Expires

AB

Program/Matrix: CWA (Non Potable Water)

4-Nitrophenol	7/1/2013	7/31/2014	LA- DE Q
Acenaphthene	7/1/2013	7/31/2014	LA- DE Q
Acenaphthylene	7/1/2013	7/31/2014	LA- DE Q
Anthracene	7/1/2013	7/31/2014	LA- DE Q
Benzo(a)anthracene	7/1/2013	7/31/2014	LA- DE Q
Benzo(a)pyrene	7/1/2013	7/31/2014	LA- DE Q
Benzo(b)fluoranthene	7/1/2013	7/31/2014	LA- DE Q
Benzo(g,h,i)perylene	7/1/2013	7/31/2014	LA- DE Q
Benzo(k)fluoranthene	7/1/2013	7/31/2014	LA- DE Q
bis(2-Chloroethoxy)methane	7/1/2013	7/31/2014	LA- DE Q
bis(2-Chloroethyl) ether	7/1/2013	7/31/2014	LA- DE Q
bis(2-Chloroisopropyl) ether	7/1/2013	7/31/2014	LA- DE Q
bis(2-Ethylhexyl) phthalate (DEHP)	7/1/2013	7/31/2014	FL
Butyl benzyl phthalate	7/1/2013	7/31/2014	LA- DE Q
Chrysene	7/1/2013	7/31/2014	LA- DE Q
Dibenz(a,h) anthracene	7/1/2013	7/31/2014	LA- DE Q
Diethyl phthalate	7/1/2013	7/31/2014	LA- DE Q
Dimethyl phthalate	7/1/2013	7/31/2014	LA- DE Q
Di-n-butyl phthalate	7/1/2013	7/31/2014	LA- DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: CWA (Non Potable Water)

Di-n-octyl phthalate	7/1/2013	7/31/2014	LA-DE Q
Fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Fluorene	7/1/2013	7/31/2014	LA-DE Q
Hexachlorobenzene	7/1/2013	7/31/2014	LA-DE Q
Hexachlorobutadiene	7/1/2013	7/31/2014	LA-DE Q
Hexachlorocyclopentadiene	7/1/2013	7/31/2014	LA-DE Q
Hexachloroethane	7/1/2013	7/31/2014	LA-DE Q
Indeno(1,2,3-cd) pyrene	7/1/2013	7/31/2014	LA-DE Q
Isophorone	7/1/2013	7/31/2014	LA-DE Q
Naphthalene	7/1/2013	7/31/2014	LA-DE Q
Nitrobenzene	7/1/2013	7/31/2014	LA-DE Q
n-Nitrosodimethylamine	7/1/2013	7/31/2014	LA-DE Q
n-Nitrosodi-n-propylamine	7/1/2013	7/31/2014	LA-DE Q
n-Nitrosodiphenylamine	7/1/2013	7/31/2014	LA-DE Q
Pentachlorophenol	7/1/2013	7/31/2014	LA-DE Q
Phenanthrene	7/1/2013	7/31/2014	LA-DE Q
Phenol	7/1/2013	7/31/2014	LA-DE Q
Pyrene	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: CWA (Non Potable Water)**Method EPA 6850**

Perchlorate

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 900

Gross-alpha

7/1/2013	7/31/2014	LA-DE Q
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Gross-beta

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 903

Radium-226

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 904

Radium-228

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 905

Strontium-90

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 906.0

Tritium

7/1/2013	7/31/2014	LA-DE Q
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Method SM 18/19thED 2340 C

Total hardness as CaCO3

7/1/2013	7/31/2014	LA-DE Q
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Method SM 18/19thED 2540 C

Residue-filterable (TDS)

7/1/2013	7/31/2014	LA-DE Q
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Method SM 18/19thED 4500-H+-B

pH

7/1/2013	7/31/2014	LA-DE Q
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Method SM 18/19thED 5310B

Total organic carbon

7/1/2013	7/31/2014	LA-DE Q
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Method SM 2320 B

Alkalinity as CaCO3

7/1/2013	7/31/2014	LA-DE Q
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Method SM 2540 B

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: CWA (Non Potable Water)

Residue-total

7/1/2013	7/31/2014	LA- DE Q
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Method SM 2540 D

Residue-nonfilterable (TSS)

7/1/2013	7/31/2014	LA- DE Q
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Method SM 4500-S2⁻ F-2011

Sulfide

7/1/2013	7/31/2014	LA- DE Q
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Method SM 5210 B

Biochemical oxygen demand

7/1/2013	7/31/2014	LA- DE Q
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TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Non Potable Water)**Method EPA 1010**

Ignitability

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 3010A

Preparation/Extraction

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 3510C

Preparation/Extraction

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 3520C

Preparation/Extraction

7/1/2013	7/31/2014	LA-DE Q
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Method EPA 3535A

Preparation/Extraction

7/1/2013	7/31/2014	UT
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Method EPA 3620C

Preparation/Extraction

7/1/2013	7/31/2014	UT
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Method EPA 3660B

Preparation/Extraction

7/1/2013	7/31/2014	UT
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Method EPA 5030

Preparation/Extraction

7/1/2013	7/31/2014	UT
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Method EPA 6010C

Aluminum

7/1/2013	7/31/2014	LA-DE Q
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Antimony

7/1/2013	7/31/2014	LA-DE Q
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Arsenic

7/1/2013	7/31/2014	LA-DE Q
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Barium

7/1/2013	7/31/2014	LA-DE Q
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Beryllium

7/1/2013	7/31/2014	LA-DE Q
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Boron

7/1/2013	7/31/2014	LA-DE Q
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Cadmium

7/1/2013	7/31/2014	LA-DE Q
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Calcium

7/1/2013	7/31/2014	LA-DE Q
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TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
Chromium	7/1/2013	7/31/2014	LA-DE Q
Cobalt	7/1/2013	7/31/2014	LA-DE Q
Copper	7/1/2013	7/31/2014	LA-DE Q
Iron	7/1/2013	7/31/2014	LA-DE Q
Lead	7/1/2013	7/31/2014	LA-DE Q
Lithium	7/1/2013	7/31/2014	LA-DE Q
Magnesium	7/1/2013	7/31/2014	LA-DE Q
Manganese	7/1/2013	7/31/2014	LA-DE Q
Molybdenum	7/1/2013	7/31/2014	LA-DE Q
Nickel	7/1/2013	7/31/2014	LA-DE Q
Potassium	7/1/2013	7/31/2014	LA-DE Q
Selenium	7/1/2013	7/31/2014	LA-DE Q
Silicon	7/1/2013	7/31/2014	FL
Silver	7/1/2013	7/31/2014	LA-DE Q
Sodium	7/1/2013	7/31/2014	LA-DE Q
Strontium	7/1/2013	7/31/2014	LA-DE Q
Thallium	7/1/2013	7/31/2014	LA-DE Q
Tin	7/1/2013	7/31/2014	LA-DE Q
Titanium	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date Expires AB**Program/Matrix: RCRA (Non Potable Water)**

Vanadium	7/1/2013	7/31/2014	LA- DE Q
Zinc	7/1/2013	7/31/2014	LA- DE Q
Method EPA 6020A			
Aluminum	7/1/2013	7/31/2014	LA- DE Q
Antimony	7/1/2013	7/31/2014	LA- DE Q
Arsenic	7/1/2013	7/31/2014	LA- DE Q
Barium	7/1/2013	7/31/2014	LA- DE Q
Beryllium	7/1/2013	7/31/2014	LA- DE Q
Boron	7/1/2013	7/31/2014	LA- DE Q
Cadmium	7/1/2013	7/31/2014	LA- DE Q
Calcium	7/1/2013	7/31/2014	LA- DE Q
Chromium	7/1/2013	7/31/2014	LA- DE Q
Cobalt	7/1/2013	7/31/2014	LA- DE Q
Copper	7/1/2013	7/31/2014	LA- DE Q
Iron	7/1/2013	7/31/2014	LA- DE Q
Lead	7/1/2013	7/31/2014	LA- DE Q
Magnesium	7/1/2013	7/31/2014	LA- DE Q
Manganese	7/1/2013	7/31/2014	LA- DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
Molybdenum	7/1/2013	7/31/2014	LA-DE Q
Nickel	7/1/2013	7/31/2014	LA-DE Q
Potassium	7/1/2013	7/31/2014	LA-DE Q
Selenium	7/1/2013	7/31/2014	LA-DE Q
Silver	7/1/2013	7/31/2014	LA-DE Q
Strontium	7/1/2013	7/31/2014	LA-DE Q
Thallium	7/1/2013	7/31/2014	LA-DE Q
Vanadium	7/1/2013	7/31/2014	LA-DE Q
Zinc	7/1/2013	7/31/2014	LA-DE Q
Method EPA 6850			
Perchlorate	7/1/2013	7/31/2014	LA-DE Q
Method EPA 7196A			
Chromium VI	7/1/2013	7/31/2014	LA-DE Q
Method EPA 7470			
Mercury	7/1/2013	7/31/2014	LA-DE Q
Method EPA 8015D			
Diesel range organics (DRO)	7/1/2013	7/31/2014	LA-DE Q
Gasoline range organics (GRO)	7/1/2013	7/31/2014	LA-DE Q
Method EPA 8081B			
4,4'-DDD	7/1/2013	7/31/2014	LA-DE Q
4,4'-DDE	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
4,4'-DDT	7/1/2013	7/31/2014	LA-DE Q
Aldrin	7/1/2013	7/31/2014	LA-DE Q
alpha-BHC (alpha-Hexachlorocyclohexane)	7/1/2013	7/31/2014	LA-DE Q
alpha-Chlordane	7/1/2013	7/31/2014	LA-DE Q
beta-BHC (beta-Hexachlorocyclohexane)	7/1/2013	7/31/2014	LA-DE Q
Chlordane (tech.)	7/1/2013	7/31/2014	LA-DE Q
delta-BHC	7/1/2013	7/31/2014	LA-DE Q
Dieldrin	7/1/2013	7/31/2014	LA-DE Q
Endosulfan I	7/1/2013	7/31/2014	LA-DE Q
Endosulfan II	7/1/2013	7/31/2014	LA-DE Q
Endosulfan sulfate	7/1/2013	7/31/2014	LA-DE Q
Endrin	7/1/2013	7/31/2014	LA-DE Q
Endrin aldehyde	7/1/2013	7/31/2014	LA-DE Q
Endrin ketone	7/1/2013	7/31/2014	LA-DE Q
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	7/1/2013	7/31/2014	LA-DE Q
gamma-Chlordane	7/1/2013	7/31/2014	LA-DE Q
Heptachlor	7/1/2013	7/31/2014	LA-DE Q
Heptachlor epoxide	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Non Potable Water)

Methoxychlor	7/1/2013	7/31/2014	LA-DE Q
Toxaphene (Chlorinated camphene)	7/1/2013	7/31/2014	LA-DE Q

Method EPA 8082A

Aroclor-1016 (PCB-1016)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1221 (PCB-1221)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1232 (PCB-1232)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1242 (PCB-1242)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1248 (PCB-1248)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1254 (PCB-1254)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1260 (PCB-1260)	7/1/2013	7/31/2014	LA-DE Q

Method EPA 8151A

2,4,5-T	7/1/2013	7/31/2014	LA-DE Q
2,4-D	7/1/2013	7/31/2014	LA-DE Q
2,4-DB	7/1/2013	7/31/2014	LA-DE Q
Dalapon	7/1/2013	7/31/2014	LA-DE Q
Dicamba	7/1/2013	7/31/2014	LA-DE Q
Dichloroprop (Dichloroprop)	7/1/2013	7/31/2014	LA-DE Q
Silvex (2,4,5-TP)	7/1/2013	7/31/2014	LA-DE Q

Method EPA 8260C

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
1,1,1,2-Tetrachloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1,1-Trichloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1,2,2-Tetrachloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1,2-Trichloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1-Dichloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1-Dichloroethylene	7/1/2013	7/31/2014	LA-DE Q
1,2,3-Trichloropropane	7/1/2013	7/31/2014	LA-DE Q
1,2,4-Trichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,2-Dibromo-3-chloropropane (DBCP)	7/1/2013	7/31/2014	LA-DE Q
1,2-Dibromoethane (EDB, Ethylene dibromide)	7/1/2013	7/31/2014	LA-DE Q
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2013	7/31/2014	LA-DE Q
1,2-Dichloroethane (Ethylene dichloride)	7/1/2013	7/31/2014	LA-DE Q
1,2-Dichloropropane	7/1/2013	7/31/2014	LA-DE Q
1,3-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,4-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,4-Dioxane (1,4- Diethyleneoxide)	7/1/2013	7/31/2014	LA-DE Q
2-Butanone (Methyl ethyl ketone, MEK)	7/1/2013	7/31/2014	LA-DE Q
2-Chloroethyl vinyl ether	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
2-Hexanone	7/1/2013	7/31/2014	LA-DE Q
4-Methyl-2-pentanone (MIBK)	7/1/2013	7/31/2014	LA-DE Q
Acetone	7/1/2013	7/31/2014	LA-DE Q
Acetonitrile	7/1/2013	7/31/2014	LA-DE Q
Acrolein (Propenal)	7/1/2013	7/31/2014	LA-DE Q
Acrylonitrile	7/1/2013	7/31/2014	LA-DE Q
Allyl chloride (3-Chloropropene)	7/1/2013	7/31/2014	LA-DE Q
Benzene	7/1/2013	7/31/2014	LA-DE Q
Bromochloromethane	7/1/2013	7/31/2014	LA-DE Q
Bromodichloromethane	7/1/2013	7/31/2014	LA-DE Q
Bromoform	7/1/2013	7/31/2014	LA-DE Q
Carbon disulfide	7/1/2013	7/31/2014	LA-DE Q
Carbon tetrachloride	7/1/2013	7/31/2014	LA-DE Q
Chlorobenzene	7/1/2013	7/31/2014	LA-DE Q
Chlorodibromomethane	7/1/2013	7/31/2014	LA-DE Q
Chloroethane (Ethyl chloride)	7/1/2013	7/31/2014	LA-DE Q
Chloroform	7/1/2013	7/31/2014	LA-DE Q
Chloroprene (2-Chloro-1,3-butadiene)	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Non Potable Water)

cis-1,2-Dichloroethylene	7/1/2013	7/31/2014	LA-DE Q
cis-1,3-Dichloropropene	7/1/2013	7/31/2014	LA-DE Q
Dibromomethane (Methylene bromide)	7/1/2013	7/31/2014	LA-DE Q
Dichlorodifluoromethane (Freon-12)	7/1/2013	7/31/2014	LA-DE Q
Diethyl ether	7/1/2013	7/31/2014	LA-DE Q
Ethyl acetate	7/1/2013	7/31/2014	LA-DE Q
Ethyl methacrylate	7/1/2013	7/31/2014	LA-DE Q
Ethylbenzene	7/1/2013	7/31/2014	LA-DE Q
Hexachlorobutadiene	7/1/2013	7/31/2014	LA-DE Q
Iodomethane (Methyl iodide)	7/1/2013	7/31/2014	LA-DE Q
Isopropylbenzene	7/1/2013	7/31/2014	LA-DE Q
Methyl bromide (Bromomethane)	7/1/2013	7/31/2014	LA-DE Q
Methyl chloride (Chloromethane)	7/1/2013	7/31/2014	LA-DE Q
Methyl methacrylate	7/1/2013	7/31/2014	LA-DE Q
Methyl tert-butyl ether (MTBE)	7/1/2013	7/31/2014	LA-DE Q
Methylene chloride (Dichloromethane)	7/1/2013	7/31/2014	LA-DE Q
m-Xylene	7/1/2013	7/31/2014	LA-DE Q
Naphthalene	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Non Potable Water)

o-Xylene	7/1/2013	7/31/2014	LA-DE Q
Pentachloroethane	7/1/2013	7/31/2014	LA-DE Q
Propionitrile (Ethyl cyanide)	7/1/2013	7/31/2014	LA-DE Q
p-Xylene	7/1/2013	7/31/2014	LA-DE Q
Styrene	7/1/2013	7/31/2014	LA-DE Q
Tetrachloroethylene (Perchloroethylene)	7/1/2013	7/31/2014	LA-DE Q
Toluene	7/1/2013	7/31/2014	LA-DE Q
trans-1,2-Dichloroethylene	7/1/2013	7/31/2014	LA-DE Q
trans-1,3-Dichloropropylene	7/1/2013	7/31/2014	LA-DE Q
trans-1,4-Dichloro-2-butene	7/1/2013	7/31/2014	LA-DE Q
Trichloroethene (Trichloroethylene)	7/1/2013	7/31/2014	LA-DE Q
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	7/1/2013	7/31/2014	LA-DE Q
Vinyl acetate	7/1/2013	7/31/2014	LA-DE Q
Vinyl chloride	7/1/2013	7/31/2014	LA-DE Q

Method EPA 8270D

1,2,4,5-Tetrachlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,2,4-Trichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2013	7/31/2014	LA-DE Q
1,3,5-Trinitrobenzene (1,3,5-TNB)	7/1/2013	7/31/2014	FL

TestAmerica St. Louis

Start Date

Expires

AB

Program/Matrix: RCRA (Non Potable Water)

1,3-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,4-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,4-Naphthoquinone	7/1/2013	7/31/2014	LA-DE Q
1-Naphthylamine	7/1/2013	7/31/2014	LA-DE Q
2,3,4,6-Tetrachlorophenol	7/1/2013	7/31/2014	LA-DE Q
2,4,5-Trichlorophenol	7/1/2013	7/31/2014	LA-DE Q
2,4,6-Trichlorophenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dichlorophenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dimethylphenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dinitrophenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dinitrotoluene (2,4-DNT)	7/1/2013	7/31/2014	LA-DE Q
2,6-Dichlorophenol	7/1/2013	7/31/2014	LA-DE Q
2,6-Dinitrotoluene (2,6-DNT)	7/1/2013	7/31/2014	LA-DE Q
2-Aminoanthraquinone	7/1/2013	7/31/2014	LA-DE Q
2-Chloronaphthalene	7/1/2013	7/31/2014	LA-DE Q
2-Methylaniline (o-Toluidine)	7/1/2013	7/31/2014	LA-DE Q
2-Methylphenol (o-Cresol)	7/1/2013	7/31/2014	LA-DE Q
2-Naphthylamine	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Non Potable Water)

2-Nitroaniline	7/1/2013	7/31/2014	LA-DE Q
2-Nitrophenol	7/1/2013	7/31/2014	LA-DE Q
3,3'-Dichlorobenzidine	7/1/2013	7/31/2014	LA-DE Q
3,3'-Dimethoxybenzidine	7/1/2013	7/31/2014	FL
3,3'-Dimethylbenzidine	7/1/2013	7/31/2014	LA-DE Q
3-Methylcholanthrene	7/1/2013	7/31/2014	LA-DE Q
3-Methylphenol (m-Cresol)	7/1/2013	7/31/2014	LA-DE Q
3-Nitroaniline	7/1/2013	7/31/2014	LA-DE Q
4-Aminobiphenyl	7/1/2013	7/31/2014	LA-DE Q
4-Chloro-3-methylphenol	7/1/2013	7/31/2014	LA-DE Q
4-Chloroaniline	7/1/2013	7/31/2014	LA-DE Q
4-Chlorophenyl phenylether	7/1/2013	7/31/2014	LA-DE Q
4-Methylphenol (p-Cresol)	7/1/2013	7/31/2014	LA-DE Q
4-Nitroaniline	7/1/2013	7/31/2014	LA-DE Q
4-Nitrophenol	7/1/2013	7/31/2014	LA-DE Q
7,12-Dimethylbenz(a) anthracene	7/1/2013	7/31/2014	LA-DE Q
a-a-Dimethylphenethylamine	7/1/2013	7/31/2014	LA-DE Q
Acenaphthene	7/1/2013	7/31/2014	LA-DE Q
Acenaphthylene	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Non Potable Water)

Acetophenone	7/1/2013	7/31/2014	LA-DE Q
Aniline	7/1/2013	7/31/2014	LA-DE Q
Anthracene	7/1/2013	7/31/2014	LA-DE Q
Aramite	7/1/2013	7/31/2014	LA-DE Q
Benzo(a)anthracene	7/1/2013	7/31/2014	LA-DE Q
Benzo(a)pyrene	7/1/2013	7/31/2014	LA-DE Q
Benzo(b)fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Benzo(g,h,i)perylene	7/1/2013	7/31/2014	LA-DE Q
Benzo(k)fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Benzoic acid	7/1/2013	7/31/2014	LA-DE Q
Benzyl alcohol	7/1/2013	7/31/2014	LA-DE Q
bis(2-Chloroethoxy)methane	7/1/2013	7/31/2014	LA-DE Q
bis(2-Chloroethyl) ether	7/1/2013	7/31/2014	LA-DE Q
bis(2-Chloroisopropyl) ether	7/1/2013	7/31/2014	LA-DE Q
bis(2-Ethylhexyl) phthalate (DEHP)	7/1/2013	7/31/2014	FL
Butyl benzyl phthalate	7/1/2013	7/31/2014	LA-DE Q
Chrysene	7/1/2013	7/31/2014	LA-DE Q
Diallate	7/1/2013	7/31/2014	LA-DE Q
Dibenz(a,h) anthracene	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
Diethyl phthalate	7/1/2013	7/31/2014	LA-DE Q
Dimethyl phthalate	7/1/2013	7/31/2014	LA-DE Q
Di-n-butyl phthalate	7/1/2013	7/31/2014	LA-DE Q
Di-n-octyl phthalate	7/1/2013	7/31/2014	LA-DE Q
Famphur	7/1/2013	7/31/2014	LA-DE Q
Fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Fluorene	7/1/2013	7/31/2014	LA-DE Q
Hexachlorobenzene	7/1/2013	7/31/2014	LA-DE Q
Hexachlorobutadiene	7/1/2013	7/31/2014	LA-DE Q
Hexachlorocyclopentadiene	7/1/2013	7/31/2014	LA-DE Q
Hexachloroethane	7/1/2013	7/31/2014	LA-DE Q
Hexachloropropene	7/1/2013	7/31/2014	LA-DE Q
Indeno(1,2,3-cd) pyrene	7/1/2013	7/31/2014	LA-DE Q
Isodrin	7/1/2013	7/31/2014	LA-DE Q
Isophorone	7/1/2013	7/31/2014	LA-DE Q
Isosafrole	7/1/2013	7/31/2014	LA-DE Q
Kepone	7/1/2013	7/31/2014	FL
Methapyrilene	7/1/2013	7/31/2014	LA-DE Q
Methyl parathion (Parathion, methyl)	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
Naphthalene	7/1/2013	7/31/2014	LA-DE Q
Nitrobenzene	7/1/2013	7/31/2014	LA-DE Q
n-Nitrosodiethylamine	7/1/2013	7/31/2014	LA-DE Q
n-Nitrosodiphenylamine	7/1/2013	7/31/2014	LA-DE Q
n-Nitrosomethylethalamine	7/1/2013	7/31/2014	LA-DE Q
n-Nitrosomorpholine	7/1/2013	7/31/2014	LA-DE Q
n-Nitrosopiperidine	7/1/2013	7/31/2014	LA-DE Q
n-Nitrosopyrrolidine	7/1/2013	7/31/2014	LA-DE Q
o,o,o-Triethyl phosphorothioate	7/1/2013	7/31/2014	FL
Pentachlorobenzene	7/1/2013	7/31/2014	LA-DE Q
Pentachloronitrobenzene	7/1/2013	7/31/2014	LA-DE Q
Pentachlorophenol	7/1/2013	7/31/2014	LA-DE Q
Phenacetin	7/1/2013	7/31/2014	LA-DE Q
Phenanthrene	7/1/2013	7/31/2014	LA-DE Q
Phenol	7/1/2013	7/31/2014	LA-DE Q
Pyrene	7/1/2013	7/31/2014	LA-DE Q
Method EPA 8310			
Acenaphthene	7/1/2013	7/31/2014	LA-DE Q
Acenaphthylene	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
Anthracene	7/1/2013	7/31/2014	LA-DE Q
Benzo(a)anthracene	7/1/2013	7/31/2014	LA-DE Q
Benzo(a)pyrene	7/1/2013	7/31/2014	LA-DE Q
Benzo(b)fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Benzo(g,h,i)perylene	7/1/2013	7/31/2014	LA-DE Q
Benzo(k)fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Chrysene	7/1/2013	7/31/2014	LA-DE Q
Dibenz(a,h) anthracene	7/1/2013	7/31/2014	LA-DE Q
Fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Fluorene	7/1/2013	7/31/2014	LA-DE Q
Indeno(1,2,3-cd) pyrene	7/1/2013	7/31/2014	LA-DE Q
Naphthalene	7/1/2013	7/31/2014	LA-DE Q
Phenanthrene	7/1/2013	7/31/2014	LA-DE Q
Pyrene	7/1/2013	7/31/2014	LA-DE Q
Method EPA 8330B			
1,3,5-Trinitrobenzene (1,3,5-TNB)	7/1/2013	7/31/2014	LA-DE Q
1,3-Dinitrobenzene (1,3-DNB)	7/1/2013	7/31/2014	LA-DE Q
2,4,6-Trinitrotoluene (2,4,6-TNT)	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
2,4-Dinitrotoluene (2,4-DNT)	7/1/2013	7/31/2014	LA-DE Q
2,6-Dinitrotoluene (2,6-DNT)	7/1/2013	7/31/2014	LA-DE Q
2-Amino-4,6-dinitrotoluene (2-am-dnt)	7/1/2013	7/31/2014	LA-DE Q
2-Nitrotoluene	7/1/2013	7/31/2014	LA-DE Q
3-Nitrotoluene	7/1/2013	7/31/2014	LA-DE Q
4-Amino-2,6-dinitrotoluene (4-am-dnt)	7/1/2013	7/31/2014	LA-DE Q
4-Nitrotoluene	7/1/2013	7/31/2014	LA-DE Q
Methyl-2,4,6-trinitrophenylnitramine (tetryl)	7/1/2013	7/31/2014	LA-DE Q
Nitrobenzene	7/1/2013	7/31/2014	LA-DE Q
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	7/1/2013	7/31/2014	LA-DE Q
RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9010A			
Total cyanide	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9012B			
Total cyanide	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9020B			
Total organic halides (TOX)	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9030B			
Preparation/Extraction	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9034			
Total sulfides	7/1/2013	7/31/2014	FL
Method EPA 9040C			

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
pH	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9050A			
Conductivity	7/1/2013	7/31/2014	FL
Method EPA 9056			
Bromide	7/1/2013	7/31/2014	LA-DE Q
Chloride	7/1/2013	7/31/2014	LA-DE Q
Fluoride	7/1/2013	7/31/2014	LA-DE Q
Nitrate as N	7/1/2013	7/31/2014	LA-DE Q
Nitrite	7/1/2013	7/31/2014	LA-DE Q
Orthophosphate as P	7/1/2013	7/31/2014	LA-DE Q
Sulfate	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9060A			
Total organic carbon	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9310			
Gross alpha-beta	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9315			
Total alpha radium	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9320			
Radium-228	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Solid & Hazardous Material)**Method EPA 1010**

Ignitability	7/1/2013	7/31/2014	FL
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Method EPA 1311

Toxicity Characteristic Leaching Procedure Metals	7/1/2013	7/31/2014	LA-DE Q
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Toxicity Characteristic Leaching Procedure Semi-Volatiles	7/1/2013	7/31/2014	LA-DE Q
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Toxicity Characteristic Leaching Procedure Volatiles	7/1/2013	7/31/2014	LA-DE Q
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Method EPA 1312

Preparation/Extraction	7/1/2013	7/31/2014	LA-DE Q
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Method EPA 3050B

Preparation/Extraction	7/1/2013	7/31/2014	LA-DE Q
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Method EPA 3550C

Preparation/Extraction	7/1/2013	7/31/2014	LA-DE Q
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Method EPA 3580

Preparation/Extraction	7/1/2013	7/31/2014	UT
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Method EPA 3620C

Preparation/Extraction	7/1/2013	7/31/2014	UT
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Method EPA 3660B

Preparation/Extraction	7/1/2013	7/31/2014	UT
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Method EPA 5030

Preparation/Extraction	7/1/2013	7/31/2014	LA-DE Q
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Method EPA 5035

Preparation/Extraction	7/1/2013	7/31/2014	LA-DE Q
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Method EPA 6010C

Aluminum	7/1/2013	7/31/2014	LA-DE Q
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Antimony	7/1/2013	7/31/2014	LA-DE Q
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Arsenic	7/1/2013	7/31/2014	LA-DE Q
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TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
Barium	7/1/2013	7/31/2014	LA-DE Q
Beryllium	7/1/2013	7/31/2014	LA-DE Q
Boron	7/1/2013	7/31/2014	LA-DE Q
Cadmium	7/1/2013	7/31/2014	LA-DE Q
Calcium	7/1/2013	7/31/2014	LA-DE Q
Chromium	7/1/2013	7/31/2014	LA-DE Q
Cobalt	7/1/2013	7/31/2014	LA-DE Q
Copper	7/1/2013	7/31/2014	LA-DE Q
Iron	7/1/2013	7/31/2014	LA-DE Q
Lead	7/1/2013	7/31/2014	LA-DE Q
Lithium	7/1/2013	7/31/2014	LA-DE Q
Magnesium	7/1/2013	7/31/2014	LA-DE Q
Manganese	7/1/2013	7/31/2014	LA-DE Q
Molybdenum	7/1/2013	7/31/2014	LA-DE Q
Nickel	7/1/2013	7/31/2014	LA-DE Q
Potassium	7/1/2013	7/31/2014	LA-DE Q
Selenium	7/1/2013	7/31/2014	LA-DE Q
Silicon	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Solid & Hazardous Material)

Silver	7/1/2013	7/31/2014	LA-DE Q
Sodium	7/1/2013	7/31/2014	LA-DE Q
Strontium	7/1/2013	7/31/2014	LA-DE Q
Thallium	7/1/2013	7/31/2014	LA-DE Q
Tin	7/1/2013	7/31/2014	LA-DE Q
Titanium	7/1/2013	7/31/2014	LA-DE Q
Vanadium	7/1/2013	7/31/2014	LA-DE Q
Zinc	7/1/2013	7/31/2014	LA-DE Q

Method EPA 6020A

Aluminum	7/1/2013	7/31/2014	LA-DE Q
Antimony	7/1/2013	7/31/2014	LA-DE Q
Arsenic	7/1/2013	7/31/2014	LA-DE Q
Barium	7/1/2013	7/31/2014	LA-DE Q
Beryllium	7/1/2013	7/31/2014	LA-DE Q
Boron	7/1/2013	7/31/2014	LA-DE Q
Cadmium	7/1/2013	7/31/2014	LA-DE Q
Calcium	7/1/2013	7/31/2014	LA-DE Q
Chromium	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
Cobalt	7/1/2013	7/31/2014	LA-DE Q
Copper	7/1/2013	7/31/2014	LA-DE Q
Iron	7/1/2013	7/31/2014	LA-DE Q
Lead	7/1/2013	7/31/2014	LA-DE Q
Magnesium	7/1/2013	7/31/2014	LA-DE Q
Manganese	7/1/2013	7/31/2014	LA-DE Q
Molybdenum	7/1/2013	7/31/2014	LA-DE Q
Nickel	7/1/2013	7/31/2014	LA-DE Q
Potassium	7/1/2013	7/31/2014	LA-DE Q
Selenium	7/1/2013	7/31/2014	LA-DE Q
Silver	7/1/2013	7/31/2014	LA-DE Q
Strontium	7/1/2013	7/31/2014	LA-DE Q
Thallium	7/1/2013	7/31/2014	LA-DE Q
Vanadium	7/1/2013	7/31/2014	LA-DE Q
Zinc	7/1/2013	7/31/2014	LA-DE Q
Method EPA 6850			
Perchlorate	7/1/2013	7/31/2014	FL
Method EPA 7196A			
Chromium VI	7/1/2013	7/31/2014	LA-DE Q
Method EPA 7471B			

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
Mercury	7/1/2013	7/31/2014	LA-DE Q
Method EPA 8015D			
Diesel range organics (DRO)	7/1/2013	7/31/2014	LA-DE Q
Gasoline range organics (GRO)	7/1/2013	7/31/2014	LA-DE Q
Method EPA 8081B			
4,4'-DDD	7/1/2013	7/31/2014	LA-DE Q
4,4'-DDE	7/1/2013	7/31/2014	LA-DE Q
4,4'-DDT	7/1/2013	7/31/2014	LA-DE Q
Aldrin	7/1/2013	7/31/2014	LA-DE Q
alpha-BHC (alpha-Hexachlorocyclohexane)	7/1/2013	7/31/2014	LA-DE Q
alpha-Chlordane	7/1/2013	7/31/2014	LA-DE Q
beta-BHC (beta-Hexachlorocyclohexane)	7/1/2013	7/31/2014	LA-DE Q
Chlordane (tech.)	7/1/2013	7/31/2014	LA-DE Q
delta-BHC	7/1/2013	7/31/2014	LA-DE Q
Dieldrin	7/1/2013	7/31/2014	LA-DE Q
Endosulfan I	7/1/2013	7/31/2014	LA-DE Q
Endosulfan II	7/1/2013	7/31/2014	LA-DE Q
Endosulfan sulfate	7/1/2013	7/31/2014	LA-DE Q
Endrin	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Solid & Hazardous Material)

Endrin aldehyde	7/1/2013	7/31/2014	LA-DE Q
Endrin ketone	7/1/2013	7/31/2014	LA-DE Q
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	7/1/2013	7/31/2014	LA-DE Q
gamma-Chlordane	7/1/2013	7/31/2014	LA-DE Q
Heptachlor	7/1/2013	7/31/2014	LA-DE Q
Heptachlor epoxide	7/1/2013	7/31/2014	LA-DE Q
Methoxychlor	7/1/2013	7/31/2014	LA-DE Q
Toxaphene (Chlorinated camphene)	7/1/2013	7/31/2014	LA-DE Q

Method EPA 8082A

Aroclor-1016 (PCB-1016)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1221 (PCB-1221)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1232 (PCB-1232)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1242 (PCB-1242)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1248 (PCB-1248)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1254 (PCB-1254)	7/1/2013	7/31/2014	LA-DE Q
Aroclor-1260 (PCB-1260)	7/1/2013	7/31/2014	LA-DE Q

Method EPA 8151A

2,4,5-T	7/1/2013	7/31/2014	LA-DE Q
2,4-D	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
2,4-DB	7/1/2013	7/31/2014	LA-DE Q
Dalapon	7/1/2013	7/31/2014	LA-DE Q
Dicamba	7/1/2013	7/31/2014	LA-DE Q
Dichloroprop (Dichloroprop)	7/1/2013	7/31/2014	LA-DE Q
Silvex (2,4,5-TP)	7/1/2013	7/31/2014	LA-DE Q
Method EPA 8260C			
1,1,1,2-Tetrachloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1,1-Trichloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1,2,2-Tetrachloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1,2-Trichloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1-Dichloroethane	7/1/2013	7/31/2014	LA-DE Q
1,1-Dichloroethylene	7/1/2013	7/31/2014	LA-DE Q
1,2,3-Trichloropropane	7/1/2013	7/31/2014	LA-DE Q
1,2,4-Trichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,2-Dibromo-3-chloropropane (DBCP)	7/1/2013	7/31/2014	LA-DE Q
1,2-Dibromoethane (EDB, Ethylene dibromide)	7/1/2013	7/31/2014	LA-DE Q
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2013	7/31/2014	LA-DE Q
1,2-Dichloroethane (Ethylene dichloride)	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
1,2-Dichloropropane	7/1/2013	7/31/2014	LA-DE Q
1,3-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,4-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,4-Dioxane (1,4- Diethyleneoxide)	7/1/2013	7/31/2014	LA-DE Q
2-Butanone (Methyl ethyl ketone, MEK)	7/1/2013	7/31/2014	LA-DE Q
2-Chloroethyl vinyl ether	7/1/2013	7/31/2014	LA-DE Q
2-Hexanone	7/1/2013	7/31/2014	LA-DE Q
4-Methyl-2-pentanone (MIBK)	7/1/2013	7/31/2014	LA-DE Q
Acetone	7/1/2013	7/31/2014	LA-DE Q
Acetonitrile	7/1/2013	7/31/2014	LA-DE Q
Acrolein (Propenal)	7/1/2013	7/31/2014	LA-DE Q
Acrylonitrile	7/1/2013	7/31/2014	LA-DE Q
Allyl chloride (3-Chloropropene)	7/1/2013	7/31/2014	LA-DE Q
Benzene	7/1/2013	7/31/2014	LA-DE Q
Bromochloromethane	7/1/2013	7/31/2014	LA-DE Q
Bromodichloromethane	7/1/2013	7/31/2014	LA-DE Q
Bromoform	7/1/2013	7/31/2014	LA-DE Q
Carbon disulfide	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date Expires AB

Program/Matrix: RCRA (Solid & Hazardous Material)

Carbon tetrachloride	7/1/2013	7/31/2014	LA- DE Q
Chlorobenzene	7/1/2013	7/31/2014	LA- DE Q
Chlorodibromomethane	7/1/2013	7/31/2014	LA- DE Q
Chloroethane (Ethyl chloride)	7/1/2013	7/31/2014	LA- DE Q
Chloroform	7/1/2013	7/31/2014	LA- DE Q
Chloroprene (2-Chloro-1,3-butadiene)	7/1/2013	7/31/2014	LA- DE Q
cis-1,2-Dichloroethylene	7/1/2013	7/31/2014	LA- DE Q
cis-1,3-Dichloropropene	7/1/2013	7/31/2014	LA- DE Q
Dibromomethane (Methylene bromide)	7/1/2013	7/31/2014	LA- DE Q
Dichlorodifluoromethane (Freon-12)	7/1/2013	7/31/2014	LA- DE Q
Diethyl ether	7/1/2013	7/31/2014	LA- DE Q
Ethyl acetate	7/1/2013	7/31/2014	LA- DE Q
Ethyl methacrylate	7/1/2013	7/31/2014	LA- DE Q
Ethylbenzene	7/1/2013	7/31/2014	LA- DE Q
Hexachlorobutadiene	7/1/2013	7/31/2014	LA- DE Q
Iodomethane (Methyl iodide)	7/1/2013	7/31/2014	LA- DE Q
Isopropylbenzene	7/1/2013	7/31/2014	LA- DE Q
Methyl bromide (Bromomethane)	7/1/2013	7/31/2014	LA- DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Solid & Hazardous Material)

Methyl chloride (Chloromethane)	7/1/2013	7/31/2014	LA-DE Q
Methyl methacrylate	7/1/2013	7/31/2014	LA-DE Q
Methyl tert-butyl ether (MTBE)	7/1/2013	7/31/2014	LA-DE Q
Methylene chloride (Dichloromethane)	7/1/2013	7/31/2014	LA-DE Q
m-Xylene	7/1/2013	7/31/2014	LA-DE Q
Naphthalene	7/1/2013	7/31/2014	LA-DE Q
o-Xylene	7/1/2013	7/31/2014	LA-DE Q
Pentachloroethane	7/1/2013	7/31/2014	LA-DE Q
Propionitrile (Ethyl cyanide)	7/1/2013	7/31/2014	LA-DE Q
p-Xylene	7/1/2013	7/31/2014	LA-DE Q
Styrene	7/1/2013	7/31/2014	LA-DE Q
Tetrachloroethylene (Perchloroethylene)	7/1/2013	7/31/2014	LA-DE Q
Toluene	7/1/2013	7/31/2014	LA-DE Q
trans-1,2-Dichloroethylene	7/1/2013	7/31/2014	LA-DE Q
trans-1,3-Dichloropropylene	7/1/2013	7/31/2014	LA-DE Q
trans-1,4-Dichloro-2-butene	7/1/2013	7/31/2014	LA-DE Q
Trichloroethene (Trichloroethylene)	7/1/2013	7/31/2014	LA-DE Q
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Solid & Hazardous Material)

Vinyl acetate	7/1/2013	7/31/2014	LA-DE Q
Vinyl chloride	7/1/2013	7/31/2014	LA-DE Q

Method EPA 8270D

1,2,4,5-Tetrachlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,2,4-Trichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2013	7/31/2014	LA-DE Q
1,3,5-Trinitrobenzene (1,3,5-TNB)	7/1/2013	7/31/2014	FL
1,3-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,4-Dichlorobenzene	7/1/2013	7/31/2014	LA-DE Q
1,4-Naphthoquinone	7/1/2013	7/31/2014	LA-DE Q
1-Naphthylamine	7/1/2013	7/31/2014	LA-DE Q
2,3,4,6-Tetrachlorophenol	7/1/2013	7/31/2014	LA-DE Q
2,4,5-Trichlorophenol	7/1/2013	7/31/2014	LA-DE Q
2,4,6-Trichlorophenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dichlorophenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dimethylphenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dinitrophenol	7/1/2013	7/31/2014	LA-DE Q
2,4-Dinitrotoluene (2,4-DNT)	7/1/2013	7/31/2014	LA-DE Q
2,6-Dichlorophenol	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
2,6-Dinitrotoluene (2,6-DNT)	7/1/2013	7/31/2014	LA-DE Q
2-Aminoanthraquinone	7/1/2013	7/31/2014	FL
2-Chloronaphthalene	7/1/2013	7/31/2014	LA-DE Q
2-Methylaniline (o-Toluidine)	7/1/2013	7/31/2014	LA-DE Q
2-Methylphenol (o-Cresol)	7/1/2013	7/31/2014	LA-DE Q
2-Naphthylamine	7/1/2013	7/31/2014	LA-DE Q
2-Nitroaniline	7/1/2013	7/31/2014	LA-DE Q
2-Nitrophenol	7/1/2013	7/31/2014	LA-DE Q
3,3'-Dichlorobenzidine	7/1/2013	7/31/2014	LA-DE Q
3,3'-Dimethoxybenzidine	7/1/2013	7/31/2014	FL
3,3'-Dimethylbenzidine	7/1/2013	7/31/2014	FL
3-Methylcholanthrene	7/1/2013	7/31/2014	FL
3-Methylphenol (m-Cresol)	7/1/2013	7/31/2014	LA-DE Q
3-Nitroaniline	7/1/2013	7/31/2014	LA-DE Q
4-Aminobiphenyl	7/1/2013	7/31/2014	LA-DE Q
4-Chloro-3-methylphenol	7/1/2013	7/31/2014	LA-DE Q
4-Chloroaniline	7/1/2013	7/31/2014	LA-DE Q
4-Chlorophenyl phenylether	7/1/2013	7/31/2014	LA-DE Q
4-Methylphenol (p-Cresol)	7/1/2013	7/31/2014	LA-DE Q
4-Nitroaniline	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
4-Nitrophenol	7/1/2013	7/31/2014	LA-DE Q
7,12-Dimethylbenz(a) anthracene	7/1/2013	7/31/2014	LA-DE Q
a-a-Dimethylphenethylamine	7/1/2013	7/31/2014	LA-DE Q
Acenaphthene	7/1/2013	7/31/2014	LA-DE Q
Acenaphthylene	7/1/2013	7/31/2014	LA-DE Q
Acetophenone	7/1/2013	7/31/2014	LA-DE Q
Aniline	7/1/2013	7/31/2014	LA-DE Q
Anthracene	7/1/2013	7/31/2014	LA-DE Q
Aramite	7/1/2013	7/31/2014	LA-DE Q
Benzo(a)anthracene	7/1/2013	7/31/2014	LA-DE Q
Benzo(a)pyrene	7/1/2013	7/31/2014	LA-DE Q
Benzo(b)fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Benzo(g,h,i)perylene	7/1/2013	7/31/2014	LA-DE Q
Benzo(k)fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Benzoic acid	7/1/2013	7/31/2014	LA-DE Q
Benzyl alcohol	7/1/2013	7/31/2014	LA-DE Q
bis(2-Chloroethoxy)methane	7/1/2013	7/31/2014	LA-DE Q
bis(2-Chloroethyl) ether	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
bis(2-Chloroisopropyl) ether	7/1/2013	7/31/2014	LA-DE Q
bis(2-Ethylhexyl) phthalate (DEHP)	7/1/2013	7/31/2014	FL
Butyl benzyl phthalate	7/1/2013	7/31/2014	LA-DE Q
Chrysene	7/1/2013	7/31/2014	LA-DE Q
Diallylate	7/1/2013	7/31/2014	LA-DE Q
Dibenz(a,h) anthracene	7/1/2013	7/31/2014	LA-DE Q
Diethyl phthalate	7/1/2013	7/31/2014	LA-DE Q
Dimethyl phthalate	7/1/2013	7/31/2014	LA-DE Q
Di-n-butyl phthalate	7/1/2013	7/31/2014	LA-DE Q
Di-n-octyl phthalate	7/1/2013	7/31/2014	LA-DE Q
Famphur	7/1/2013	7/31/2014	LA-DE Q
Fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Fluorene	7/1/2013	7/31/2014	LA-DE Q
Hexachlorobenzene	7/1/2013	7/31/2014	LA-DE Q
Hexachlorobutadiene	7/1/2013	7/31/2014	LA-DE Q
Hexachlorocyclopentadiene	7/1/2013	7/31/2014	LA-DE Q
Hexachloroethane	7/1/2013	7/31/2014	LA-DE Q
Hexachloropropene	7/1/2013	7/31/2014	LA-DE Q
Indeno(1,2,3-cd) pyrene	7/1/2013	7/31/2014	LA-DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
Isodrin	7/1/2013	7/31/2014	FL
Isophorone	7/1/2013	7/31/2014	LA- DE Q
Isosafrole	7/1/2013	7/31/2014	LA- DE Q
Methapyrilene	7/1/2013	7/31/2014	LA- DE Q
Naphthalene	7/1/2013	7/31/2014	LA- DE Q
Nitrobenzene	7/1/2013	7/31/2014	LA- DE Q
n-Nitrosodiethylamine	7/1/2013	7/31/2014	LA- DE Q
n-Nitrosodiphenylamine	7/1/2013	7/31/2014	LA- DE Q
n-Nitrosomethylethalamine	7/1/2013	7/31/2014	LA- DE Q
n-Nitrosomorpholine	7/1/2013	7/31/2014	LA- DE Q
n-Nitrosopiperidine	7/1/2013	7/31/2014	LA- DE Q
n-Nitrosopyrrolidine	7/1/2013	7/31/2014	LA- DE Q
o,o,o-Triethyl phosphorothioate	7/1/2013	7/31/2014	FL
Pentachlorobenzene	7/1/2013	7/31/2014	LA- DE Q
Pentachloronitrobenzene	7/1/2013	7/31/2014	LA- DE Q
Pentachlorophenol	7/1/2013	7/31/2014	LA- DE Q
Phenacetin	7/1/2013	7/31/2014	LA- DE Q
Phenanthrene	7/1/2013	7/31/2014	LA- DE Q
Phenol	7/1/2013	7/31/2014	LA- DE Q

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
Pyrene	7/1/2013	7/31/2014	LA-DE Q
Method EPA 8310			
Acenaphthene	7/1/2013	7/31/2014	LA-DE Q
Acenaphthylene	7/1/2013	7/31/2014	LA-DE Q
Anthracene	7/1/2013	7/31/2014	LA-DE Q
Benzo(a)anthracene	7/1/2013	7/31/2014	LA-DE Q
Benzo(a)pyrene	7/1/2013	7/31/2014	LA-DE Q
Benzo(b)fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Benzo(g,h,i)perylene	7/1/2013	7/31/2014	LA-DE Q
Benzo(k)fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Chrysene	7/1/2013	7/31/2014	LA-DE Q
Dibenz(a,h) anthracene	7/1/2013	7/31/2014	LA-DE Q
Fluoranthene	7/1/2013	7/31/2014	LA-DE Q
Fluorene	7/1/2013	7/31/2014	LA-DE Q
Indeno(1,2,3-cd) pyrene	7/1/2013	7/31/2014	LA-DE Q
Naphthalene	7/1/2013	7/31/2014	LA-DE Q
Phenanthrene	7/1/2013	7/31/2014	LA-DE Q
Pyrene	7/1/2013	7/31/2014	LA-DE Q
Method EPA 8330			
1,3-Dinitrobenzene (1,3-DNB)	7/1/2013	7/31/2014	FL

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Solid & Hazardous Material)

Methyl-2,4,6-trinitrophenylnitramine (tetryl)	7/1/2013	7/31/2014	LA-DE Q
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Method EPA 8330B

1,3,5-Trinitrobenzene (1,3,5-TNB)	7/1/2013	7/31/2014	LA-DE Q
1,3-Dinitrobenzene (1,3-DNB)	7/1/2013	7/31/2014	LA-DE Q
2,4,6-Trinitrotoluene (2,4,6-TNT)	7/1/2013	7/31/2014	LA-DE Q
2,4-Dinitrotoluene (2,4-DNT)	7/1/2013	7/31/2014	LA-DE Q
2,6-Dinitrotoluene (2,6-DNT)	7/1/2013	7/31/2014	LA-DE Q
2-Amino-4,6-dinitrotoluene (2-am-dnt)	7/1/2013	7/31/2014	LA-DE Q
2-Nitrotoluene	7/1/2013	7/31/2014	LA-DE Q
3-Nitrotoluene	7/1/2013	7/31/2014	LA-DE Q
4-Amino-2,6-dinitrotoluene (4-am-dnt)	7/1/2013	7/31/2014	LA-DE Q
4-Nitrotoluene	7/1/2013	7/31/2014	LA-DE Q
Methyl-2,4,6-trinitrophenylnitramine (tetryl)	7/1/2013	7/31/2014	LA-DE Q
Nitrobenzene	7/1/2013	7/31/2014	LA-DE Q
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	7/1/2013	7/31/2014	LA-DE Q
RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	7/1/2013	7/31/2014	LA-DE Q

Method EPA 9010A

Total cyanide	7/1/2013	7/31/2014	LA-DE Q
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Method EPA 9012B

TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
Total cyanide	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9045D			
pH	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9056			
Bromide	7/1/2013	7/31/2014	LA-DE Q
Chloride	7/1/2013	7/31/2014	LA-DE Q
Fluoride	7/1/2013	7/31/2014	LA-DE Q
Nitrate as N	7/1/2013	7/31/2014	LA-DE Q
Nitrite	7/1/2013	7/31/2014	LA-DE Q
Orthophosphate as P	7/1/2013	7/31/2014	LA-DE Q
Sulfate	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9095B			
Free liquid	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9310			
Gross alpha-beta	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9315			
Total alpha radium	7/1/2013	7/31/2014	LA-DE Q
Method EPA 9320			
Radium-228	7/1/2013	7/31/2014	LA-DE Q
Method EPA H2S Test Method			
Reactive sulfide	7/1/2013	7/31/2014	LA-DE Q
Method EPA HCN Test Method			

TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: RCRA (Solid & Hazardous Material)

Reactive Cyanide

7/1/2013	7/31/2014	LA- DE Q
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TestAmerica St. Louis

Start Date	Expires	AB
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Program/Matrix: SDWA (Potable Water)**Method EPA 200.8**

Uranium

7/1/2013	7/31/2014	FL
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Method EPA 524.2

1,1,1,2-Tetrachloroethane	7/1/2013	7/31/2014	FL
1,1,1-Trichloroethane	7/1/2013	7/31/2014	FL
1,1,2,2-Tetrachloroethane	7/1/2013	7/31/2014	FL
1,1,2-Trichloroethane	7/1/2013	7/31/2014	FL
1,1-Dichloroethane	7/1/2013	7/31/2014	FL
1,1-Dichloroethylene	7/1/2013	7/31/2014	FL
1,1-Dichloropropene	7/1/2013	7/31/2014	FL
1,2,3-Trichlorobenzene	7/1/2013	7/31/2014	FL
1,2,3-Trichloropropane	7/1/2013	7/31/2014	FL
1,2,4-Trichlorobenzene	7/1/2013	7/31/2014	FL
1,2,4-Trimethylbenzene	7/1/2013	7/31/2014	FL
1,2-Dibromo-3-chloropropane (DBCP)	7/1/2013	7/31/2014	FL
1,2-Dibromoethane (EDB, Ethylene dibromide)	7/1/2013	7/31/2014	FL
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2013	7/31/2014	FL
1,2-Dichloroethane (Ethylene dichloride)	7/1/2013	7/31/2014	FL
1,2-Dichloropropane	7/1/2013	7/31/2014	FL
1,3,5-Trimethylbenzene	7/1/2013	7/31/2014	FL
1,3-Dichlorobenzene	7/1/2013	7/31/2014	FL
1,3-Dichloropropane	7/1/2013	7/31/2014	FL
1,4-Dichlorobenzene	7/1/2013	7/31/2014	FL
2,2-Dichloropropane	7/1/2013	7/31/2014	FL
2-Chlorotoluene	7/1/2013	7/31/2014	FL
2-Hexanone	7/1/2013	7/31/2014	FL
4-Chlorotoluene	7/1/2013	7/31/2014	FL
4-Isopropyltoluene (p-Cymene,p-Isopropyltoluene)	7/1/2013	7/31/2014	FL
4-Methyl-2-pentanone (MIBK)	7/1/2013	7/31/2014	FL
Acetone	7/1/2013	7/31/2014	FL
Benzene	7/1/2013	7/31/2014	FL
Bromobenzene	7/1/2013	7/31/2014	FL
Bromochloromethane	7/1/2013	7/31/2014	FL
Bromodichloromethane	7/1/2013	7/31/2014	FL
Bromoform	7/1/2013	7/31/2014	FL
Carbon disulfide	7/1/2013	7/31/2014	FL
Carbon tetrachloride	7/1/2013	7/31/2014	FL
Chlorobenzene	7/1/2013	7/31/2014	FL
Chlorodibromomethane	7/1/2013	7/31/2014	FL
Chloroethane (Ethyl chloride)	7/1/2013	7/31/2014	FL
Chloroform	7/1/2013	7/31/2014	FL
cis-1,2-Dichloroethylene	7/1/2013	7/31/2014	FL
cis-1,3-Dichloropropene	7/1/2013	7/31/2014	FL
Dibromomethane (Methylene bromide)	7/1/2013	7/31/2014	FL
Dichlorodifluoromethane (Freon-12)	7/1/2013	7/31/2014	FL
Ethylbenzene	7/1/2013	7/31/2014	FL
Hexachlorobutadiene	7/1/2013	7/31/2014	FL
Isopropylbenzene	7/1/2013	7/31/2014	FL

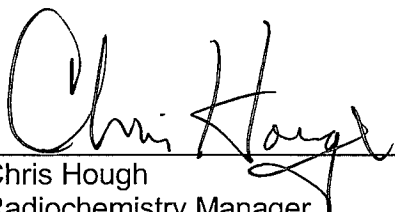
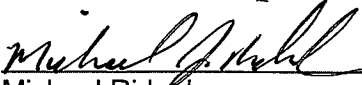
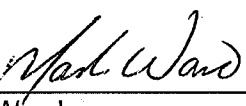
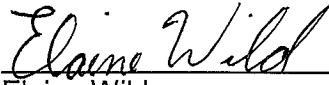
TestAmerica St. Louis

	Start Date	Expires	AB
Program/Matrix: SDWA (Potable Water)			
Methyl bromide (Bromomethane)	7/1/2013	7/31/2014	FL
Methyl chloride (Chloromethane)	7/1/2013	7/31/2014	FL
Methyl tert-butyl ether (MTBE)	7/1/2013	7/31/2014	FL
Methylene chloride (Dichloromethane)	7/1/2013	7/31/2014	FL
Naphthalene	7/1/2013	7/31/2014	FL
n-Butylbenzene	7/1/2013	7/31/2014	FL
n-Propylbenzene	7/1/2013	7/31/2014	FL
sec-Butylbenzene	7/1/2013	7/31/2014	FL
Styrene	7/1/2013	7/31/2014	FL
tert-Butylbenzene	7/1/2013	7/31/2014	FL
Tetrachloroethylene (Perchloroethylene)	7/1/2013	7/31/2014	FL
Toluene	7/1/2013	7/31/2014	FL
trans-1,2-Dichloroethylene	7/1/2013	7/31/2014	FL
trans-1,3-Dichloropropylene	7/1/2013	7/31/2014	FL
Trichloroethene (Trichloroethylene)	7/1/2013	7/31/2014	FL
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	7/1/2013	7/31/2014	FL
Vinyl chloride	7/1/2013	7/31/2014	FL
Method EPA 900.0			
Gross-alpha	7/1/2013	7/31/2014	FL
Gross-beta	7/1/2013	7/31/2014	FL
Method EPA 903			
Radium-226	7/1/2013	7/31/2014	FL
Method EPA 904			
Radium-228	7/1/2013	7/31/2014	FL
Method EPA 905			
Strontium-90	7/1/2013	7/31/2014	FL
Method EPA 906			
Tritium	7/1/2013	7/31/2014	FL

The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method.

The analytes by method which a laboratory is authorized to perform at any given time will be those indicated in the most recent certificate letter. The most recent certification letter supersedes all previous certification or authorization letters. It is the certified laboratory's responsibility to review this letter for discrepancies. The certified laboratory must document any discrepancies in this letter and send notice to this bureau within 15 days of receipt. This certificate letter will be recalled in the event your laboratory's certification is revoked.

Title: GAMMAVISION ANALYSIS

Approvals (Signature/Date):	
 Chris Hough Radiochemistry Manager	<u>5/18/12</u> Date
 Michael Ridenhower Health & Safety Manager / Coordinator	<u>5/18/12</u> Date
 Marti Ward Quality Assurance Manager	<u>5/18/12</u> Date
 Elaine Wild Laboratory Director	<u>5/18/12</u> Date

This SOP was previously identified as SOP No. ST-RD-0102 Rev. 8

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1.0 SCOPE AND APPLICATION

- 1.1 This procedure applies to all germanium detectors and the computer assisted germanium spectroscopy analysis system.
- 1.2 Due to the nature of gamma spectroscopy, once the system is calibrated to a particular geometry a similar matrix may be run as long as it is prepared to match a calibrated geometry.
- 1.3 This SOP is based on EPA Method 901.1 and DOE EML HASL 300 Method GA-01-R.
- 1.4 The reporting limits, method detectable activities and QC limits are maintained in the Information Management System (QuantIMS). Because of their dynamic nature, they are not specifically listed in this document, but can be retrieved at any time using TraQAr tools. A copy of the SACs are included in this SOP to demonstrate this information.

2.0 SUMMARY OF METHOD

- 2.1 This procedure provides detailed instructions for energy calibration, efficiency determination, quality control checks, background and sample counting of the germanium spectroscopy system.

3.0 DEFINITIONS

- 3.1 See the TestAmerica Quality Assurance Manual (QAM) for a glossary of common laboratory terms and data reporting qualifiers.

4.0 INTERFERENCES

- 4.1 Germanium spectrometry has potential interference. Interferences are usually in the form of radionuclides with unresolved photon emissions. These interferences are limited by the careful design/construction of the gamma spectral identification and interference libraries.

5.0 SAFETY

- 5.1 Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

6.0 EQUIPMENT AND SUPPLIES

- 6.1 Germanium spectroscopy system utilizing a computer based data acquisition system.

7.0 REAGENTS AND STANDARDS

- 7.1 All standards and reagent preparation, documentation and labeling must follow the requirements of SOP ST-QA-0002, current revision.

- 7.2 Commercially prepared mixed gamma standards in reproducible geometries, with all appropriate NIST Source Certificate information.

8.0 SAMPLE COLLECTION, PRESERVATION AND STORAGE

- 8.1 TestAmerica St. Louis supplies sample containers and chemical preservatives in accordance with the method. TestAmerica St. Louis does not perform sample collection. Samplers should reference the methods referenced and other applicable sample collection documents for detailed collection procedures. Sample volumes and preservative information is given in ST-PM-0002.
- 8.2 Samples may be collected in glass or plastic containers.
- 8.3 Aqueous samples are preserved with nitric acid to a pH of less than 2.
- 8.4 Sample hold time is 180 days from collection.

9.0 QUALITY CONTROL

9.1 Batch

- 9.1.1 A sample batch is a maximum of 20 environmental samples, which are prepared together using the same process and same lot(s) of reagents.
- 9.1.2 Instrument conditions must be the same for all standards, samples and QC samples.
- 9.1.3 For this analysis, batch QC consists of a method blank, a Laboratory Control Sample, and Sample Duplicate.

9.2 Method Blank (MB)

- 9.2.1 A method blank must be counted with every sample batch.
- 9.2.1.1 For soils, a method blank is sodium sulfate filled in the specified geometry.
- 9.2.1.2 For waters, a method blank is DI water filled in the specified geometry.
- 9.2.1.3 For filters, a method blank is a blank petri dish.

9.3 Laboratory Control Sample (LCS)

- 9.3.1 An LCS must be counted with every sample batch.
- 9.3.1.1 For water, a purchased mixed nuclide source in the specified geometry.
- 9.3.1.2 For soil, a purchased mixed nuclide source in the specified geometry.
- 9.3.1.3 For filters, a purchased mixed nuclide source in a petri dish.

9.4 Sample Duplicate

- 9.4.1 A Sample Duplicate is a recounted field sample to demonstrate instrument precision, since there is no sample preparation.
- 9.4.1.1 If requested, the laboratory may perform a Sample Duplicate which is an additional aliquot of a field sample.

9.5 Procedural Variations/ Nonconformance and Corrective Action

- 9.5.1 Any variation shall be completely documented using a Nonconformance Memo and approved by the Supervisor and QA Manager. See SOP ST-QA-0036 for details regarding the NCM process.
- 9.5.2 Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the Supervisor and QA Manager. See SOP ST-QA-0036 for details regarding the NCM process.

10.0 CALIBRATION AND STANDARDIZATION

- 10.1 Initial Calibration
 - 10.1.1 Prepare a minimum of **8** energy levels.
 - 10.1.1.1 A new calibration curve must be generated after major changes to the system or when the continuing calibration criteria cannot be met. Major changes include significant changes in instrument operating parameters, and major instrument maintenance (e.g. replacing the detector)
 - 10.1.1.2 Except in specific instances, it is NOT acceptable to remove points from a calibration curve for the purpose of meeting criteria. Refer to the TestAmerica Policy CA-T-P-0002, Selection of Calibration Points
 - 10.1.2 Energy calibrations shall be established for the germanium spectroscopy systems **annually**, or when the calibration quality control check indicates an unacceptable change in the energy calibration parameters.
 - 10.1.3 FWHM calibrations shall be established for the germanium spectroscopy systems **annually**, or when the calibration quality control check indicates an unacceptable change in the energy calibration parameters.
 - 10.1.4 Energy Calibration Criteria
 - 10.1.4.1 The curve should have eight calibration points used to determine the energy relationship of the calibration.
 - 10.1.4.2 The calibration source must have radionuclides that “bracket” the intended range of calibration.
 - 10.1.4.3 The energy difference should be within 0.05% for all calibration points or within 0.2keV for the calibration points.
 - 10.1.4.4 The FWHM must be less than 3.0 keV at 1332 keV.
 - 10.1.4.5 FWHM difference should be within 8% for all calibration points.
 - 10.1.5 Efficiency Calibration Criteria
 - 10.1.5.1 The curve should have at least eight points to determine the efficiency
 - 10.1.5.2 A minimum of 10,000 counts will be accumulated for each data point
 - 10.1.5.3 The efficiency difference should be within 8% for each point
 - 10.1.5.4 The calibration verification (a recount of the calibration source) should be within 8% of the known value.
- 10.2 Initial Calibration Verification (ICV)
 - 10.2.1 An initial calibration verification standard must be a different standard source than the one used for the initial calibration.
 - 10.2.1.1 The ICV check does not include short half nuclides which may exist in the purchased standard. At a minimum, the ICV will always contain Americium 241, Cesium 137 and Cobalt 60.
 - 10.2.2 An ICV must be performed with every initial calibration.
 - 10.2.3 The ICV percent recovery must be within +/- 10% criteria for each nuclide.
 - 10.2.4 Not meeting this requirement may be indicative of serious system malfunction or inaccuracies in the standards used for the initial calibration curve or ICV standard. Corrective action must be taken (including reanalysis of the ICV, or analysis of a different ICV). Any decision to proceed with analysis of samples when the ICV is out-of-control must be taken with great care and in consultation with the QA department and the laboratory director. Any such action must be documented in an NCM.
- 10.3 Background
 - 10.3.1 Background subtraction spectrum shall be established for the germanium spectroscopy systems **monthly**, or when the background quality control check indicates an unacceptable change in the daily background parameters, or as needed per client requirements.
 - 10.3.1.1 Background count time is 36 hours.
 - 10.3.1.1.1 If a client project requires a longer count time, then the background must be performed at the longer time before initiating analysis.

10.4 Daily Checks

- 10.4.1 The energy, resolution and efficiency calibrations for a detector shall be checked with its respective source each day that the germanium spectroscopy system is used.
- 10.4.2 The detector background shall be checked each day that the germanium spectroscopy system is used.
- 10.4.3 Calibration and background checks are acceptable if the value on the Analyze Spectrum utility is less than the action (3σ) limit. The routine calibration and background quality control parameters that will be monitored are:
 - 10.4.3.1 Energy for energy alignment (low- and high-energy)
 - 10.4.3.2 Activity check (low-, mid-, and high-energy) difference – limits are set to represent the percent difference between the source activity and the reported activity.
 - 10.4.3.3 Full-Width at the Half Maximum (FWHM) for peak shape monitoring (low-, mid-, and high-energy)
 - 10.4.3.4 Background Count Rate
 - 10.4.3.5 Channel centroid check – (low, high)
 - 10.4.3.6 Calibration (FWHM and background) quality control parameters will be found **acceptable** if the result is within the (3σ) limits.
 - 10.4.3.7 Energy and channel fixed limits are set symmetrical around target.
 - 10.4.3.8 Calibration (efficiency, resolution, energy alignment, and background) quality control parameters will be found **not acceptable** if the result is outside the established limits (3σ range) and marked as “OOS” (Out Of Service). In the case of an action, the daily QC check may be counted again or tagged out. The Daily QC check may only be recounted once without corrective action.
 - 10.4.3.8.1 If the out of control parameter is found acceptable for the rerun, the instrument can be used for the analysis of samples. No corrective action is necessary for this situation since the uncertainty can be attributed to the stochastic uncertainty of decay process (statistics), uncertainty of the sources, or a known uncorrected trend.
 - 10.4.3.8.2 If the instrument fails to meet the acceptance criteria for the rerun for peak centroid and activity, the instrument must be declared "Out of Service". The detector/instrument must be "tagged out". (See ST-QA-0036 for NCM details regarding tagging out of service).
 - 10.4.3.8.3 If the QC check fails for a second time, the analyst may want to:
 - 10.4.3.8.3.1 Check the expiration date of the radioactive standard to confirm the material is current, for the isotopes being utilized.
 - 10.4.3.8.3.2 Check source positioning and all instrument settings.
 - 10.4.3.8.3.3 Check all cables for any apparent damage and confirm that all cables are routed to proper connectors and are in good working order.
 - 10.4.3.9 The instrument may be returned to service once the malfunction has been corrected and the above acceptance criteria have been met. Corrective actions must be noted in the instrument maintenance log.
 - 10.4.3.10 If a parameter has two successive values in the warning/investigate limits, the system will be examined for a trend and noted in the maintenance log. Decisions will be based upon the Data Quality Objectives (DQO) and the degree of the bias in relation to the parameter.

10.5 Calibration Software Handling

- 10.5.1 Gamma Detector System Energy and Shape Calibration
 - 10.5.1.1 Acquire a spectrum from a calibration standard in the manual mode for an appropriate duration. Save the spectrum to the path
“C:\User\Cal\Spectra\DetX\OriginalCountfileName.sp” where:

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- 10.5.1.1.1 X = Detector Number
 - 10.5.1.1.2 Analysis method
 - 10.5.1.1.3 Select library
 - 10.5.1.1.4 Enter correct sample data.
 - 10.5.1.1.5 Enter correct conversion time.
 - 10.5.1.2 Close all detectors windows in the current instance of gamma vision, then recall the appropriate calibration spectrum into the buffer window.
 - 10.5.1.3 Select the menu "Analyze\Setting\Sample type...."
 - 10.5.1.4 Select the browse button next to the "File" field and open the file. Click the "OK" button of the window to close it.
 - 10.5.1.5 Recall the application Calibration File from the menu "Calibration \Recall Calibration..."
 - 10.5.1.6 Select the menu "Calibrate\Calibration wizard..."
 - 10.5.1.7 Select the option to create new energy calibrations. Select the next button.
 - 10.5.1.8 On the energy calibration wizard page, select the file "DET_EnergyStandardMix Lib" or appropriate library for mixed gamma used the browser button if desired. Select the next button.
 - 10.5.1.9 Select the next button to perform the energy, FWHM.
 - 10.5.1.10 Select the edit energy button to review the energy.
 - 10.5.1.10.1 Close the energy calibration sidebar window.
 - 10.5.1.11 Select the save calibration button and save the calibration to "Cal\Energy\X_Energy.clb" where X is the detector.
 - 10.5.1.12 Enter the calibration description in the format "X_ENERGY_GEOMETRY" where X is the detector number and Geometry is an appropriate geometry description when prompted. Select the Finish button to close the calibration wizard.
 - 10.5.1.13 Print the calibration report from the menu "Calibrate \print calibration.
- 10.5.2 Gamma Detector System Efficiency Calibration
- 10.5.2.1 Acquire a spectrum from a calibration standard in the manual mode for an appropriate duration. Save the spectrum to the path "C:\User\Cal\Spectra\DetX\OriginalCountfileName.spc" where:
 - 10.5.2.1.1 X = Detector Number
 - 10.5.2.1.2 Analysis method
 - 10.5.2.1.3 Select library
 - 10.5.2.1.4 Enter correct sample data.
 - 10.5.2.1.5 Enter correct conversion time.
 - 10.5.2.2 Close all detector windows in the current instance of Gamma Vision, then recall the appropriate calibration spectrum into the buffer window.
 - 10.5.2.3 Select the menu "Analyze\Setting\Sample Type"
 - 10.5.2.4 Select the browse button next to the "File", field and open the file. Click the "OK" button at the bottom of the window to close it.
 - 10.5.2.5 Recall the applicable calibration file from the menu "Calibration\Recall Calibration" (if the geometry file currently exists)
 - 10.5.2.6 Select the menu "Calibrate\Calibration Wizard"
 - 10.5.2.7 Select the option to create new energy and efficiency calibration. Select next button.
 - 10.5.2.8 On the Energy Calibration Wizard page select the file "EnergyStandardMix Lib" or appropriate library for mixed gamma used the browser button if desired. Select the Next button.
 - 10.5.2.9 On the Efficiency Calibration Wizard page, select library file, "DET_EfficiencyCalibration.Lib" for mixed gamma sources.
 - 10.5.2.10 On the Efficiency Calibration Wizard page, select the appropriate Certification file from the directory.

- 10.5.2.11 Select the next button to perform the energy FWHM and efficiency calibration.
 - 10.5.2.12 Select the Edit Energy button to review the energy and FWHM Calibration.
 - 10.5.2.12.1 Close the Efficiency Calibration side window.
 - 10.5.2.13 Select the save calibration button and save the calibration to Cal\X_Geometry.clb” where X is the detector and geometry is an appropriate geometry name.
 - 10.5.2.14 Enter the calibration description in the format “x_Geometry_Source number_date counted” where X is the detector number and geometry is an appropriate geometry description when prompted. Select the finish button to close the calibration wizard.
 - 10.5.2.15 Print calibration report from the menu “Calibrate\Print Calibration”
 - 10.5.2.16 Select “Analyze”, select “Entire spectrum in memory” and file point.
 - 10.5.2.17 Close the spectrum Buffer window and save the spectrum when prompted.
- 10.5.3 Detector Long Background Counting
- 10.5.3.1 Remove any samples from the detector, clean the detector, close the shield lid and start acquisition.
 - 10.5.3.2 Select detector 1 in Global Value Quick Start
 - 10.5.3.3 Select Monthly Background PBC under Automation Groups
 - 10.5.3.4 Select Background PBC Long Count under Automation Jobs.
 - 10.5.3.5 Login using name and password.
 - 10.5.3.6 Select “OK”, ensure detector cave is empty.
 - 10.5.3.7 Repeat for each detector which background you would like to start.
 - 10.5.3.8 After the background is complete it will save as a PBC file.

11.0 PROCEDURE

- 11.1 Calibration Quality Control (Daily Check)
 - 11.1.1 Place the calibration quality control sample on the detector, and start acquisition.
 - 11.1.2 Select detector from Global Value Quick Start.
 - 11.1.3 Select Quality Control under Automation Groups.
 - 11.1.4 Select Daily Quality Control Check under Automation Jobs.
 - 11.1.5 Login with user name and password.
 - 11.1.6 Select “OK”, ensure source is on detector.
 - 11.1.7 Repeat for each detector.
 - 11.1.8 Record in the instrument run log.
- 11.2 Background Quality Control (Daily Background)
 - 11.2.1 Remove any samples from the detector, and start acquisition
 - 11.2.2 Select detector global value quick start.
 - 11.2.3 Select quality control under automation groups.
 - 11.2.4 Select daily background check under automation jobs.
 - 11.2.5 Login with username and password.
 - 11.2.6 Select “OK”, ensure detector cave is empty.
 - 11.2.7 Repeat for each detector.
 - 11.2.8 Record in the instrument run log.
- 11.3 Sample Counting
 - 11.3.1 Remove any samples from the detector and start acquisition.
 - 11.3.2 Place the sample on the detector.
 - 11.3.3 Select detector from global value quick start.
 - 11.3.4 Select analyze samples under automation groups
 - 11.3.5 Select count sample under automation jobs.
 - 11.3.6 Login with username and password.

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- 11.3.7 Scan sample description from barcode report.
- 11.3.8 Select analysis method, sample type, geometry, library, correct date, count time, continue
- 11.3.9 Select "OK", ensure sample is on detector.
- 11.3.10 Record in the instrument run log.

12.0 DATA ANALYSIS AND CALCULATIONS

- 12.1 Commonly used calculations (e.g. % recovery and RPD) and standard instrument software calculations are given in the TestAmerica St. Louis QAM.
- 12.2 All calculations are performed in GammaVision; conversions are performed in RadCapture. Calculations are found in QAM.

13.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA; CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

- 13.1 The data assessment and corrective action process is detailed through the Clouseau Nonconformance Memorandum (NCM) process. The NCM process is described in SOP: ST-QA-0036. Below is a subset of the data assessment and QC excursion types within Clouseau; the text in underline is the exact "type" line in Clouseau. For a complete and current listing, please access the software program.
- 13.2 Method Blank
 - 13.2.1 Acceptance Criteria:
 - 13.2.1.1 No target analytes may be present in the method blank above the reporting limit.
 - 13.2.1.2 Project specific requirements if more stringent than our routine procedure (e.g. no target analytes present above ½ RL), will be noted on the client requirements sheet.
 - 13.2.2 Corrective Action for Method Blanks not meeting acceptance criteria:
 - 13.2.2.1 Method Blank Contamination – See Clouseau NCM for corrective action (e.g. reprep/reanalysis, narration). Note certain analytes are common laboratory contaminants which require special narrative comment. These compounds are so designated in Clouseau.
- 13.3 Laboratory Control Sample (LCS)
 - 13.3.1 Acceptance Criteria:
 - 13.3.1.1 All control analytes must be within the specified control limits for accuracy (%Recovery) and precision (RPD).
 - 13.3.2 Corrective Action for LCS not meeting acceptance criteria:
 - 13.3.2.1 LCS Spike Recovery excursion (high) – See Clouseau NCM for corrective action (e.g. , reanalysis, narration).
 - 13.3.2.2 LCS Spike Recovery excursion (low) – See Clouseau NCM for corrective action (e.g. , reanalysis, narration).
 - 13.3.2.3 RPD/RER Duplicate excursion – See Clouseau NCM for corrective action (e.g. , reanalysis, narration).
- 13.4 Duplicate
 - 13.4.1 Acceptance Criteria:
 - 13.4.1.1 All control analytes must be within the specified control limits for precision (RPD), max. 40% RPD, RER < 1.
 - 13.4.2 Corrective Action for LCS not meeting acceptance criteria:

13.4.2.1 RPD/RER Duplicate excursion – See Clouseau NCM for corrective action (e.g. , reanalysis, narration).

13.5 Insufficient Sample

13.5.1 For any prescribed re-preparation corrective action, if there is insufficient sample to repeat the analysis and narrative comment stating such is included in the report narrative. The insufficient sample description is included in the the Clouseau NCM within the type defining the excursion.

14.0 METHOD PERFORMANCE AND DEMONSTRATION OF CAPABILITY

14.1 Method performance data, Reporting Limits, and QC acceptance limits, are given in the appendix of this SOP.

14.2 Demonstration of Capability

14.2.1 Initial and continuing demonstrations of capability requirements are established in the QAM.

14.3 Training Qualification

14.3.1 The manager/supervisor has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

14.3.2 The analyst must have successfully completed the initial demonstration capability requirements prior to working independently. See requirements in the QAM.

14.4 Annually, the analyst must successfully demonstrate proficiency to continue to perform this analysis. See requirements in the QAM.

15.0 VALIDATION

15.1 Laboratory SOPs are based on standard reference EPA and DOE Methods that have been validated by the EPA and the lab is not required to perform validation for these methods. The requirements for lab demonstration of capability are included in QAM. Lab validation data would be appropriate for performance based measurement systems or non-standard methods. St. Louis will include this information in the SOP when accreditation is sought for a performance based measurement system or non-standard method

16.0 WASTE MANAGEMENT AND POLLUTION PREVENTION

16.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Environmental Health and Safety Manual for “Waste Management and Pollution Prevention.”

17.0 REFERENCES

- 17.1 Department of Energy (DOE) Environmental Monitoring Laboratory (EML) HASL-300 28th Edition, method GA-01-R, Gamma Radioassay
- 17.2 EPA Prescribed Procedures for Measurement of Radioactivity in Drinking Water Method 901.1
- 17.3 Ortec MCB Connections-32, Hardware Property Dialogs Manual, current version
- 17.4 MAESTRO-32, MCA Emulator, current version
- 17.5 Gammavision -32, Gamma-Ray Spectrum Analysis and MCA Emulator, current version
- 17.6 Master library Source: Gerhard Erdtmann, Werner Soyka

- 17.7 TestAmerica Quality Assurance Manual (QAM), current revision
- 17.8 TestAmerica Corporate Environmental Health and Safety Manual (CW-E-M-001) and St. Louis Facility Addendum (SOP ST-HS-0002), current revisions.
- 17.9 TestAmerica Policy CA-T-P-0002, Selection of Calibration Points
- 17.10 Associated SOPs:
 - 17.10.1 ST-RC-0004, current revision, Preparation of Soil Samples for Radiochemical Analysis
 - 17.10.2 ST-RC-0025, current revision, Preparation of Samples for Gamma Spectroscopy
 - 17.10.3 ST-QA-0002, current revision, Standards and Reagent Preparation
 - 17.10.4 ST-QA-0014, current revision, Evaluation of Analytical Accuracy and Precision Through the Use of Control Charts
 - 17.10.5 ST-QA-0036, current revision, Non-Conformance Memorandum (NCM) Process

18.0 CLARIFICATIONS, MODIFICATIONS TO THE REFERENCE METHOD

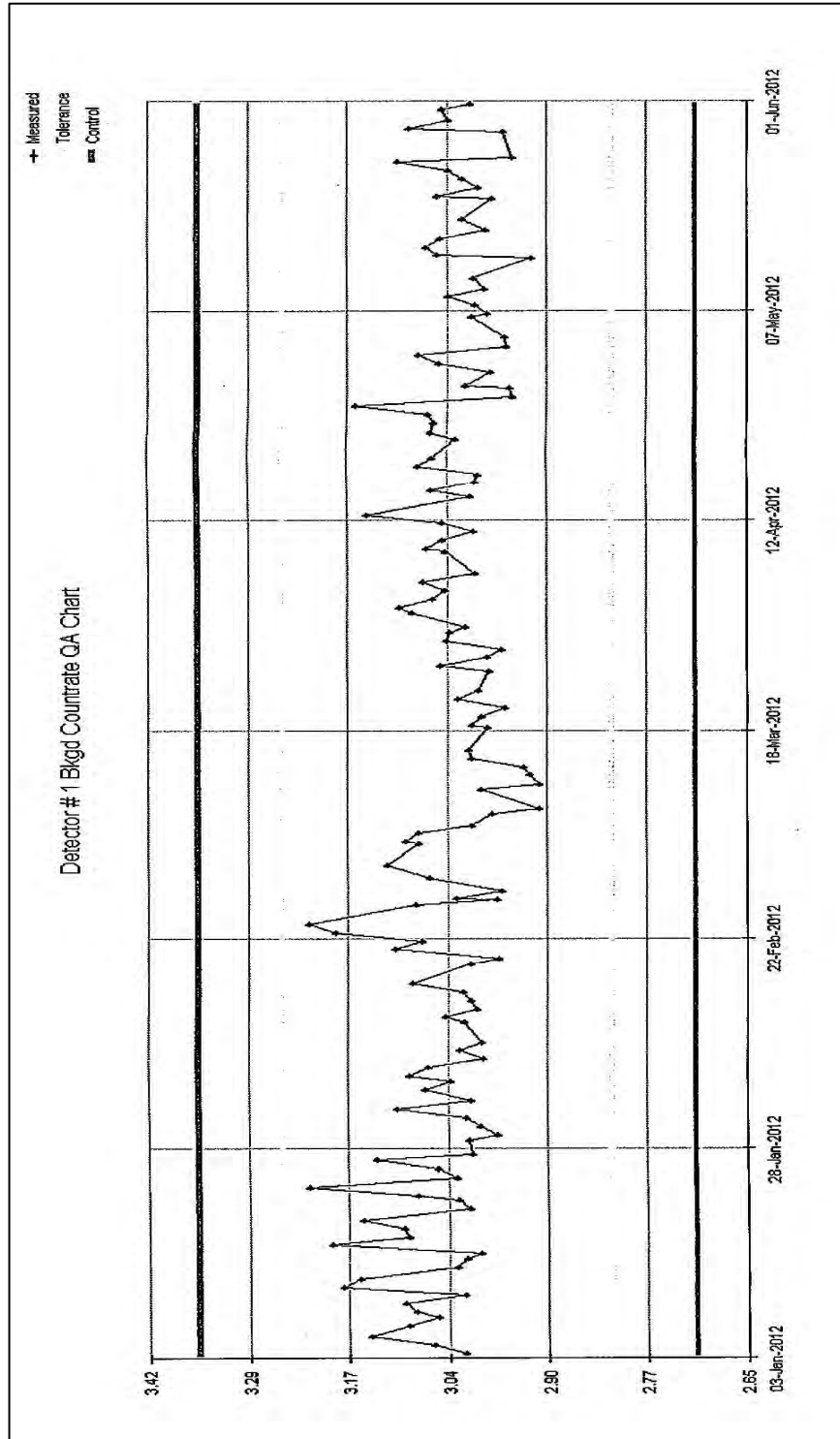
- 18.1 None.

19.0 CHANGES FROM PREVIOUS REVISION

- 19.1 Annual Review, No Changes.
- 19.2 Rev. 8:
 - 19.2.1 Increased background count times from 12 to 36 hours in section 10.3.1.1.
 - 19.2.2 Updated the procedure for detector long background counting in section 10.5 to reflect new software.
 - 19.2.3 Updated daily calibration checks, daily background and sample counting procedures in section 11.0 to reflect new software.
- 19.3 Rev. 9:
 - 19.3.1 Replaced quartz sand with sodium sulfate to be used for soil method blanks in section 9.2.
 - 19.3.2 Updated section 10.4 regarding instrument daily checks.
 - 19.3.3 Updated data assessment and acceptance criteria in section 13.0
 - 19.3.4 Updated section 9.0 regarding batch, method blank and laboratory control samples.
 - 19.3.5 Updated the calibration points for an internal calibration in section 10.1.
 - 19.3.6 Updated the percent recovery regarding the ICV in section 10.2.
 - 19.3.7 Updated software storage file name throughout section 10.5.

Attachment 1

Attachment 1



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TAL Reference Data Summary

Structured Analysis Code: I-G7-4F-01-06		Matrix: WATER	
Target Analyte List: All Analytes		Extraction: Direct Addition of Sample to Geometry	
		Method: Gamma Iodine by GA-01-R MOD	
		QC Program: STANDARD TEST SET	
		Location: TestAmerica St. Louis	

Analyte List		Detection Limits			Check List 6581			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD

5409	Iodine 125	10	pCi/L							
4047	Iodine 129	10	pCi/L			C	Y			90 110 40
4049	Iodine 131	10	pCi/L							

TAL Reference Data Summary

Structured Analysis Code: A-K5-4F-01-06

Target Analyte List: All Analytes

Matrix:	SOLID
Extraction:	As Recd
Method:	Gamma
QC Program:	STANDARD
Location:	Test Area

[illegible]

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TAL Reference Data Summary

Structured Analysis Code: I-G7-0A-01-06

Target Analyte List: All Analytes

Matrix: WATER
Extraction: Direct Addition of Sample to Geometry
Method: Gamma Cs-137 & Hits by DOE GA-01-R MOD
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List		RL	Detection Limits		Units	Run Date	Check List 6506		Spike List 0	
Syn	Compound		Units	MDL			T	A	Units	LCL UCL RPD
3995	Actinium 227		pCi/L			0				
3997	Actinium 228		pCi/L			0				
3984	Americium 241		pCi/L			0	C	Y	90	111 40
4280	Antimony 124		pCi/L			0				
4103	Antimony 125		pCi/L			0				
3999	Barium 140		pCi/L			0				
4001	Beryllium 7		pCi/L			0				
4798	Bismuth 211 eq Th-227		pCi/L			0				
5053	Bismuth 207		pCi/L			0				
5068	Bismuth-210M		pCi/L			0				
4800	Bismuth 212		pCi/L			0				
4005	Bismuth 214		pCi/L			0				
4009	Cerium 141		pCi/L			0				
4804	Cerium 139		pCi/L			0				
4011	Cerium 144		pCi/L			0				
4031	Cesium 134		pCi/L			0				
4033	Cesium 137	20	pCi/L			0	C	Y	90	111 40
4029	Chromium 51		pCi/L			0				
5399	Cobalt 56		pCi/L			0				
4023	Cobalt 57		pCi/L			0				
4025	Cobalt 58		pCi/L			0				
4027	Cobalt 60		pCi/L			0	C	Y	89	110 40
4035	Europium 152		pCi/L			0				
4037	Europium 154		pCi/L			0				
4039	Europium 155		pCi/L			0				
4049	Iodine 131		pCi/L			0				
4043	Iron 59		pCi/L			0				
4156	Lead 210		pCi/L			0				
4077	Lead 212		pCi/L			0				
4079	Lead 214		pCi/L			0				
4055	Manganese 54		pCi/L			0				
4061	Niobium 94		pCi/L			0				
4063	Niobium 95		pCi/L			0				
4051	Potassium 40		pCi/L			0				
4081	Promethium 144		pCi/L			0				
5225	Protactinium 234M		pCi/L			0				
5220	Rhodium 106		pCi/L			0				

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Structured Analysis Code: I-G7-0A-01-06

Target Analyte List: All Analytes

MATRIX

Matrix: WATER
Extraction: Direct Addition of Sample to Geometry
Method: Gamma Cs-137 & Hits by DOE GA-01-R MOD
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List		Detection Limits				Check List 6506				Spike List 0			
		RL	Units	MDL	Units	T	A	Amt	Units	LCL	UCL	RPD	Units
Syn	Compound												
4099	Ruthenium 103		pCi/L										
4101	Ruthenium 106		pCi/L										
5044	Scandium 46		pCi/L										
5404	Silver 108m		pCi/L										
4779	Silver 110m		pCi/L										
4057	Sodium 22		pCi/L										
4125	Thallium 208		pCi/L										
4816	Thorium 227		pCi/L										
4119	Thorium 231		pCi/L										
4123	Thorium 234		pCi/L										
4278	Tin 113		pCi/L										
4131	Uranium 235		pCi/L										
4133	Uranium 238		pCi/L										
4137	Yttrium 88		pCi/L										
4141	Zinc 65		pCi/L										
4143	Zirconium 95		pCi/L										

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TAL Reference Data Summary

Structured Analysis Code: A-G6-0A-01-06

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: Dry, Grind, and Fill Geometry
Method: Gamma Cs-137 & Hits by DOE GA-01-R MOD
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List		RL	Detection Limits		Run Date	Check List 6506				Spike List 0								
Syn	Compound		Units	MDL		Units	T	A	Amt	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL
3995	Actinium 227		pCi/g		0													
3997	Actinium 228		pCi/g		0													
3984	Americium 241		pCi/g		0	C	Y		90	115	40							
4280	Antimony 124		pCi/g		0													
4103	Antimony 125		pCi/g		0													
4211	Barium/Lanthanum-140		pCi/g		0													
3999	Barium 140		pCi/g		0													
4001	Beryllium 7		pCi/g		0													
5676	Bismuth 210 eq Pb-210		pCi/g		0													
4798	Bismuth 211 eq Th-227		pCi/g		0													
5067	Bismuth-207		pCi/g		0													
5068	Bismuth-210M		pCi/g		0													
4800	Bismuth 212		pCi/g		0													
4005	Bismuth 214		pCi/g		0													
4009	Cerium 141		pCi/g		0													
4804	Cerium 139		pCi/g		0													
4011	Cerium 144		pCi/g		0													
4031	Cesium 134		pCi/g		0													
4033	Cesium 137	0.2	pCi/g		0	C	Y		90	123	40							
4029	Chromium 51		pCi/g		0													
5399	Cobalt 56		pCi/g		0													
4023	Cobalt 57		pCi/g		0													
4025	Cobalt 58		pCi/g		0													
4027	Cobalt 60		pCi/g		0	C	Y		90	114	40							
4035	Europium 152		pCi/g		0													
4037	Europium 154		pCi/g		0													
4039	Europium 155		pCi/g		0													
5415	Gadolinium 153		pCi/g		0													
4213	Hafnium 181		pCi/g		0													
4049	Iodine 131		pCi/g		0													
5416	Iridium 192		pCi/g		0													
4043	Iron 59		pCi/g		0													
4156	Lead 210		pCi/g		0													
4077	Lead 212		pCi/g		0													
4079	Lead 214		pCi/g		0													
4055	Manganese 54		pCi/g		0													
4061	Niobium 94		pCi/g		0													

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Structured Analysis Code: A-G6-0A-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: Dry, Grind, and Fill Geometry

Method: Gamma Cs-137 & Hits by DOE GA-01-R MOD

QC Program: STANDARD TEST SET

Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6506			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
4063	Niobium 95		pCi/g							
4051	Potassium 40		pCi/g							
4081	Promethium 144		pCi/g							
4083	Promethium 146		pCi/g							
5225	Protactinium 234M		pCi/g							
4071	Protactinium 231		pCi/g							
5571	Radium 226		pCi/g							
2259	Radium 228		pCi/g							
4097	Radon 222		pCi/g							
5220	Rhodium 106		pCi/g							
4099	Ruthenium 103		pCi/g							
4101	Ruthenium 106		pCi/g							
5044	Scandium 46		pCi/g							
5404	Silver 108m		pCi/g							
4779	Silver 110m		pCi/g							
4057	Sodium 22		pCi/g							
5553	Tantalum 182		pCi/g							
5554	Terbium 160		pCi/g							
4125	Thallium 208		pCi/g							
4816	Thorium 227		pCi/g							
4392	Thorium 229		pCi/g							
4119	Thorium 231		pCi/g							
4123	Thorium 234		pCi/g							
4278	Tin 113		pCi/g							
4131	Uranium 235		pCi/g							
4133	Uranium 238		pCi/g							
4137	Yttrium 88		pCi/g							
4141	Zinc 65		pCi/g							
4143	Zirconium 95		pCi/g							

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TAL Reference Data Summary

Structured Analysis Code: A-K1-0A-01-06

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: As Received, Fill Geometry
Method: Gamma Cs-137 & Hits by DOE GA-01-R MOD
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List		RL	Detection Limits		Run Date	Check List 6506			Spike List 0		
Syn	Compound		Units	MDL		T	A	Amt	Units	LCL	UCL
3995	Actinium 227		pCi/g		0						
3997	Actinium 228		pCi/g		0						
3984	Americium 241		pCi/g		0	C	Y	90	115	40	
4280	Antimony 124		pCi/g		0						
4103	Antimony 125		pCi/g		0						
5556	Barium-137		pCi/g		0						
4211	Barium/Lanthanum-140		pCi/g		0						
4168	Barium 133		pCi/g		0						
3999	Barium 140		pCi/g		0						
4001	Beryllium 7		pCi/g		0						
4798	Bismuth 211 eq Th-227		pCi/g		0						
5067	Bismuth-207		pCi/g		0						
5068	Bismuth-210M		pCi/g		0						
4800	Bismuth 212		pCi/g		0						
4005	Bismuth 214		pCi/g		0						
4802	Cadmium 109		pCi/g		0						
5557	Calcium-45		pCi/g		0						
4009	Cerium 141		pCi/g		0						
4804	Cerium 139		pCi/g		0						
4011	Cerium 144		pCi/g		0						
4031	Cesium 134		pCi/g		0						
4033	Cesium 137	0.2	pCi/g		0	C	Y	90	123	40	
4029	Chromium 51		pCi/g		0						
5399	Cobalt 56		pCi/g		0						
4023	Cobalt 57		pCi/g		0						
4025	Cobalt 58		pCi/g		0						
4027	Cobalt 60		pCi/g		0	C	Y	90	114	40	
4035	Europium 152		pCi/g		0						
4037	Europium 154		pCi/g		0						
4039	Europium 155		pCi/g		0						
5415	Gadolinium 153		pCi/g		0						
4213	Hafnium 181		pCi/g		0						
4049	Iodine 131		pCi/g		0						
5416	Iridium 192		pCi/g		0						
4043	Iron 59		pCi/g		0						
5438	Kr-85		pCi/g		0						
4156	Lead 210		pCi/g		0						

Structured Analysis Code: A-K1-0A-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: As Received, Fill Geometry

Method: Gamma Cs-137 & Hits by DOE GA-01-R MOD

QC Program: STANDARD TEST SET

Location: TestAmerica St. Louis

Analyte List		Detection Limits				Check List 6506				Spike List 0			
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	T	A	Amt	Units
4077	Lead 212		pCi/g			0							
4079	Lead 214		pCi/g			0							
5558	Manganese-56		pCi/g			0							
4055	Manganese 54		pCi/g			0							
4806	Mercury 203		pCi/g			0							
4069	Neptunium 237		pCi/g			0							
4172	Neptunium 239		pCi/g			0							
5877	Niobium 83		pCi/g			0							
4061	Niobium 94		pCi/g			0							
4063	Niobium 95		pCi/g			0							
4051	Potassium 40		pCi/g			0							
4081	Promethium 144		pCi/g			0							
4083	Promethium 146		pCi/g			0							
4085	Promethium 147		pCi/g			0							
5225	Protactinium 234M		pCi/g			0							
4071	Protactinium 231		pCi/g			0							
4073	Protactinium 234		pCi/g			0							
2257	Radium (226)		pCi/g			0							
2259	Radium 228		pCi/g			0							
5094	Radium-225		pCi/g			0							
4810	Radium 223 (assumes equilibrium w/		pCi/g			0							
4095	Radium 224		pCi/g			0							
5220	Rhodium 106		pCi/g			0							
4099	Ruthenium 103		pCi/g			0							
4101	Ruthenium 106		pCi/g			0							
5044	Scandium 46		pCi/g			0							
5404	Silver 108m		pCi/g			0							
4779	Silver 110m		pCi/g			0							
4057	Sodium 22		pCi/g			0							
4059	Sodium 24		pCi/g			0							
4107	Strontium 85		pCi/g			0							
5553	Tantalum 182		pCi/g			0							
5554	Terbium 160		pCi/g			0							
4125	Thallium 208		pCi/g			0							
4816	Thorium 227		pCi/g			0							
4115	Thorium 228		pCi/g			0							
4117	Thorium 230		pCi/g			0							
4119	Thorium 231		pCi/g			0							
4121	Thorium 232		pCi/g			0							

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Structured Analysis Code: A-K1-0A-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: As Received, Fill Geometry

Method: Gamma Cs-137 & Hits by DOE GA-01-R MOD

QC Program: STANDARD TEST SET

Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6506			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
4123	Thorium 234		pCi/g							
4278	Tin 113		pCi/g							
4131	Uranium 235		pCi/g							
4133	Uranium 238		pCi/g							
5559	Vanadium-48		pCi/g							
4137	Yttrium 88		pCi/g							
4141	Zinc 65		pCi/g							
4143	Zirconium 95		pCi/g							

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TAL Reference Data Summary

Structured Analysis Code: I-G7-Z7-01-06

Target Analyte List: All Analytes

Matrix: WATER
Extraction: Direct Addition of Sample to Geometry
Method: Gamma Cs-137 & Hits by EPA 901.1 MOD
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6506			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
5869	Actinium 227 (assumes equilibrium w/		pCi/L							
3997	Actinium 228		pCi/L							
3984	Americium 241		pCi/L			C	Y		90	111 40
4280	Antimony 124		pCi/L							
4103	Antimony 125		pCi/L							
5556	Barium-137		pCi/L							
4211	Barium/Lanthanum-140		pCi/L							
4168	Barium 133		pCi/L							
3999	Barium 140		pCi/L							
4001	Beryllium 7		pCi/L							
4798	Bismuth 211 eq Th-227		pCi/L							
5053	Bismuth 207		pCi/L							
5068	Bismuth-210M		pCi/L							
4800	Bismuth 212		pCi/L							
4005	Bismuth 214		pCi/L							
5557	Calcium-45		pCi/L							
4009	Cerium 141		pCi/L							
4804	Cerium 139		pCi/L							
4011	Cerium 144		pCi/L							
4031	Cesium 134		pCi/L							
4033	Cesium 137	20	pCi/L			C	Y		90	111 40
5399	Cobalt 56		pCi/L							
4023	Cobalt 57		pCi/L							
4025	Cobalt 58		pCi/L							
4027	Cobalt 60		pCi/L			C	Y		89	110 40
4035	Europium 152		pCi/L							
4037	Europium 154		pCi/L							
4039	Europium 155		pCi/L							
4213	Hafnium 181		pCi/L							
4049	Iodine 131		pCi/L							
5416	Iridium 192		pCi/L							
4043	Iron 59		pCi/L							
4053	Lanthanum 140		pCi/L							
4156	Lead 210		pCi/L							
4075	Lead 211		pCi/L							
4077	Lead 212		pCi/L							
4079	Lead 214		pCi/L							

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Structured Analysis Code: I-G7-Z7-01-06

Target Analyte List: All Analytes

Matrix: WATER

Extraction: Direct Addition of Sample to Geometry
 Method: Gamma Cs-137 & Hits by EPA 901.1 MOD
 QC Program: STANDARD TEST SET
 Location: TestAmerica St. Louis

Analyte List		Detection Limits				Check List 6506				Spike List 0			
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	RPD	T	A	Amt	Units
5558	Manganese-56		pCi/L										
4055	Manganese 54		pCi/L										
4806	Mercury 203		pCi/L										
4069	Neptunium 237		pCi/L										
4172	Neptunium 239		pCi/L										
5877	Niobium 83		pCi/L										
4061	Niobium 94		pCi/L										
4063	Niobium 95		pCi/L										
4051	Potassium 40		pCi/L										
4081	Promethium 144		pCi/L										
4083	Promethium 146		pCi/L										
4085	Promethium 147		pCi/L										
5225	Protactinium 234M		pCi/L										
4071	Protactinium 231		pCi/L										
4073	Protactinium 234		pCi/L										
2257	Radium (226)		pCi/L										
2259	Radium 228		pCi/L										
4810	Radium 223 (assumes equilibrium w/		pCi/L										
4095	Radium 224		pCi/L										
4101	Ruthenium 106		pCi/L										
5044	Scandium 46		pCi/L										
4057	Sodium 22		pCi/L										
4059	Sodium 24		pCi/L										
4107	Strontium 85		pCi/L										
4125	Thallium 208		pCi/L										
4816	Thorium 227		pCi/L										
4115	Thorium 228		pCi/L										
4117	Thorium 230		pCi/L										
4119	Thorium 231		pCi/L										
4121	Thorium 232		pCi/L										
4123	Thorium 234		pCi/L										
4278	Tin 113		pCi/L										
4131	Uranium 235		pCi/L										
4133	Uranium 238		pCi/L										
5559	Vanadium-48		pCi/L										
4137	Yttrium 88		pCi/L										
4141	Zinc 65		pCi/L										
4143	Zirconium 95		pCi/L										

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TAL Reference Data Summary

Structured Analysis Code: A-G6-Z7-01-06

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: Dry, Grind, and Fill Geometry
Method: Gamma Cs-137 & Hits by EPA 901.1 MOD
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List		RL	Detection Limits		Run Date	Check List 6506				Spike List 0								
Syn	Compound		Units	MDL		T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL
5869	Actinium 227 (assumes equilibrium w/		pCi/g		0													
3997	Actinium 228		pCi/g		0													
3984	Americium 241		pCi/g		0	C	Y			90	115	40						
4280	Antimony 124		pCi/g		0													
4103	Antimony 125		pCi/g		0													
4001	Beryllium 7		pCi/g		0													
5676	Bismuth 210 eq Pb-210		pCi/g		0													
4798	Bismuth 211 eq Th-227		pCi/g		0													
5053	Bismuth 207		pCi/g		0													
5068	Bismuth-210M		pCi/g		0													
4800	Bismuth 212		pCi/g		0													
4005	Bismuth 214		pCi/g		0													
4009	Cerium 141		pCi/g		0													
4011	Cerium 144		pCi/g		0													
4031	Cesium 134		pCi/g		0													
4033	Cesium 137	0.2	pCi/g		0	C	Y			90	123	40						
5399	Cobalt 56		pCi/g		0													
4023	Cobalt 57		pCi/g		0													
4025	Cobalt 58		pCi/g		0													
4027	Cobalt 60		pCi/g		0	C	Y			90	114	40						
4035	Europium 152		pCi/g		0													
4037	Europium 154		pCi/g		0													
4039	Europium 155		pCi/g		0													
4213	Hafnium 181		pCi/g		0													
4049	Iodine 131		pCi/g		0													
4043	Iron 59		pCi/g		0													
4156	Lead 210		pCi/g		0													
4077	Lead 212		pCi/g		0													
4079	Lead 214		pCi/g		0													
4055	Manganese 54		pCi/g		0													
4061	Niobium 94		pCi/g		0													
4063	Niobium 95		pCi/g		0													
4051	Potassium 40		pCi/g		0													
4081	Promethium 144		pCi/g		0													
5225	Protactinium 234M		pCi/g		0													
4071	Protactinium 231		pCi/g		0													
4073	Protactinium 234		pCi/g		0													

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Structured Analysis Code: A-G6-Z7-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: Dry, Grind, and Fill Geometry

Method: Gamma Cs-137 & Hits by EPA 901.1 MOD

QC Program: STANDARD TEST SET

Location: TestAmerica St. Louis

Analyte List			Detection Limits			Check List 6506			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	T	A
2257	Radium (226)		pCi/g			0					
2259	Radium 228		pCi/g			0					
4810	Radium 223 (assumes equilibrium w/		pCi/g			0					
4095	Radium 224		pCi/g			0					
5248	Rh-106		pCi/g			0					
4099	Ruthenium 103		pCi/g			0					
4101	Ruthenium 106		pCi/g			0					
5044	Scandium 46		pCi/g			0					
5404	Silver 108m		pCi/g			0					
4779	Silver 110m		pCi/g			0					
4057	Sodium 22		pCi/g			0					
5868	Thallium 207 eq Th-227		pCi/g			0					
4125	Thallium 208		pCi/g			0					
4816	Thorium 227		pCi/g			0					
4117	Thorium 230		pCi/g			0					
4119	Thorium 231		pCi/g			0					
4121	Thorium 232		pCi/g			0					
4123	Thorium 234		pCi/g			0					
4278	Tin 113		pCi/g			0					
4131	Uranium 235		pCi/g			0					
4133	Uranium 238		pCi/g			0					
4141	Zinc 65		pCi/g			0					
4143	Zirconium 95		pCi/g			0					

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TAL Reference Data Summary

Structured Analysis Code: A-K1-Z7-01-06

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: As Received, Fill Geometry
Method: Gamma Cs-137 & Hits by EPA 901.1 MOD
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6506			Spike List 0		
Syn	Compound	RL	Units	MDL	Run Date	T	A	Amt	Units	LCL UCL RPD
3995	Actinium 227		pCi/g		0					
3997	Actinium 228		pCi/g		0					
3984	Americium 241		pCi/g		0	C	Y		90	115 40
4280	Antimony 124		pCi/g		0					
4103	Antimony 125		pCi/g		0					
5556	Barium-137		pCi/g		0					
4211	Barium/Lanthanum-140		pCi/g		0					
4168	Barium 133		pCi/g		0					
3999	Barium 140		pCi/g		0					
4001	Beryllium 7		pCi/g		0					
4798	Bismuth 211 eq Th-227		pCi/g		0					
5068	Bismuth-210M		pCi/g		0					
4800	Bismuth 212		pCi/g		0					
4005	Bismuth 214		pCi/g		0					
4802	Cadmium 109		pCi/g		0					
5557	Calcium-45		pCi/g		0					
4009	Cerium 141		pCi/g		0					
4804	Cerium 139		pCi/g		0					
4011	Cerium 144		pCi/g		0					
4031	Cesium 134		pCi/g		0					
4033	Cesium 137	0.2	pCi/g		0	C	Y	90	123 40	
4029	Chromium 51		pCi/g		0					
5399	Cobalt 56		pCi/g		0					
4023	Cobalt 57		pCi/g		0					
4025	Cobalt 58		pCi/g		0					
4027	Cobalt 60		pCi/g		0	C	Y	90	114 40	
4035	Europium 152		pCi/g		0					
4037	Europium 154		pCi/g		0					
4039	Europium 155		pCi/g		0					
5415	Gadolinium 153		pCi/g		0					
4213	Hafnium 181		pCi/g		0					
4049	Iodine 131		pCi/g		0					
5416	Iridium 192		pCi/g		0					
4043	Iron 59		pCi/g		0					
5438	Kr-85		pCi/g		0					
4156	Lead 210		pCi/g		0					
4077	Lead 212		pCi/g		0					

Structured Analysis Code: A-K1-Z7-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: As Received, Fill Geometry

Method: Gamma Cs-137 & Hits by EPA 901.1 MOD

QC Program: STANDARD TEST SET

Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6506				Spike List 0						
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	LCL	UCL	RPD	LCL	UCL	RPD
4079	Lead 214		pCi/g			0									
5558	Manganese-56		pCi/g			0									
4055	Manganese 54		pCi/g			0									
4806	Mercury 203		pCi/g			0									
4069	Neptunium 237		pCi/g			0									
4172	Neptunium 239		pCi/g			0									
5877	Niobium 83		pCi/g			0									
4061	Niobium 94		pCi/g			0									
4063	Niobium 95		pCi/g			0									
4051	Potassium 40		pCi/g			0									
4081	Promethium 144		pCi/g			0									
4083	Promethium 146		pCi/g			0									
4085	Promethium 147		pCi/g			0									
5225	Protactinium 234M		pCi/g			0									
4071	Protactinium 231		pCi/g			0									
4073	Protactinium 234		pCi/g			0									
2257	Radium (226)		pCi/g			0									
2259	Radium 228		pCi/g			0									
5094	Radium-225		pCi/g			0									
4810	Radium 223 (assumes equilibrium w/		pCi/g			0									
4095	Radium 224		pCi/g			0									
5220	Rhodium 106		pCi/g			0									
4099	Ruthenium 103		pCi/g			0									
4101	Ruthenium 106		pCi/g			0									
5044	Scandium 46		pCi/g			0									
5404	Silver 108m		pCi/g			0									
4779	Silver 110m		pCi/g			0									
4057	Sodium 22		pCi/g			0									
4059	Sodium 24		pCi/g			0									
4107	Strontium 85		pCi/g			0									
5553	Tantalum 182		pCi/g			0									
5554	Terbium 160		pCi/g			0									
4125	Thallium 208		pCi/g			0									
4816	Thorium 227		pCi/g			0									
4115	Thorium 228		pCi/g			0									
4117	Thorium 230		pCi/g			0									
4119	Thorium 231		pCi/g			0									
4121	Thorium 232		pCi/g			0									
4123	Thorium 234		pCi/g			0									

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Structured Analysis Code: A-K1-Z7-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: As Received, Fill Geometry
 Method: Gamma Cs-137 & Hits by EPA 901.1 MOD
 QC Program: STANDARD TEST SET
 Location: TestAmerica St. Louis

Analyte List		RL	Detection Limits		Run Date	Check List 6506			Spike List 0			
Syn	Compound		Units	MDL		Units	T	A	Amt	Units	LCL	UCL
4278	Tin 113		pCi/g		0							
4131	Uranium 235		pCi/g		0							
4133	Uranium 238		pCi/g		0							
5559	Vanadium-48		pCi/g		0							
4137	Yttrium 88		pCi/g		0							
4141	Zinc 65		pCi/g		0							
4143	Zirconium 95		pCi/g		0							

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Structured Analysis Code: A-GM-0B-01-06

Target Analyte List: All Analytes

Matrix: SOLID
 Extraction: Dry, Grind, Fill Geometry - 10-DAY Ingrowth
 Method: Gamma Ra-226 & HIs By DOE GA-010R MOD
 QC Program: STANDARD TEST SET
 Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6547			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	Run Date	T A	T A	Units	LCL UCL RPD
2257	Radium (226)	1.0	pCi/g			0	C Y	12.2	pCi/g	80 110 40
2259	Radium 228		pCi/g			0				
4095	Radium 224		pCi/g			0				
4101	Ruthenium 106		pCi/g			0				
4057	Sodium 22		pCi/g			0				
4059	Sodium 24		pCi/g			0				
4125	Thallium 208		pCi/g			0				
4121	Thorium 232		pCi/g			0	C Y	9.5	pCi/g	90 127 40
4123	Thorium 234		pCi/g			0				
4278	Tin 113		pCi/g			0				
4131	Uranium 235		pCi/g			0				
4133	Uranium 238		pCi/g			0	C N	11.9	pCi/g	75 135 40
4137	Yttrium 88		pCi/g			0				
4141	Zinc 65		pCi/g			0				
4143	Zirconium 95		pCi/g			0				

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TAL Reference Data Summary

Structured Analysis Code: A-J9-0B-01-06

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: Dry, Grind, and Fill Geometry -> 21 day in-growth
Method: Gamma Ra-226 & HIs By DOE GA-010R MOD
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6547			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
3995	Actinium 227		pCi/g		0					
3997	Actinium 228		pCi/g		0					
3984	Americium 241		pCi/g		0					
4280	Antimony 124		pCi/g		0					
4103	Antimony 125		pCi/g		0					
4211	Barium/Lanthanum-140		pCi/g		0					
4168	Barium 133		pCi/g		0					
3999	Barium 140		pCi/g		0					
4001	Beryllium 7		pCi/g		0					
5053	Bismuth 207		pCi/g		0					
5068	Bismuth-210M		pCi/g		0					
4800	Bismuth 212		pCi/g		0					
4005	Bismuth 214		pCi/g		0					
4009	Cerium 141		pCi/g		0					
4011	Cerium 144		pCi/g		0					
4031	Cesium 134		pCi/g		0					
4033	Cesium 137		pCi/g		0					
4023	Cobalt 57		pCi/g		0					
4025	Cobalt 58		pCi/g		0					
4027	Cobalt 60		pCi/g		0					
4035	Europium 152		pCi/g		0					
4037	Europium 154		pCi/g		0					
4039	Europium 155		pCi/g		0					
4213	Hafnium 181		pCi/g		0					
4049	Iodine 131		pCi/g		0					
4043	Iron 59		pCi/g		0					
4156	Lead 210		pCi/g		0	C	N	9.3	pCi/g	75 135 40
4077	Lead 212		pCi/g		0					
4079	Lead 214		pCi/g		0					
4055	Manganese 54		pCi/g		0					
4069	Neptunium 237		pCi/g		0					
4172	Neptunium 239		pCi/g		0					
4051	Potassium 40		pCi/g		0					
4081	Promethium 144		pCi/g		0					
4083	Promethium 146		pCi/g		0					
4085	Promethium 147		pCi/g		0					
5225	Protactinium 234M		pCi/g		0					

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Structured Analysis Code: A-J9-0B-01-06

Target Analyte List: All Analytes

Matrix: SOLID
 Extraction: Dry, Grind, and Fill Geometry -> 21 day in-growth
 Method: Gamma Ra-226 & Hits By DOE GA-010R MOD
 QC Program: STANDARD TEST SET
 Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6547			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units
4071	Protactinium 231		pCi/g			0				
4073	Protactinium 234		pCi/g			0				
2257	Radium (226)	1.0	pCi/g			0	C	Y	12.2	pCi/g
2259	Radium 228		pCi/g			0			80	110
4810	Radium 223 (assumes equilibrium w/		pCi/g			0			40	
4095	Radium 224		pCi/g			0				
4101	Ruthenium 106		pCi/g			0				
4057	Sodium 22		pCi/g			0				
4059	Sodium 24		pCi/g			0				
4125	Thallium 208		pCi/g			0				
4119	Thorium 231		pCi/g			0				
4121	Thorium 232		pCi/g			0				
4123	Thorium 234		pCi/g			0				
4278	Tin 113		pCi/g			0				
4131	Uranium 235		pCi/g			0				
4133	Uranium 238		pCi/g			0	C	N	11.9	pCi/g
4137	Yttrium 88		pCi/g			0			75	135
4141	Zinc 65		pCi/g			0			40	
4143	Zirconium 95		pCi/g			0				

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TAL Reference Data Summary

Structured Analysis Code: A-ML-0B-01-06

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: As Received, Fill Geometry 21 day in-growth
Method: Gamma Ra-226 & Hits By DOE GA-010R MOD
QC Program: STANDARD TEST SET
Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6547			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
3995	Actinium 227		pCi/g		0					
3997	Actinium 228		pCi/g		0					
3984	Americium 241		pCi/g		0					
4280	Antimony 124		pCi/g		0					
4103	Antimony 125		pCi/g		0					
4211	Barium/Lanthanum-140		pCi/g		0					
4168	Barium 133		pCi/g		0					
3999	Barium 140		pCi/g		0					
4001	Beryllium 7		pCi/g		0					
5053	Bismuth 207		pCi/g		0					
5068	Bismuth-210M		pCi/g		0					
4800	Bismuth 212		pCi/g		0					
4005	Bismuth 214		pCi/g		0					
4009	Cerium 141		pCi/g		0					
4011	Cerium 144		pCi/g		0					
4031	Cesium 134		pCi/g		0					
4033	Cesium 137		pCi/g		0					
4023	Cobalt 57		pCi/g		0					
4025	Cobalt 58		pCi/g		0					
4027	Cobalt 60		pCi/g		0					
4035	Europium 152		pCi/g		0					
4037	Europium 154		pCi/g		0					
4039	Europium 155		pCi/g		0					
4213	Hafnium 181		pCi/g		0					
4049	Iodine 131		pCi/g		0					
4043	Iron 59		pCi/g		0					
4156	Lead 210		pCi/g		0					
4077	Lead 212		pCi/g		0					
4079	Lead 214		pCi/g		0					
4055	Manganese 54		pCi/g		0					
4069	Neptunium 237		pCi/g		0					
4172	Neptunium 239		pCi/g		0					
4051	Potassium 40		pCi/g		0					
4081	Promethium 144		pCi/g		0					
4083	Promethium 146		pCi/g		0					
4085	Promethium 147		pCi/g		0					
5225	Protactinium 234M		pCi/g		0					
					C	N	9.3	pCi/g	75	135 40

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Structured Analysis Code: A-ML-0B-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: As Received, Fill Geometry 21 day in-growth
 Method: Gamma Ra-226 & Hits By DOE GA-010R MOD
 QC Program: STANDARD TEST SET
 Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6547			Spike List 0		
Syn	Compound	RL	Units	MDL	Run Date	T	A	Amt	Units	LCL UCL RPD
4071	Protactinium 231		pCi/g		0					
2257	Radium (226)	1.0	pCi/g		0	C	Y	12.2	pCi/g	80 110 40
5571	Radium 226	1.0	pCi/g		0					
2259	Radium 228		pCi/g		0					
4810	Radium 223 (assumes equilibrium w/		pCi/g		0					
4095	Radium 224		pCi/g		0					
4101	Ruthenium 106		pCi/g		0					
4057	Sodium 22		pCi/g		0					
4059	Sodium 24		pCi/g		0					
4125	Thallium 208		pCi/g		0					
4115	Thorium 228		pCi/g		0					
4121	Thorium 232		pCi/g		0	C	Y	9.5	pCi/g	90 127 40
4123	Thorium 234		pCi/g		0					
4278	Tin 113		pCi/g		0					
4131	Uranium 235		pCi/g		0					
4133	Uranium 238		pCi/g		0	C	N	11.9	pCi/g	75 135 40
4137	Yttrium 88		pCi/g		0					
4141	Zinc 65		pCi/g		0					
4143	Zirconium 95		pCi/g		0					

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TAL Reference Data Summary

Structured Analysis Code: A-MW-0B-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: As Received, Fill Geometry 10 day in-growth

Method: Gamma Ra-226 & Hits By DOE GA-010R MOD

QC Program: STANDARD TEST SET

Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6547			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
3995	Actinium 227		pCi/g		0					
3997	Actinium 228		pCi/g		0					
3984	Americium 241		pCi/g		0					
4280	Antimony 124		pCi/g		0					
4103	Antimony 125		pCi/g		0					
4211	Barium/Lanthanum-140		pCi/g		0					
4168	Barium 133		pCi/g		0					
3999	Barium 140		pCi/g		0					
4001	Beryllium 7		pCi/g		0					
5053	Bismuth 207		pCi/g		0					
5068	Bismuth-210M		pCi/g		0					
4800	Bismuth 212		pCi/g		0					
4005	Bismuth 214		pCi/g		0					
4009	Cerium 141		pCi/g		0					
4011	Cerium 144		pCi/g		0					
4031	Cesium 134		pCi/g		0					
4033	Cesium 137		pCi/g		0					
4023	Cobalt 57		pCi/g		0					
4025	Cobalt 58		pCi/g		0					
4027	Cobalt 60		pCi/g		0					
4035	Europium 152		pCi/g		0					
4037	Europium 154		pCi/g		0					
4039	Europium 155		pCi/g		0					
4213	Hafnium 181		pCi/g		0					
4049	Iodine 131		pCi/g		0					
4043	Iron 59		pCi/g		0					
4156	Lead 210		pCi/g		0	C	N	9.3	pCi/g	75 135 40
4077	Lead 212		pCi/g		0					
4079	Lead 214		pCi/g		0					
4055	Manganese 54		pCi/g		0					
4069	Neptunium 237		pCi/g		0					
4172	Neptunium 239		pCi/g		0					
4051	Potassium 40		pCi/g		0					
4081	Promethium 144		pCi/g		0					
4083	Promethium 146		pCi/g		0					
4085	Promethium 147		pCi/g		0					
4071	Protactinium 231		pCi/g		0					

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Structured Analysis Code: A-MW-0B-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: As Received, Fill Geometry 10 day in-growth
Method: Gamma Ra-226 & Hlts By DOE GA-010R MOD

QC Program: STANDARD TEST SET

Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6547			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	Run Date	T A	T A	RPD	Units
2257	Radium (226)	1.0	pCi/g			0	C Y	12.2	80	110 40
2259	Radium 228		pCi/g			0				
4095	Radium 224		pCi/g			0				
4101	Ruthenium 106		pCi/g			0				
4057	Sodium 22		pCi/g			0				
4059	Sodium 24		pCi/g			0				
4125	Thallium 208		pCi/g			0				
4121	Thorium 232		pCi/g			0	C Y	9.5	90	127 40
4123	Thorium 234		pCi/g			0				
4278	Tin 113		pCi/g			0				
4131	Uranium 235		pCi/g			0				
4133	Uranium 238		pCi/g			0	C N	11.9	75	135 40
4137	Yttrium 88		pCi/g			0				
4141	Zinc 65		pCi/g			0				
4143	Zirconium 95		pCi/g			0				

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Page number 1

Structured Analysis Code: A-NA-0B-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: As Received, 14 day ingrowth

Method: Gamma Ra-226 & Hits By DOE GA-010R MOD

QC Program: STANDARD TEST SET

Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6547			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	Run Date	T A	Amt	Units	LCL UCL RPD
5225	Protactinium 234M		pCi/g			0				
4071	Protactinium 231		pCi/g			0				
2257	Radium (226)	1.0	pCi/g			0	C Y	12.2	pCi/g	80 110 40
2259	Radium 228		pCi/g			0				
4810	Radium 223 (assumes equilibrium w/		pCi/g			0				
4095	Radium 224		pCi/g			0				
4101	Ruthenium 106		pCi/g			0				
4057	Sodium 22		pCi/g			0				
4059	Sodium 24		pCi/g			0				
4125	Thallium 208		pCi/g			0				
4121	Thorium 232		pCi/g			0	C Y	9.5	pCi/g	90 127 40
4123	Thorium 234		pCi/g			0				
4278	Tin 113		pCi/g			0				
4131	Uranium 235		pCi/g			0				
4133	Uranium 238		pCi/g			0	C N	11.9	pCi/g	75 135 40
4137	Yttrium 88		pCi/g			0				
4141	Zinc 65		pCi/g			0				
4143	Zirconium 95		pCi/g			0				

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Structured Analysis Code: A-6O-0B-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: Dry, Grind and Fill - 14 day in-growth

Method: Gamma Ra-226 & Hits By DOE GA-010R MOD

QC Program: STANDARD TEST SET

Location: TestAmerica St. Louis

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Structured Analysis Code: A-60-0B-01-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: Dry, Grind and Fill - 14 day in-growth

Method: Gamma Ra-226 & Hits By DOE GA-010R MOD

QC Program: STANDARD TEST SET

Location: TestAmerica St. Louis

Analyte List		Detection Limits				Check List 6547				Spike List 0			
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD
5225	Protactinium 234M		pCi/g			0							
4071	Protactinium 231		pCi/g			0							
2257	Radium (226)	1.0	pCi/g			0	C	Y	12.2	pCi/g	80	110	40
2259	Radium 228		pCi/g			0							
4810	Radium 223 (assumes equilibrium w/		pCi/g			0							
4095	Radium 224		pCi/g			0							
4101	Ruthenium 106		pCi/g			0							
4057	Sodium 22		pCi/g			0							
4059	Sodium 24		pCi/g			0							
4125	Thallium 208		pCi/g			0							
4121	Thorium 232		pCi/g			0	C	Y	9.5	pCi/g	90	127	40
4123	Thorium 234		pCi/g			0							
4278	Tin 113		pCi/g			0							
4131	Uranium 235		pCi/g			0							
4133	Uranium 238		pCi/g			0	C	N	11.9	pCi/g	75	135	40
4137	Yttrium 88		pCi/g			0							
4141	Zinc 65		pCi/g			0							
4143	Zirconium 95		pCi/g			0							

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TAL Reference Data Summary

Structured Analysis Code: I-G7-4F-DO-06

Target Analyte List: All Analytes

Matrix: WATER
Extraction: Direct Addition of Sample to Geometry
Method: Gamma Iodine by GA-01-R MOD
QC Program: DOE QSAS
Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6894			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
5409	Iodine 125	10	pCi/L		0					
4047	Iodine 129	10	pCi/L		0	C	Y			75 125 25
4049	Iodine 131	10	pCi/L		0					

TAL Reference Data Summary

Structured Analysis Code: A-K5-4F-DO-06

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: As Received, Direct Addition of Sample
Method: Gamma Iodine by GA-01-R MOD
QC Program: DOE QSAS
Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6894			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	T	A	Units	T	A
5409	Iodine 125	30	pCi/g							
4047	Iodine 129	30	pCi/g			C	Y	75	125	25
4049	Iodine 131	30	pCi/g							

TAL Reference Data Summary

Structured Analysis Code: I-G7-0A-DO-06

Target Analyte List: All Analytes

Matrix: WATER
Extraction: Direct Addition of Sample to Geometry
Method: Gamma Cs-137 & Hits by DOE GA-01-R MOD
QC Program: DOE QSAS
Location: TestAmerica St. Louis

Analyte List		RL	Detection Limits		Units	Run Date	Check List 6858				Spike List 6859			
Syn	Compound		Units	MDL			T	A	Amt	Units	T	A	Amt	Units
3995	Actinium 227		pCi/L		0									
3997	Actinium 228		pCi/L		0									
3984	Americium 241		pCi/L		0	C Y								
4280	Antimony 124		pCi/L		0									
4103	Antimony 125		pCi/L		0									
4211	Barium/Lanthanum-140		pCi/L		0									
3999	Barium 140		pCi/L		0									
4001	Beryllium 7		pCi/L		0									
4798	Bismuth 211 eq Th-227		pCi/L		0									
5053	Bismuth 207		pCi/L		0									
5068	Bismuth-210M		pCi/L		0									
4800	Bismuth 212		pCi/L		0									
4005	Bismuth 214		pCi/L		0									
4009	Cerium 141		pCi/L		0									
4804	Cerium 139		pCi/L		0									
4011	Cerium 144		pCi/L		0									
4031	Cesium 134		pCi/L		0									
4033	Cesium 137	20	pCi/L		0	C Y								
4029	Chromium 51		pCi/L		0									
5399	Cobalt 56		pCi/L		0									
4023	Cobalt 57		pCi/L		0									
4025	Cobalt 58		pCi/L		0									
4027	Cobalt 60		pCi/L		0	C Y								
4035	Europium 152		pCi/L		0									
4037	Europium 154		pCi/L		0									
4039	Europium 155		pCi/L		0									
5415	Gadolinium 153		pCi/L		0									
4213	Hafnium 181		pCi/L		0									
4049	Iodine 131		pCi/L		0									
5416	Iridium 192		pCi/L		0									
4043	Iron 59		pCi/L		0									
4156	Lead 210		pCi/L		0									
4077	Lead 212		pCi/L		0									
4079	Lead 214		pCi/L		0									
4055	Manganese 54		pCi/L		0									
4061	Niobium 94		pCi/L		0									
4063	Niobium 95		pCi/L		0									

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Structured Analysis Code: I-G7-0A-DO-06

Target Analyte List: All Analytes

Matrix: WATER

Extraction: Direct Addition of Sample to Geometry
Method: Gamma Cs-137 & Hits by DOE GA-01-R MOD
QC Program: DOE QSAS
Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6858			Spike List 6859		
		Units	MDL	Units	T	A	Amt	Units	LCL	UCL
Syn	Compound	RL			Run Date					
4051	Potassium 40		pCi/L		0					
4081	Promethium 144		pCi/L		0					
4083	Promethium 146		pCi/L		0					
5225	Protactinium 234M		pCi/L		0					
5220	Rhodium 106		pCi/L		0					
4099	Ruthenium 103		pCi/L		0					
4101	Ruthenium 106		pCi/L		0					
5044	Scandium 46		pCi/L		0					
5404	Silver 108m		pCi/L		0					
4779	Silver 110m		pCi/L		0					
4057	Sodium 22		pCi/L		0					
5553	Tantalum 182		pCi/L		0					
5554	Terbium 160		pCi/L		0					
4125	Thallium 208		pCi/L		0					
4816	Thorium 227		pCi/L		0					
4119	Thorium 231		pCi/L		0					
4123	Thorium 234		pCi/L		0					
4278	Tin 113		pCi/L		0					
4131	Uranium 235		pCi/L		0					
4133	Uranium 238		pCi/L		0					
4137	Yttrium 88		pCi/L		0					
4141	Zinc 65		pCi/L		0					
4143	Zirconium 95		pCi/L		0					

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TAL Reference Data Summary

Structured Analysis Code: A-G6-0A-DO-06

Target Analyte List: All Analytes

Matrix: SOLID
Extraction: Dry, Grind, and Fill Geometry
Method: Gamma Cs-137 & Hits by DOE GA-01-R MOD
QC Program: DOE QSAS
Location: TestAmerica St. Louis

Analyte List		RL	Detection Limits		Units	Run Date	Check List 6858				Spike List 6859			
Syn	Compound		Units	MDL			T	A	Amt	Units	LCL	UCL	RPD	Units
3995	Actinium 227		pCi/g		0									
3997	Actinium 228		pCi/g		0									
3984	Americium 241		pCi/g		0	C Y					75	125	25	60 140 25
4280	Antimony 124		pCi/g		0									
4103	Antimony 125		pCi/g		0									
4211	Barium/Lanthanum-140		pCi/g		0									
3999	Barium 140		pCi/g		0									
4001	Beryllium 7		pCi/g		0									
4798	Bismuth 211 eq Th-227		pCi/g		0									
5067	Bismuth-207		pCi/g		0									
5068	Bismuth-210M		pCi/g		0									
4800	Bismuth 212		pCi/g		0									
4005	Bismuth 214		pCi/g		0									
4009	Cerium 141		pCi/g		0									
4804	Cerium 139		pCi/g		0									
4011	Cerium 144		pCi/g		0									
4031	Cesium 134		pCi/g		0									
4033	Cesium 137	0.2	pCi/g		0	C Y					75	125	25	60 140 25
4029	Chromium 51		pCi/g		0									
5399	Cobalt 56		pCi/g		0									
4023	Cobalt 57		pCi/g		0									
4025	Cobalt 58		pCi/g		0									
4027	Cobalt 60		pCi/g		0	C Y					75	125	25	60 140 25
4035	Europium 152		pCi/g		0									
4037	Europium 154		pCi/g		0									
4039	Europium 155		pCi/g		0									
5415	Gadolinium 153		pCi/g		0									
4213	Hafnium 181		pCi/g		0									
4049	Iodine 131		pCi/g		0									
5416	Iridium 192		pCi/g		0									
4043	Iron 59		pCi/g		0									
4156	Lead 210		pCi/g		0									
4077	Lead 212		pCi/g		0									
4079	Lead 214		pCi/g		0									
4055	Manganese 54		pCi/g		0									
4061	Niobium 94		pCi/g		0									
4063	Niobium 95		pCi/g		0									

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Structured Analysis Code: A-G6-0A-DO-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: Dry, Grind, and Fill Geometry

Method: Gamma Cs-137 & Hits by DOE GA-01-R MOD

QC Program: DOE QSAS

Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6858			Spike List 6859		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
4051	Potassium 40		pCi/g							
4081	Promethium 144		pCi/g							
4083	Promethium 146		pCi/g							
5225	Protactinium 234M		pCi/g							
5220	Rhodium 106		pCi/g							
4099	Ruthenium 103		pCi/g							
4101	Ruthenium 106		pCi/g							
5044	Scandium 46		pCi/g							
5404	Silver 108m		pCi/g							
4779	Silver 110m		pCi/g							
4057	Sodium 22		pCi/g							
5553	Tantalum 182		pCi/g							
5554	Terbium 160		pCi/g							
4125	Thallium 208		pCi/g							
4816	Thorium 227		pCi/g							
4119	Thorium 231		pCi/g							
4123	Thorium 234		pCi/g							
4278	Tin 113		pCi/g							
4131	Uranium 235		pCi/g							
4133	Uranium 238		pCi/g							
4137	Yttrium 88		pCi/g							
4141	Zinc 65		pCi/g							
4143	Zirconium 95		pCi/g							

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TAL Reference Data Summary

Structured Analysis Code: I-G7-Z7-DO-06

Target Analyte List: All Analytes

Matrix: WATER

Extraction: Direct Addition of Sample to Geometry
Method: Gamma Cs-137 & Hits by EPA 901.1 MOD
QC Program: DOE QSAS
Location: TestAmerica St. Louis

Analyte List		RL	Detection Limits			Run Date	Check List 6858			Spike List 6859		
Syn	Compound		Units	MDL	Units		T	A	Amt	Units	LCL	UCL
3997	Actinium 228		pCi/L			0						
3984	Americium 241		pCi/L			0	C	Y			60	140
4280	Antimony 124		pCi/L			0					25	25
4103	Antimony 125		pCi/L			0						
4168	Barium 133		pCi/L			0						
4001	Beryllium 7		pCi/L			0						
4798	Bismuth 211 eq Th-227		pCi/L			0						
5053	Bismuth 207		pCi/L			0						
5068	Bismuth-210M		pCi/L			0						
4800	Bismuth 212		pCi/L			0						
4005	Bismuth 214		pCi/L			0						
4009	Cerium 141		pCi/L			0						
4011	Cerium 144		pCi/L			0						
4031	Cesium 134		pCi/L			0						
4033	Cesium 137	20	pCi/L			0	C	Y		60	140	25
5399	Cobalt 56		pCi/L			0						
4023	Cobalt 57		pCi/L			0						
4025	Cobalt 58		pCi/L			0						
4027	Cobalt 60		pCi/L			0	C	Y		60	140	25
4035	Europium 152		pCi/L			0						
4037	Europium 154		pCi/L			0						
4039	Europium 155		pCi/L			0						
4213	Hafnium 181		pCi/L			0						
4049	Iodine 131		pCi/L			0						
5416	Iridium 192		pCi/L			0						
4043	Iron 59		pCi/L			0						
4156	Lead 210		pCi/L			0						
4075	Lead 211		pCi/L			0						
4077	Lead 212		pCi/L			0						
4079	Lead 214		pCi/L			0						
4055	Manganese 54		pCi/L			0						
4061	Niobium 94		pCi/L			0						
4063	Niobium 95		pCi/L			0						
4051	Potassium 40		pCi/L			0						
4081	Promethium 144		pCi/L			0						
5225	Protactinium 234M		pCi/L			0						
4101	Ruthenium 106		pCi/L			0						

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Structured Analysis Code: I-G7-Z7-DO-06

Target Analyte List: All Analytes

Matrix: WATER

Extraction: Direct Addition of Sample to Geometry
 Method: Gamma Cs-137 & Hits by EPA 901.1 MOD
 QC Program: DOE QSAS
 Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6858			Spike List 6859		
Syn	Compound	RL	Units	MDL	Units	T	A	Units	LCL	UCL
5044	Scandium 46		pCi/L							
4057	Sodium 22		pCi/L							
4125	Thallium 208		pCi/L							
4816	Thorium 227		pCi/L							
4119	Thorium 231		pCi/L							
4123	Thorium 234		pCi/L							
4278	Tin 113		pCi/L							
4131	Uranium 235		pCi/L							
4133	Uranium 238		pCi/L							
4141	Zinc 65		pCi/L							
4143	Zirconium 95		pCi/L							

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TAL Reference Data Summary

Structured Analysis Code: A-G6-Z7-DO-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: Dry, Grind, and Fill Geometry

Method: Gamma Cs-137 & Hits by EPA 901.1 MOD

QC Program: DOE QSAS

Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6858			Spike List 6859		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
5869	Actinium 227 (assumes equilibrium w/		pCi/g							
3997	Actinium 228		pCi/g							
3984	Americium 241		pCi/g							
4280	Antimony 124		pCi/g			C	Y			60 140 25
4103	Antimony 125		pCi/g							
4001	Beryllium 7		pCi/g							
5676	Bismuth 210 eq Pb-210		pCi/g							
4798	Bismuth 211 eq Th-227		pCi/g							
5053	Bismuth 207		pCi/g							
5068	Bismuth-210M		pCi/g							
4800	Bismuth 212		pCi/g							
4005	Bismuth 214		pCi/g							
4009	Cerium 141		pCi/g							
4011	Cerium 144		pCi/g							
4031	Cesium 134		pCi/g							
4033	Cesium 137	0.2	pCi/g			C	Y			60 140 25
5399	Cobalt 56		pCi/g							
4023	Cobalt 57		pCi/g							
4025	Cobalt 58		pCi/g							
4027	Cobalt 60		pCi/g			C	Y			60 140 25
4035	Europium 152		pCi/g							
4037	Europium 154		pCi/g							
4039	Europium 155		pCi/g							
4213	Hafnium 181		pCi/g							
4049	Iodine 131		pCi/g							
4043	Iron 59		pCi/g							
4156	Lead 210		pCi/g							
4077	Lead 212		pCi/g							
4079	Lead 214		pCi/g							
4055	Manganese 54		pCi/g							
4061	Niobium 94		pCi/g							
4063	Niobium 95		pCi/g							
4051	Potassium 40		pCi/g							
4081	Promethium 144		pCi/g							
5225	Protactinium 234M		pCi/g							
4071	Protactinium 231		pCi/g							
4073	Protactinium 234		pCi/g							

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Structured Analysis Code: A-G6-Z7-DO-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: Dry, Grind, and Fill Geometry
 Method: Gamma Cs-137 & Hits by EPA 901.1 MOD
 QC Program: DOE QSAS
 Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6858			Spike List 6859		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
2257	Radium (226)		pCi/g							
2259	Radium 228		pCi/g							
4810	Radium 223 (assumes equilibrium w/		pCi/g							
4095	Radium 224		pCi/g							
5248	Rh-106		pCi/g							
4099	Ruthenium 103		pCi/g							
4101	Ruthenium 106		pCi/g							
5044	Scandium 46		pCi/g							
5404	Silver 108m		pCi/g							
4779	Silver 110m		pCi/g							
4057	Sodium 22		pCi/g							
5868	Thallium 207 eq Th-227		pCi/g							
4125	Thallium 208		pCi/g							
4816	Thorium 227		pCi/g							
4119	Thorium 231		pCi/g							
4121	Thorium 232		pCi/g							
4123	Thorium 234		pCi/g							
4278	Tin 113		pCi/g							
4131	Uranium 235		pCi/g							
4133	Uranium 238		pCi/g							
4141	Zinc 65		pCi/g							
4143	Zirconium 95		pCi/g							

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TAL Reference Data Summary

Structured Analysis Code: A-J9-0B-DO-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: Dry, Grind, and Fill Geometry -> 21 day in-growth

Method: Gamma Ra-226 & Hits By DOE GA-010R MOD

QC Program: DOE QSAS

Location: TestAmerica St. Louis

Analyte List			Detection Limits			Check List 6858					Spike List 6859									
Syn	Compound	RL	Units	MDL	Units	Run Date	T	A	Amt	Units	LCL	UCL	RPD	T	A	Amt	Units	LCL	UCL	RPD
3995	Actinium 227		pCi/g			0														
3997	Actinium 228		pCi/g			0														
3984	Americium 241		pCi/g			0	C	Y			75	125	25	C	Y			60	140	25
4280	Antimony 124		pCi/g			0														
4103	Antimony 125		pCi/g			0														
4211	Barium/Lanthanum-140		pCi/g			0														
4168	Barium 133		pCi/g			0														
3999	Barium 140		pCi/g			0														
4001	Beryllium 7		pCi/g			0														
5053	Bismuth 207		pCi/g			0														
5068	Bismuth-210M		pCi/g			0														
4800	Bismuth 212		pCi/g			0														
4005	Bismuth 214		pCi/g			0														
4009	Cerium 141		pCi/g			0														
4011	Cerium 144		pCi/g			0														
4031	Cesium 134		pCi/g			0														
4033	Cesium 137		pCi/g			0	C	Y			75	125	25	C	Y			60	140	25
4023	Cobalt 57		pCi/g			0														
4025	Cobalt 58		pCi/g			0														
4027	Cobalt 60		pCi/g			0	C	Y			75	125	25	C	Y			60	140	25
4035	Europium 152		pCi/g			0														
4037	Europium 154		pCi/g			0														
4039	Europium 155		pCi/g			0														
4213	Hafnium 181		pCi/g			0														
4049	Iodine 131		pCi/g			0														
4043	Iron 59		pCi/g			0														
4156	Lead 210		pCi/g			0														
4077	Lead 212		pCi/g			0														
4079	Lead 214		pCi/g			0														
4055	Manganese 54		pCi/g			0														
4069	Neptunium 237		pCi/g			0														
4172	Neptunium 239		pCi/g			0														
4051	Potassium 40		pCi/g			0														
4081	Promethium 144		pCi/g			0														
4083	Promethium 146		pCi/g			0														
4085	Promethium 147		pCi/g			0														
5225	Protactinium 234M		pCi/g			0														

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Structured Analysis Code: A-J9-0B-DO-06

Target Analyte List: All Analytes

Matrix: SOLID

Extraction: Dry, Grind, and Fill Geometry -> 21 day in-growth
Method: Gamma Ra-226 & Hits By DOE GA-010R MOD

QC Program: DOE QSAS

Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6858			Spike List 6859		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
4071	Protactinium 231		pCi/g							
2257	Radium (226)	1.0	pCi/g							
2259	Radium 228		pCi/g							
4810	Radium 223 (assumes equilibrium w/		pCi/g							
4095	Radium 224		pCi/g							
4101	Ruthenium 106		pCi/g							
4057	Sodium 22		pCi/g							
4059	Sodium 24		pCi/g							
4125	Thallium 208		pCi/g							
4121	Thorium 232		pCi/g							
4123	Thorium 234		pCi/g							
4278	Tin 113		pCi/g							
4131	Uranium 235		pCi/g							
4133	Uranium 238		pCi/g							
4137	Yttrium 88		pCi/g							
4141	Zinc 65		pCi/g							
4143	Zirconium 95		pCi/g							

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TAL Reference Data Summary

Structured Analysis Code: I-G7-4F-01-06

Target Analyte List: All Analytes

Matrix: WATER

Extraction: Direct Addition of Sample to Geometry

Method: Gamma Iodine by GA-01-R MOD

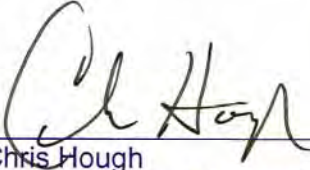
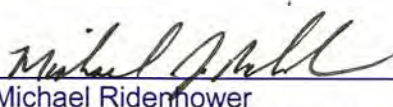
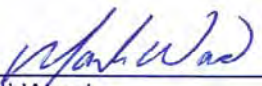
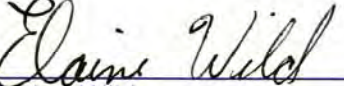
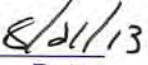
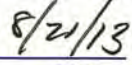
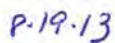
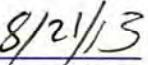
QC Program: STANDARD TEST SET

Location: TestAmerica St. Louis

Analyte List		Detection Limits			Check List 6581			Spike List 0		
Syn	Compound	RL	Units	MDL	Units	T	A	Amt	Units	LCL UCL RPD
5409	Iodine 125	10	pCi/L							
4047	Iodine 129	10	pCi/L			C	Y			
4049	Iodine 131	10	pCi/L							

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**Title: ALPHA SPECTROSCOPY ANALYSIS
[DOE HASL-300 A-01-R]**

Approvals (Signature/Date):	
 Chris Hough Radiochemistry Manager	 Michael Ridemower Health & Safety Manager / Coordinator
 Marti Ward Quality Assurance Manager	 Elaine Wild Laboratory Director
 Date	 Date
 Date	 Date

This SOP was previously identified as SOP No. ST-RD-0210 Rev. 10

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1.0 SCOPE AND APPLICATION

- 1.1 This procedure applies to alpha spectroscopy detectors and the computer assisted alpha spectroscopy analysis systems, using AlphaVision software.
- 1.2 This SOP is based on DOE method A-01-R
- 1.3 This SOP is applicable to both liquid and solid matrices.
- 1.4 The requested limits (RL), minimum detectable amount (MDA) and QC limits are maintained in the Laboratory Information Management System (LIMS).

2.0 SUMMARY OF METHOD

- 2.1 This SOP provides detailed instructions for energy calibration, efficiency determination, quality control checks, background and sample counting of the alpha spectroscopy system.

3.0 DEFINITIONS

- 3.1 See the TestAmerica St. Louis Quality Assurance Manual (ST-QAM) for glossary of common terms and data qualifiers.
- 3.2 Tracer – A known amount of ^{232}U , ^{242}Pu or ^{236}Pu , ^{243}Am , ^{209}Po , ^{244}Cm or ^{229}Th (depending on analyte(s) required) added to each sample to determine chemical yield. The tracer serves as an internal standard, which is used to calculate the activity of the target isotopes.
- 3.3 Region of Interest (ROI) – The keV range through which the target isotope peak signal responds.
- 3.4 keV - (kilo electron Volt) – electron volt is a unit of energy defined as the amount of energy gained (or lost) by the charge of a single [electron](#) moved across an [electric potential difference](#) of one [volt](#).
- 3.5 Tailing – Tailing is a delayed return of a peak to chromatographic baseline or continuation of response beyond its normal response window (RT window, ROI) due to high concentration of the analyte or matrix interference.
- 3.6 AlphaVision – The Alpha Spectrometer data collection and processing software.

4.0 INTERFERENCES

- 4.1 Alpha spectrometry has many potential interferences. These are usually in the form of radionuclides with unresolved alpha emissions. Poorly resolved alpha peaks are often due to high alpha activity rates or attenuation of the alpha emissions.
- 4.2 Isotope peak responses, when sufficiently high, may tail into other isotope ROI. Th-229 tailing into the Th-230 region of interest is a recognized example. This interference is minimized by maintaining low activities of the Th-229 tracer and monitoring of the separation of the ROI for Th-229 and Th-230. The use of manual integration may be required.
- 4.3 Some isotopic elements are not distinguishable and are reported as an isotopic pair, unless specifically directed by the client not to do so. These pairs may be reported separately depending

on the client's DQO and the use-ability of the data. When reported separately, the narrative must describe the technical aspects of how the isotopic pair was divided.

- 4.3.1 Recognized Isotopic Pairs:
 - 4.3.1.1 Plutonium-239/240
 - 4.3.1.2 Uranium-235/236
 - 4.3.1.3 Uranium-233/234
 - 4.3.1.4 Curium-245/246
 - 4.3.1.5 Curium-247/248

5.0 SAFETY

- 5.1 Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.
- 5.2 SPECIFIC SAFETY CONCERNS OR REQUIREMENTS
None.
- 5.3 PRIMARY MATERIALS USED
None.

6.0 EQUIPMENT AND SUPPLIES

- 6.1 Alpha spectroscopy system utilizing a computer based data acquisition system.
 - 6.1.1 Hardware – Octete Plus and Alpha Ensemble
 - 6.1.2 Software – AlphaVision and Radcapture

7.0 REAGENTS AND STANDARDS

- 7.1 All standards and reagent preparation, documentation and labeling must follow the requirements of SOP ST-QA-0002, current revision.
- 7.2 Commercially prepared alpha standards for the isotopes Th-230, Pu-239 and Am-243.

8.0 SAMPLE COLLECTION, PRESERVATION AND STORAGE

- 8.1 TestAmerica St. Louis supplies sample containers and chemical preservatives in accordance with the method. TestAmerica St. Louis does not perform sample collection. Samplers should reference the methods referenced and other applicable sample collection documents for detailed collection procedures. Sample volumes and preservative information is given in ST-PM-0002.

9.0 QUALITY CONTROL

- 9.1 See actinide preparation SOPs for additional information regarding QC types, frequency and preparation
- 9.2 **Batch**

- 9.2.1 A sample batch is a maximum of 20 environmental samples, which are prepared together using the same process and same lot(s) of reagents.
- 9.2.2 Instrument conditions must be the same for all standards, samples and QC samples.
- 9.2.3 For this analysis, batch QC consists of a Method Blank (MB), a Laboratory Control Sample (LCS), and Sample Duplicate (Dup). In the event that there is insufficient sample to analyze a sample duplicate, an LCS Duplicate (LCSD) is prepared and analyzed.
 - 9.2.3.1 Matrix Spike (MS) and Matrix Spike Duplicate (MSD) may be performed upon client request, and are noted in the Client Requirement Sheets and Log-in.
- 9.3 **Method Blank (MB)**
 - 9.3.1 A method blank is a blank matrix processed simultaneously with, and under the same conditions as, samples through all steps of the procedure.
 - 9.3.2 A method blank must be prepared with every sample batch.
- 9.4 **Laboratory Control Sample (LCS)**
 - 9.4.1 An LCS is a blank matrix spiked with a known amount of analyte(s), processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.
 - 9.4.2 An LCS must be prepared with every sample batch.
- 9.5 **Matrix Spike (MS)**
 - 9.5.1 A Matrix Spike is an aliquot of a field sample to which a known amount of target analyte(s) is added, and is processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.
- 9.6 **Sample Duplicate (Dup)**
 - 9.6.1 A Sample Duplicate is an additional aliquot of a field sample taken through the entire analytical process to demonstrate precision.
- 9.7 **Procedural Variations/ Nonconformance and Corrective Action**
 - 9.7.1 Any variation shall be completely documented using a Nonconformance Memo and approved by the Supervisor and QA, see SOP ST-QA-0036 for details regarding the NCM process.
 - 9.7.2 Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the Supervisor and QA, see SOP ST-QA-0036 for details regarding the NCM process.

10.0 INSTRUMENT SETUP, CALIBRATION, AND STANDARDIZATION

- 10.1 Initial instrument setup is performed when instrument is first installed, when a detector or chamber is changed/replaced, when a chamber is returned from the manufacturer after servicing, or other such circumstances. The following steps should be taken to ensure proper setup. Steps may be accomplished either through hardware knobs/potentiometers or through software settings (depending upon the system hardware/software). See the hardware and/or software manual to determine further detailed instructions:
 - 10.1.1 Set the conversion gain to 1024 channels.
 - 10.1.2 Adjust the coarse and fine gain as well as the offset to adjust the location of the three peaks of the alpha source such that the lower energy peak (Th-230 at 4688 keV) falls into channel 176, the mid-energy peak (Pu-239 at 5155 keV) falls into channel 239, and the higher energy peak (Am-241 at 5486 keV) falls into channel 283. Note that this results in 107 channels between the low energy and high energy peaks (about 7.46 keV/channel with offset of approximately 3375 keV). Ensure each peak is within 2 channels of the desired channel before beginning energy and efficiency calibrations.

- 10.1.2.1 Gain adjustment:
 - 10.1.2.1.1 Turning the knob counter-clockwise decreases the gain (decrease the value in the fine gain for software adjustment), causing the spectrum peaks to move closer to each other (smaller keV/channel slope) and toward the lower energy.
 - 10.1.2.1.2 Turning the knob clockwise increases the gain (increase the value in the fine gain for software adjustment), causing the spectrum peaks to spread apart (larger keV/channel slope) and toward higher energy.
- 10.1.2.2 Offset adjustment:
 - 10.1.2.2.1 Increasing the offset moves the peak/spectra toward the left (lower channel number) without altering the keV/channel (slope).
 - 10.1.2.2.2 Decreasing the offset moves the peak/spectra toward the right (higher channel number) without altering the keV/channel (slope).
- 10.1.3 Adjust the pulser setting such that the pulser peak is centered at about channel 222 (approximately 5 MeV).
- 10.2 Calibrations, see 10.6 for procedure.
 - 10.2.1 Energy calibrations shall be performed for the alpha spectroscopy systems yearly, or when a calibration quality control check indicates an unacceptable change in the energy calibration parameters.
 - 10.1.1.1 Energy Calibrations shall be performed using at least three isotopes within the energy range of 3-6 MeV. Typical isotopes used are Th-230, Pu-239, and Am-241. Final peak energy positions of all observed isotopes shall be within ± 5 channels (~ 40 keV) of expected channel/energy (see 10.1.2). The actual energy vs. channel and the equation with the slope is not calculated. Setting the peaks to within 5 channels of expected will ensure calculations utilizing fixed Regions of Interest (ROI) for each isotope will provide accurate results with minimal need for manual adjustment of ROI. Routine pulser checks and continuing calibration verifications (see below) will help control/monitor for drift.
 - 10.2.2 Efficiency calibrations shall be established for the alpha spectroscopy systems yearly, or when a calibration quality control check indicates an unacceptable change in the efficiency calibration parameters.
 - 10.2.2.1 Calibrated efficiency should fall between 20% and 32%. Values outside this range do not constitute a failure. However, if the calibrated efficiency does fall outside this range, an evaluation of the suitability of the detector for use should be performed and documented.
 - 10.2.3 Initial calibration verifications (ICV) shall be performed utilizing an independent second source following the initial calibration.
 - 10.2.3.1 The efficiency of the ICV must fall within 95%-105% of the initial calibration efficiency value.
 - 10.2.3.2 A second level review will be performed before detectors are placed into service and will be noted as acceptable in the electronic monthly maintenance log.
- 10.3 Continuing Calibration Verification (CCV)
 - 10.3.1 A continuing calibration verification shall be performed on a monthly basis.
 - 10.3.1.1 The Final peak energy positions for the isotopes should fall within ± 5 channels of the expected channel/energy.
 - 10.3.1.2 The efficiency should fall within 95%-105% of the calibrated efficiency.
 - 10.3.1.3 A second level review will be performed before detectors are placed into service and will be noted as acceptable in the electronic monthly maintenance log.
- 10.4 Background subtraction spectrum shall be established for the alpha spectroscopy systems monthly, or when the background quality control check indicates an unacceptable change in the daily background parameters.
- 10.5 Daily Checks (Pulsers)
 - 10.5.1 Routine pulser quality control verifications are performed each day of use.

- 10.5.1.1 The pulser energy, peak centroid, peak resolution, peak area quality control for a detector shall be checked each day that the alpha spectroscopy system is used. The limits for pulser centroid and pulser energy will be as below:
- 10.5.1.1.1 Gross counts must be within 5% of the average (20-point minimum) for each detector.
 - 10.5.1.1.2 The peak resolution (FWHM) must fall within 10-20 keV.
 - 10.5.1.1.3 The pulser centroid must fall within ± 5 channels of the average (20-point minimum) for each detector.
 - 10.5.1.1.4 The pulser energy must fall within ± 40 keV of the average (20-point minimum) for each detector.
- 10.5.2 Routine calibration, background and pulser quality control parameters using the “Boundry” out-of-range test will be found unacceptable if the value is outside parameter tolerance.
- 10.5.2.1 The routine quality control check should be rerun to determine the statistical significance of the out of control parameter.
 - 10.5.2.2 If the out of control parameter is found acceptable in the rerun, the investigation will be noted in the instrument maintenance log.
 - 10.5.2.3 Check the integrity of the radioactive standard.
 - 10.5.2.4 Check source positioning and all instrument settings.
 - 10.5.2.5 Check all cables for any apparent damage and to confirm that all cables are routed to proper connectors and are in good working order.
- 10.5.3 If the instrument fails to meet the acceptance criteria, and the corrective actions above do not resolve the problem, the instrument must be “tagged” out of service (OOS) for the day see [Attachment 1](#) for OOS tag example.
- 10.5.3.1 This is noted on the Alpha Spec Daily report by marking the report (The report will display FAIL for criteria not met). The detector will be marked out of service with the date and initials of the analyst performing the daily check.
 - 10.5.3.2 If a detector fails three consecutive days for the same criteria, the detector will be taken out of service until the problem is resolved. This is done by clicking on the detector in Alphavision. Right click on the the detector, select detector properties, check the “out of service” box and fill in the description field briefly explaining the problem. Mark the detector with an OOS tag as a visual indicator of its status.
 - 10.5.3.3 The instrument may be returned to service once the malfunction has been corrected and the above acceptance criteria have been met. Note any repairs in the maintenance log.
- 10.6 Calibration process in the Software
- 10.6.1 Alpha Detector System Energy and Efficiency Calibration**
- 10.6.1.1 Print out the standards sheet for calibration
 - 10.6.1.1.1 Location: [\\slsvr01\rad\alpha\Calibration_Sources](#) .
 - 10.6.1.2 Load sources into the detector
 - 10.6.1.3 In the AlphaVision software, click on the Calibration icon.
 - 10.6.1.4 Click on the detector to be calibrated.
 - 10.6.1.5 Select Process and then select calibration from the dropdown menu.
 - 10.6.1.5.1 The Calibration Explorer Window will appear.
 - 10.6.1.6 In the General Window: Scan the source name;AV(detector)#-#_date (with year month day format YYYYMMDD).
 - 10.6.1.7 Choose the correct source template.
 - 10.6.1.8 Click next
 - 10.6.1.9 In the Acquisition window, confirm count time of 140 minutes
 - 10.6.1.10 Click next
 - 10.6.1.11 In the Energy/Efficiency Calibration Window, confirm the correct source is used, and select which shelf the source is on. (This will be shelf 1) Make sure the

'Active' box is checked so the calibratoin is put in use immediately after calibration is processed.

- 10.6.1.12 Click next
- 10.6.1.13 In the Report Window, select print on completion
- 10.6.1.14 Click finish
- 10.6.1.15 When count is complete, the Manual Energy and Efficiency Calibration Window will appear. In this window, select Calibration ROI, Click Calibrate, click Save.
- 10.6.1.16 Verify the efficiency is above 20% and below 32%
- 10.6.1.17 Repeat for each detector
- 10.6.1.18 Record the calibration in the Alpha Maintenance Log.

10.6.2 ICV Procedure

- 10.6.2.1 Print out the standards sheet for ICV
 - 10.6.2.1.1 Location: [\\slsvr01\rad\alpha\Calibration Sources](#)
- 10.6.2.2 Place the correct source into the detector.
- 10.6.2.3 In The AlphaVision software, click on the Calibration Icon
- 10.6.2.4 Click on the detector to be calibrated
- 10.6.2.5 Select Process and then select calibration from the dropdown menu
 - 10.6.2.5.2 The Calibration Explorer Window will appear.
- 10.6.2.6 In the General Window; Scan the source name;AV(detector)#-#_date (with year month day format YYYYMMDD).
- 10.6.2.7 Chose the correct source template
- 10.6.2.8 Click next
- 10.6.2.9 In the Energy/Efficiency Calibration Window, confirm the correct source is used, and select which shelf the source is on. (This will be shelf 1)
- 10.6.2.10 Click next
- 10.6.2.11 In the Report Window, select print on completion
- 10.6.2.12 Click finish
- 10.6.2.13 When the count is complete, the Manual Energy and Efficiency Calibration Window will appear. In this window, select Calibration ROI, click Calibrate and click Save.
- 10.6.2.14 Verify the efficiency is above 20% and below 32%
- 10.6.2.15 Repeat for each detector
- 10.6.2.16 Record the ICV in the Alpha Maintenance Log.
- 10.6.2.17 Open the AlphaVision Access database program on computer slrad18
- 10.6.2.18 Select QC main from the form tab
- 10.6.2.19 Enter date range
- 10.6.2.20 Select system 1 for AlphaVision or system 2 for AlphaVision 1
- 10.6.2.21 Select Get Cal Data.
- 10.6.2.22 Exit
- 10.6.2.23 Select Check Ver to run the report and verify the ICV passes criteria.
- 10.6.2.24 For the Initial Calibratin (IC), the detectors must have the box checked in the Cal Data window for that specific calibration and the previous year's IC must be unchecked and the 'do not use' box must be checked to ensure the correct calibration is being used.

10.6.3 CCV Procedure

- 10.6.3.1 Print out standards sheet for CCV on the network
 - 10.6.3.1.1 Location: [\\slsvr01\rad\alpha\Calibration Sources](#)
- 10.6.3.2 Load sources into the detectors
- 10.6.3.3 In the AlphaVision software, click on the Calibration Icon.
- 10.6.3.4 Click on the detector to be calibrated
- 10.6.3.5 Select process and then select calibration from the dropdown menu
 - 10.6.3.5.1 The Calibration Explorer Window will appear.

- 10.6.3.6 In the General Window: "Scan the source name;AV(detector)#-#_date (with year month day format YYYYMMDD)."
- 10.6.3.7 Select correct source template
- 10.6.3.8 Click Next
- 10.6.3.9 In the Acquisition window, confirm count time of 60 mins
- 10.6.3.10 Click Next
- 10.6.3.11 In the Energy/Efficiency Calibration Window, confirm the correct source is used and select which shelf the source is on. (This will be shelf 1)
- 10.6.3.12 Click next
- 10.6.3.13 In the Report Window, select print on completion
- 10.6.3.14 Click finish
- 10.6.3.15 When the count is complete, the Manual Energy and Efficiency Calibration window will appear. In this window, select Calibration ROI, select Calibrate and Save.
- 10.6.3.16 Verify the efficiency is above 20% and below 32%.
- 10.6.3.17 Repeat for each detector
- 10.6.3.18 Record the CCV in the Alpha Maintenance Log. Efficiency must be greater than 20% and less than 32%.
- 10.6.3.19 Open the AlphaVision Access database program on computer slrad18.
- 10.6.3.20 Select QC main from the form tab.
- 10.6.3.21 Enter date range.
- 10.6.3.22 Select system 1 for AlphaVision or system 2 for AlphaVision 1.
- 10.6.3.23 Select Get Cal Data.
- 10.6.3.24 Exit.
- 10.6.3.25 Select Check Ver to run the report and verify the CCV passes criteria.

10.6.4 Detector Background Process (See Section 10.4)

- 10.6.4.1 Select the Batch Icon
- 10.6.4.2 Select backgrounds from the Tool Bar
- 10.6.4.3 Select Process.
 - 10.6.4.3.1 This will open the General Window in Batch Wizard
- 10.6.4.4 Name the background with month_year format MonthYYMMM_YY (e.g. JAN_04)
- 10.6.4.5 Select correct template (provided by analyst)
- 10.6.4.6 Click next.
- 10.6.4.7 In the Sample Window, add all detector names with the format: ICB;AV(detector)#.
- 10.6.4.8 Click next
- 10.6.4.9 In the Acquisition Window, confirm count time is set at 960 minutes (or as long as the longest sample count time)
- 10.6.4.10 Click next
- 10.6.4.11 In the Analysis Set Up Page, select Background Library and Background ROI, check the Use ROI box.
- 10.6.4.12 Click next
- 10.6.4.13 In the Report Window, select print on completion
- 10.6.4.14 Click finish
- 10.6.4.15 The Detector Assignment worksheet will appear, assign detectors, and select start now.
- 10.6.4.16 Record the backgrounds in the instrument maintenance log.
- 10.6.4.17 The background spectrum will be processed by the software
- 10.6.4.18 The detectors shall be "categorized" after each monthly background. The detectors will be labelled as follows:

Counts in Region of Interest (i.e. Th230, Th232, U234, U238, Pu238, Pu239):

- 0-2 counts – Blue – Ultra Low Level
- 0-4 counts – Yellow – Intermediate Low Level
- 0-20 counts – Green – Low Level
- 0-40 counts –Red – Always designated for Routine analysis when the RL=1 or the activity is from a known radioactive site.

See [Attachment 1](#) Detector Color Key

- 10.6.4.19 Detectors with backgrounds above the counts listed above are taken out of service for cleaning.
- 10.6.4.20 Detectors may also be removed from service when there is a visible peak present or at analyst judgment.
- 10.6.4.21 Backgrounds will be 2nd reviewed before placing into service and a notation of acceptable will be listed in the electronic monthly maintenance log.
- 10.7 Detector Cleaning (This should be done before starting Backgrounds)
 - 10.7.1 Clean detector surface with ethanol and a clean cotton ball.
 - 10.7.2 Clean the sample tray and place a clean background planchette on the tray.
 - 10.7.2.1 A passing background count is required before returning the detector to service.
- 10.6 Standard Verification Procedure
 - 10.6.2 Receive manual batch from prep
 - 10.6.3 Count for 960 minutes (make sure batch is set up correctly).
 - 10.6.4 After count, open decay corrector (located in Rad Dive, LSC, decay corrector) to see if isotope you are verifying needs to be decay corrected. (if the isotope verifying is located in this spreadsheet, it needs to be decay corrected). Note, new activity on the prep sheet.
 - 10.6.5 Open new spreadsheet verification folder (located in Rad Drive) and select master 3 or 6 point verification (depending on how many standards are made)
 - 10.6.6 Enter calculated value from Decay Corrector (as True value) and value from the spectra print outs (activity on the spectra for the Isotope you are verifying).
 - 10.6.7 Make sure units match.
 - 10.6.8 Standard passes if the mean value is within 5% of certified (true) value, the 1.96 sigma value is within 10% of mean value and the standard reverification acceptability evaluations are all yes.
 - 10.6.9 Sign bottom of prep sheet and calculation page.
 - 10.6.10 Give to prep supervisor.

11 PROCEDURE

- 11.6 For sample preparation reference the applicable preparation SOP.
- 11.7 Initial Setup
 - 11.7.2 Establish the normal instrument settings for all controls.
 - 11.7.2.6 Detector specific high voltage settings and required polarity are listed in the method software settings.
 - 11.7.3 Pulser quality controls shall be checked before each use of the instrument.
- 11.8 Counting Samples

- 11.8.2 In Radcapture, go to Utilities > Export>Choose 'Alphavision' or 'Alphavision1' depending on which instrument the samples were set up on>, enter batch # in the window that pops up, and click ok to export to Alphavision.
- 11.8.3 In Alphavision, go to Process, select Batch to open the Batch Wizard.
- 11.8.4 Choose Load from LIMS, and pick the batch.
- 11.8.5 Choose proper analysis by clicking on the correct isotope
- 11.8.6 Select Next
- 11.8.7 Click on blank, and then pick blank type (Uu blank, Pu Blank, etc...)
- 11.8.8 Click on LCS, and then pick LCS type with correct spike number. For amount, use the spike aliquot amount (0.1, 0.2 mL, 0.1326 g, etc) which is printed on the batch paper work.
- 11.8.9 Select Next
- 11.8.10 Live time is count time. Enter correct count time for the batch, select next.
- 11.8.11 Select Nuclide Library, choose correct ROI and the specified tracer that is printed on the batch paper work.
- 11.8.12 Select next
- 10.7.3 Select correct activity units (DPM, pCi, etc), select Activity concentration,
 - 10.7.3.1 QuantIMS: change TPU Sigma to 2 (unless otherwise noted in client requirements), add 5% systematic uncertainty and check the negative activity box. .
 - 10.7.3.2 TALS: always select TPU Sigma 1, add 5% systematic uncertainty and check the negative activity box. .
- 11.8.13 Select Next, two times.
- 11.8.14 Select Print on Completion.
- 11.8.15 Select Finish.
- 11.8.16 Click and drag correct detectors to the correct sample ID and select Start Now.
- 11.8.17 The spectrum will be processed by the software.
- 10.7.4 For DOE:
 - 10.7.4.1 FWHM of each tracer peak shall be ≤ 100 keV
 - 10.7.4.2 Tracer peak energy for each sample shall be within ± 50 keV of the expected energy.
- 11.8.18 Backgrounds are checked after high activity samples by counting an 180 minute background with an empty chamber (see 11.9.2).
- 11.9 Samples with a count rate of greater than 1 CPS should be removed from the alpha counting system to prevent contamination of detector(s).
- 11.9.2 Alpha detectors exposed to samples with count rates greater than 1 CPS should be tagged out-of-service until an empty chamber check can be performed. To perform an empty chamber check, place a clean stainless steel disc in the chamber, establish vacuum, turn on bias and start acquisition for the pre-set time (180 minutes). Note this in the instrument and maintenance log.

12 DATA ANALYSIS AND CALCULATIONS

- 12.1 Commonly used calculations (e.g. % recovery, RPD, uncertainty, MDC, tracer recovery) and standard instrument software calculations are given in the TestAmerica St. Louis QAM.
- 12.2 Isotope ROI and libraries are derived from the PCNudat master nuclide library:.
 - 12.2.1 http://www.nndc.bnl.gov/nudat2/indx_dec.jsp
- 12.3 Any manual integration of a peak or group of peaks must be documented. In all instances where the data system report has been edited or where manual integration has been performed, the

operator must clearly identify such edits or manual procedures. Reference SOP ST-QA-0040 for details.

13.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA; CORRECTIVE ACTIONS FOR OUT OF CONTROL DATA

- 13.1 The data assessment and corrective action process is detailed through the LIMS Nonconformance Memorandum (NCM) module. The NCM process is described in SOP: ST-QA-0036.
- 13.2 Method Blank
 - 13.2.1 Acceptance Criteria:
 - 13.2.1.1 No target analytes may be present in the method blank above the reporting limit.
 - 13.2.1.2 Project specific requirements if more stringent than our routine procedure (e.g. no target analytes present above ½ RL), will be noted on the client requirements sheet.
 - 13.2.2 Corrective Action for Method Blanks not meeting acceptance criteria:
 - 13.2.2.1 Method Blank Contamination – If the MB concentration exceeds the applicable criteria, the batch must be re-prepped unless the concentration of all associated samples is less than the RL or greater than ten times the concentration found in the blank.
- 13.3 Laboratory Control Sample (LCS)
 - 13.3.1 Acceptance Criteria:
 - 13.3.1.1 All control analytes must be within the specified control limits for accuracy (%Recovery) and precision (RPD).
 - 13.3.2 Corrective Action for LCS not meeting acceptance criteria:
 - 13.3.2.1 LCS Spike Recovery excursion (high) – Samples with results less than the RL may be reported with an NCM (unless prohibited by client requirements). Samples with detects for the isotopes with a high bias in the LCS are re-prepped and re-analyzed.
 - 13.3.2.2 LCS Spike Recovery excursion (low) – The batch is re-prepped and re-analyzed for the affected isotope.
 - 13.3.2.3 RPD/RER Duplicate excursion – For the RPD/RER one or both must be within acceptance limits. The RPD limit is 40% or less. The RER limit is 1 or less depending on the significant digits. Not meeting the criteria requires a reprep of the samples. If samples have a physical matrix issue (ie, nonhomogenous), results can be reported with an NCM. If samples fail RPD/RER criteria after the reprep and no matrix issue is observed sample may be reported with client approval and narrated in an NCM.
- 13.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)
 - 13.4.1 Analytes should be within control limits for accuracy (%Recovery) and precision (RPD).
 - 13.4.2 Corrective Action for MS/MSD not meeting acceptance criteria:
 - 13.4.2.1 MS/MSD Spike Rec. excursion may not necessarily warrant corrective action other than narration
- 13.5 Sample Result Evaluation
 - 13.5.1 Tracer recovery must be within specified limits. Tracer limits are 30% - 110% unless otherwise specified by the client
 - 13.5.2 Tracer/Carrier recovery (low) – Re-extract using a reduced volume or recount for maximum count time to achieve 400 tracer counts
 - 13.5.2.1 *Note: QSAS allows for reporting results as quantitative when tracer recoveries are below 30% if:*
 - 13.5.2.1.1 *the relative uncertainty associated with the tracer recovery is less than 10% (2 sigma)*

13.5.2.1.2 *spectral resolution requirements are met and there are no indications of spectral interferences (resolution of <100 keV).*

13.5.2.1.3 *detection limit requirements have been met*

13.5.3 Tracer/Carrier recovery (high) – If the blank and LCS are **within limits**, have the sample logged in for native analysis if not already logged in for native. If the blank and or LCS has **high recovery**, a reprep is required.

13.5.3.1 Truncation to 100%: Truncation can be done at the clients discretion, or with approval from manager or technical director or based on sample history.

13.5.3.2 A sample tracer recovery outside QC limits may be accepted if the sample results are determined valid:

13.5.3.2.1 minimum number of tracer counts

13.5.3.2.2 level of uncertainty

13.5.3.2.3 client project requirements/approval

13.5.4 These expectations will be documented using the NCM process. The NCM will narrate the conditions upon which the sample results were accepted with tracer recovery excursions.

13.5.5 The following occurrences require a dilution to be performed:

13.5.5.1 Dilution level is determined by taking the highest gross counts divided by the count time divided by a factor of 2. (ie: $7200/180/2=1:20$)

$$DL = GCts_{High} / t_{count} / 2$$

DL = Dilution Level

GCts_{High} = Highest Gross Counts

t_{count} = Count Time

13.5.5.1.1 Tailing – A peak is significantly tailing out side its region of interest (ROI)

13.5.5.1.2 The tracer recovery is low due the high activity of the sample

13.5.5.1.3 Peak Interference – A Peak is observed which is identified as an interference

13.6 Insufficient Sample

13.6.1 For any prescribed re-preparation corrective action, if there is insufficient sample to repeat the analysis an NCM is written and a narrative comment stating such is included in the report narrative.

14.0 METHOD PERFORMANCE AND DEMONSTRATION OF CAPABILITY

14.1 Method performance data, Reporting Limits, and QC acceptance limits, are maintained in the LIMS.

14.2 Demonstration of Capability

14.2.1 Initial and continuing demonstrations of capability requirements are established in ST-QAM

14.3 Training Qualification

14.3.1 The manager/supervisor has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and has the required experience.

14.3.2 The analyst must have successfully completed the initial demonstration capability requirements prior to working independently. See requirements in ST-QAM.

- 14.1 Annually, the analyst must successfully demonstrate proficiency to continue to perform this analysis. See requirements in ST-QAM.

15.0 VALIDATION

- 15.1 Laboratory SOPs are based on published methods (EPA, DOE, ASTM, Eichrom, Standard Methods) and do not require validation by the laboratory. The requirements for laboratory demonstration of capability are included in the ST-QAM. Laboratory validation data would be appropriate for performance based measurement systems, non-standard methods and significant modifications to published methods. Data from said validations is held in the QA department.

16.0 WASTE MANAGEMENT AND POLLUTION PREVENTION

- 16.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."
- 16.2 Waste Streams Produced by the Method
- 16.2.1 The following waste streams are produced when this method is carried out.
- 16.2.1.1 Contaminated disposable glass or plastic materials utilized in the analysis are disposed of in the sanitary trash. If the lab ware was used for the analysis of radioactive samples and contains radioactivity at a level of 100 cpm over background as determined by a GM meter, the lab ware will be collected in waste barrels designated for solid rad waste for disposal by the EH&S Coordinator.

17.0 REFERENCES

- 17.1 Department of Energy (DOE) Environmental Measurement Laboratory (EML) HASL 300 28th Edition method A-01-R, Alpha Radioassay
- 17.2 AlphaVision-32, Alpha Particle Spectrum Acquisition and Analysis for Microsoft Windows and NT, Software Version 5.0 Installation, User Interface and Reference Guide, Ortec (latest version)
- 17.3 OCTETE Plus, Integrated Alpha-Spectroscopy System Hardware Operating Manual, 777720, Ortec (latest version)
- 17.4 MAESTRO-32, MCA Emulator for Microsoft Windows, A65-B32 Software User's Manual, 777800, Ortec (latest version)
- 17.5 U.S. Nuclear Regulatory Commission, Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment, Regulatory Guide 4.15.
- 17.6 "Quality Assurance Program Requirements for Nuclear Facilities", ANSI/ASME NQA-1 (latest edition).
- 17.7 TestAmerica, St. Louis Quality Assurance Manual, current revision
- 17.8 Corporate Environmental Health and Safety Manual (CW-E-M-001) and St. Louis Facility Addendum (SOP ST-HS-0002), current revisions.

- 17.9 Decay Radiation Database, Version of 5/8/2013; http://www.nndc.bnl.gov/nudat2/indx_dec.jsp
- 17.10 Associated SOPs, current revisions
- 17.10.1 ST-PM-0002, Chain of Custody
 - 17.10.2 ST-QA-0002, Standard and Reagent Preparation
 - 17.10.3 ST-QA-0014, Evaluation of Analytical Accuracy and Precision Through the Use of Control Charts
 - 17.10.4 ST-QA-0036 Non-Conformance Memorandum (NCM) Procedure
 - 17.10.5 ST-QA-0040, Manual Integration Procedure
 - 17.10.6 ST-RC-0040, Total Alpha Emitting Isotopes of Radium
 - 17.10.7 ST-RC-0238, Isotopic Uranium By Eichrom® Uteva Resin For Various Matrices
 - 17.10.8 ST-RC-0210, Determination Of Polonium-210 By Alpha Spectrometry
 - 17.10.9 ST-RC-0232, Isotopic Thorium And/Or Neptunium In Various Matrices By Eichrom® Teva Separation Resin
 - 17.10.10 ST-RC-0240, Isotopic Americium, Curium, Plutonium, Thorium, And Uranium In Various Matrices By Eichrom® Separation Resin
 - 17.10.11 ST-RC-0241, Americium, Plutonium, Curium, And Uranium In Various Matrices By Eichrom® Uteva And Tru Resins (With Vacuum Box System)
 - 17.10.12 ST-RC-0242, Isotopic Thorium, Plutonium And Uranium In Various Matrices By Eichrom® Separation Resins
 - 17.10.13 ST-RC-0246, Isotopic Americium, Curium, Uranium In Various Matrices By Eichrom® Separation Resins

18.0 MODIFICATIONS TO REFERENCE METHOD

- 18.1 Energy calibrations checks are performed monthly. Daily pulsar checks are performed in place of the weekly energy calibration checks.
- 18.2 Backgrounds are determined monthly rather weekly
- 18.3 CCV's are determined monthly rather than before and after each measurement.

19.0 CHANGES TO PREVIOUS REVISION

- 19.1 No Changes- Annual Review
- 19.2 Rev. 8:
- 19.2.1 Section 10 additions
 - 19.2.1.1 Addition of Instrument setup as §10.1
 - 19.2.1.2 Addition of Calibration Quality Control Check as §10.3
 - 19.2.1.3 Addition of calibration acceptance criteria
- 19.3 Rev. 9:
- 19.3.1 Section 10.5, addition of limits for pulser centroid and pulser energy
- 19.4 Rev. 10:
- 19.4.1 Section 10:
 - 19.4.1.1 2nd level review for ICV and CCV added to section 10
 - 19.4.1.2 1200 minute setting for acquisition window for special projects
 - 19.4.1.3 Upper control limits for long backgrounds
 - 19.4.1.4 Detector cleaning
 - 19.4.2 Section 12: addition of ROI and library reference
 - 19.4.3 Section 13: Occurrences that require dilution
 - 19.4.4 Addition of Attachment 1
- 19.5 Rev. 11:
- 19.5.1 Grammatical corrections through out and removal of reference to QuantIMS and Clouseau

- 19.5.2 Section 10, updated internal calibrations information in section and the calibration process in the lab software throughout
- 19.5.3 Section 10, added new standards verification procedure
- 19.5.4 Section 13, added corrective actions and equation for dilution level
- 19.5.5 Section 15, updated with new verbiage
- 19.5.6 Attachment 1 revised
- 19.5.7 Section 13, removed "See Clouseau NCM for Corrective Action" and added specific Corrective Actions to the SOP
- 19.5.8 Section 18, added backgrounds will be done monthly and added CCV's will be done monthly.
- 19.5.9 Section 3, Added "keV" definition
- 19.5.10 Section 6, Added Hardware and Software specifics

Attachment 1

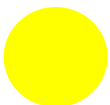
AlphaVision Detector Key



Red – Routine only 0-40 counts



Green – Low Level 0-20 counts



Yellow – Intermediate Low Level 0 – 4 counts

***Special Projects and QC samples (Method
Blanks and Lab Control Samples) Only***



Blue – Ultra Low Level (for Pu/Am/Np)

Special Projects Only

Out of
Service

OOS reason
written here

OOS Tag – Out of Service (OOS)



**LABORATORY
ACCREDITATION
BUREAU**



Certificate of Accreditation

ISO/IEC 17025:2005

Certificate Number L2257

ALS Environmental

225 Commerce Drive
Fort Collins CO 80524

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation valid through: June 1, 2016

**R. Douglas Leonard, Jr., President, COO
Laboratory Accreditation Bureau
Presented the 15th of April 2013**

*See the laboratory's Scope of Accreditation for details of accredited parameters

**Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

Scope of Accreditation

For

ALS Environmental

225 Commerce Drive
Fort Collins, CO 80524
Robert P. DiRienzo
970-490-1511

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.2) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to ALS Laboratory Group to perform the following tests:

Accreditation granted through: **June 1, 2016**

Testing – Environmental

Non-Potable Water		
Technology	Method	Analyte
Ion Chromatography	EPA 300.0 / 9056A	Bromide
Ion Chromatography	EPA 300.0 / 9056A	Chloride
Ion Chromatography	EPA 300.0 / 9056A	Fluoride
Ion Chromatography	EPA 300.0 / 9056A	Nitrate as N
Ion Chromatography	EPA 300.0 / 9056A	Nitrite as N
Ion Chromatography	EPA 300.0 / 9056A	Orthophosphate as P
Ion Chromatography	EPA 300.0 / 9056A	Sulfate
Analyzer	EPA 415.1 / 9060	TOC
ICP	EPA 6010B	Aluminum
ICP	EPA 6010B	Antimony
ICP	EPA 6010B	Arsenic
ICP	EPA 6010B	Barium
ICP	EPA 6010B	Beryllium
ICP	EPA 6010B	Bismuth
ICP	EPA 6010B	Boron
ICP	EPA 6010B	Cadmium
ICP	EPA 6010B	Calcium
ICP	EPA 6010B	Chromium

Non-Potable Water		
Technology	Method	Analyte
ICP	EPA 6010B	Cobalt
ICP	EPA 6010B	Copper
ICP	EPA 6010B	Iron
ICP	EPA 6010B	Lead
ICP	EPA 6010B	Lithium
ICP	EPA 6010B	Magnesium
ICP	EPA 6010B	Manganese
ICP	EPA 6010B	Molybdenum
ICP	EPA 6010B	Nickel
ICP	EPA 6010B	Phosphorus
ICP	EPA 6010B	Potassium
ICP	EPA 6010B	Selenium
ICP	EPA 6010B	Silicon
ICP	EPA 6010B	Silicon as SiO ₂
ICP	EPA 6010B	Silver
ICP	EPA 6010B	Sodium
ICP	EPA 6010B	Strontium
ICP	EPA 6010B	Sulfur
ICP	EPA 6010B	Thallium
ICP	EPA 6010B	Tin
ICP	EPA 6010B	Titanium
ICP	EPA 6010B	Uranium
ICP	EPA 6010B	Vanadium
ICP	EPA 6010B	Zinc
ICP	EPA 6010B	Zirconium
ICP / MS	EPA 6020A	Aluminum
ICP / MS	EPA 6020A	Antimony
ICP / MS	EPA 6020A	Arsenic
ICP / MS	EPA 6020A	Barium
ICP / MS	EPA 6020A	Beryllium
ICP / MS	EPA 6020A	Cadmium
ICP / MS	EPA 6020A	Calcium
ICP / MS	EPA 6020A	Cerium

Non-Potable Water		
Technology	Method	Analyte
ICP / MS	EPA 6020A	Chromium
ICP / MS	EPA 6020A	Cobalt
ICP / MS	EPA 6020A	Copper
ICP / MS	EPA 6020A	Iron
ICP / MS	EPA 6020A	Lanthanum
ICP / MS	EPA 6020A	Lead
ICP / MS	EPA 6020A	Magnesium
ICP / MS	EPA 6020A	Manganese
ICP / MS	EPA 6020A	Molybdenum
ICP / MS	EPA 6020A	Neodymium
ICP / MS	EPA 6020A	Nickel
ICP / MS	EPA 6020A	Potassium
ICP / MS	EPA 6020A	Praseodymium
ICP / MS	EPA 6020A	Selenium
ICP / MS	EPA 6020A	Silver
ICP / MS	EPA 6020A	Sodium
ICP / MS	EPA 6020A	Strontium
ICP / MS	EPA 6020A	Thallium
ICP / MS	EPA 6020A	Thorium
ICP / MS	EPA 6020A	Tin
ICP / MS	EPA 6020A	Titanium
ICP / MS	EPA 6020A	U-235
ICP / MS	EPA 6020A	U-238
ICP / MS	EPA 6020A	Uranium
ICP / MS	EPA 6020A	Vanadium
ICP / MS	EPA 6020A	Yttrium
ICP / MS	EPA 6020A	Zinc
Colorimetric	EPA 335.1 SM 4500-CN C,E	Cyanide (Total and Amenable)
UV-Vis	EPA 9010C	Cyanide (Total and Amenable)
UV-Vis	EPA 7196A	Hexavalent Chromium (Cr ^{VI})
Titrimetric	EPA 9013 / 9014 / 335.2	Cyanide
Gravimetric	EPA 160.1/SM 2540 C	Total Dissolved Solids
Gravimetric	EPA 160.2 / SM 2540 D	Total Suspended Solids

Non-Potable Water		
Technology	Method	Analyte
Gravimetric	EPA 1664A / 9071B	HEM/Oil And Grease
ISE	SM 2510B EPA 120.1 / 9050A	Conductivity
Titration	SM 2320B EPA 310.1	Alkalinity
UV/VIS	EPA 353.2	Nitrogen, Nitrate-Nitrite
Colorimetric	EPA 354.1 SM 4500-NO ₂ B	Nitrogen, Nitrite
Colorimetric	EPA 365.2 SM 4500-P E	Phosphorous, Total And Ortho
Titrimetric	EPA 376.1 SM 4500-S ₂ F	Sulfide
Gravimetric	EPA 9095A	Paint Filter Liquids Test
CVAA	EPA 245.1 / 7470	Mercury
ISE	EPA 150.1 / 9040C SM 4500-H ⁺ B	pH
Flash Point	EPA 1010A	Ignitability
GC / ECD	EPA 8081A	4,4'-DDD
GC / ECD	EPA 8081A	4,4'-DDE
GC / ECD	EPA 8081A	4,4'-DDT
GC / ECD	EPA 8081A	Aldrin
GC / ECD	EPA 8081A	Alpha-BHC
GC / ECD	EPA 8081A	Alpha-Chlordane
GC / ECD	EPA 8081A	Beta-BHC
GC / ECD	EPA 8081A	Chlordane
GC / ECD	EPA 8081A	Delta-BHC
GC / ECD	EPA 8081A	Dieldrin
GC / ECD	EPA 8081A	Endosulfan I
GC / ECD	EPA 8081A	Endosulfan II
GC / ECD	EPA 8081A	Endosulfan Sulfate
GC / ECD	EPA 8081A	Endrin
GC / ECD	EPA 8081A	Endrin Aldehyde
GC / ECD	EPA 8081A	Endrin Ketone
GC / ECD	EPA 8081A	Gamma-BHC (Lindane)
GC / ECD	EPA 8081A	Gamma-Chlordane
GC / ECD	EPA 8081A	Heptachlor

Non-Potable Water		
Technology	Method	Analyte
GC / ECD	EPA 8081A	Heptachlor Epoxide
GC / ECD	EPA 8081A	Methoxychlor
GC / ECD	EPA 8081A	Toxaphene
GC / ECD	EPA 8082	Aroclor-1016
GC / ECD	EPA 8082	Aroclor-1221
GC / ECD	EPA 8082	Aroclor-1232
GC / ECD	EPA 8082	Aroclor-1242
GC / ECD	EPA 8082	Aroclor-1248
GC / ECD	EPA 8082	Aroclor-1254
GC / ECD	EPA 8082	Aroclor-1260
GC / ECD	EPA 8082	Aroclor-1262
GC / ECD	EPA 8082	Aroclor-1268
GC / ECD	EPA 8151A	2,4,5-T
GC / ECD	EPA 8151A	2,4-D
GC / ECD	EPA 8151A	2,4-DB
GC / ECD	EPA 8151A	Dalapon
GC / ECD	EPA 8151A	Dicamba
GC / ECD	EPA 8151A	Dichloroprop
GC / ECD	EPA 8151A	Dinoseb
GC / ECD	EPA 8151A	MCPA
GC / ECD	EPA 8151A	MCPP
GC / ECD	EPA 8151A	Silvex
GC / FPD	EPA 8141A	Chlorpyrifos
GC / FPD	EPA 8141A	Coumaphos
GC / FPD	EPA 8141A	Demeton O + S
GC / FPD	EPA 8141A	Diazinon
GC / FPD	EPA 8141A	Dichlorvos
GC / FPD	EPA 8141A	Disulfoton
GC / FPD	EPA 8141A	Ethoprop
GC / FPD	EPA 8141A	Fensulfothion
GC / FPD	EPA 8141A	Fenthion
GC / FPD	EPA 8141A	Malathion
GC / FPD	EPA 8141A	Merphos A + B

Non-Potable Water		
Technology	Method	Analyte
GC / FPD	EPA 8141A	Methyl Azinphos
GC / FPD	EPA 8141A	Methyl Parathion
GC / FPD	EPA 8141A	Mevinphos
GC / FPD	EPA 8141A	Naled
GC / FPD	EPA 8141A	Phorate
GC / FPD	EPA 8141A	Ronnel
GC / FPD	EPA 8141A	Sulprofos
GC / FPD	EPA 8141A	Tetrachlorvinphos
GC / FPD	EPA 8141A	Tokuthion
GC / FPD	EPA 8141A	Trichloronate
GC / FPD	EPA 8141A	Triphenylphosphate
GC / FID	EPA 8015B	GRO
GC / FID	EPA 8015B	DRO
GC / MS	EPA 8260C	Chloroacetonitrile
GC / MS	EPA 8260C	1-chlorobutane
GC / MS	EPA 8260C	Methyl acrylate
GC / MS	EPA 8260C	Pentafluorobenzene
GC / MS	EPA 8260C	1,1,1,2-Tetrachloroethane
GC / MS	EPA 8260C	1,1,1-Trichloroethane
GC / MS	EPA 8260C	1,1,2,2-Tetrachloroethane
GC / MS	EPA 8260C	1,1,2-Trichloro-1,2,2-Trifluoroethane
GC / MS	EPA 8260C	1,1,2-Trichloroethane
GC / MS	EPA 8260C	1,1-Dichloroethane
GC / MS	EPA 8260C	1,1-Dichloroethene
GC / MS	EPA 8260C	1,1-Dichloropropene
GC / MS	EPA 8260C	1,2,3-Trichlorobenzene
GC / MS	EPA 8260C	1,2,3-Trichloropropane
GC / MS	EPA 8260C	1,2,4-Trichlorobenzene
GC / MS	EPA 8260C	1,2,4-Trimethylbenzene
GC / MS	EPA 8260C	1,2-Dibromo-3-Chloropropane
GC / MS	EPA 8260C	1,2-Dibromoethane
GC / MS	EPA 8260C	1,2-Dichlorobenzene
GC / MS	EPA 8260C	1,2-Dichloroethane

Non-Potable Water		
Technology	Method	Analyte
GC / MS	EPA 8260C	1,2-Dichloroethene (Total)
GC / MS	EPA 8260C	1,2-Dichloropropane
GC / MS	EPA 8260C	1,3,5-Trimethylbenzene
GC / MS	EPA 8260C	1,3-Dichlorobenzene
GC / MS	EPA 8260C	1,3-Dichloropropane
GC / MS	EPA 8260C	1,4-Dichlorobenzene
GC / MS	EPA 8260C	1-Chlorohexane
GC / MS	EPA 8260C	2,2-Dichloropropane
GC / MS	EPA 8260C	2-Butanone
GC / MS	EPA 8260C	2-Chlorotoluene
GC / MS	EPA 8260C	2-Hexanone
GC / MS	EPA 8260C	4-Chlorotoluene
GC / MS	EPA 8260C	4-Methyl-2-Pentanone
GC / MS	EPA 8260C	Acetone
GC / MS	EPA 8260C	Benzene
GC / MS	EPA 8260C	Bromobenzene
GC / MS	EPA 8260C	Bromochloromethane
GC / MS	EPA 8260C	Bromodichloromethane
GC / MS	EPA 8260C	Bromoform
GC / MS	EPA 8260C	Bromomethane
GC / MS	EPA 8260C	Carbon Disulfide
GC / MS	EPA 8260C	Carbon Tetrachloride
GC / MS	EPA 8260C	Chlorobenzene
GC / MS	EPA 8260C	Chloroethane
GC / MS	EPA 8260C	Chloroform
GC / MS	EPA 8260C	Chloromethane
GC / MS	EPA 8260C	Cis-1,2-Dichloroethene
GC / MS	EPA 8260C	Cis-1,3-Dichloropropene
GC / MS	EPA 8260C	Dibromochloromethane
GC / MS	EPA 8260C	Dibromomethane
GC / MS	EPA 8260C	Dichlorodifluoromethane
GC / MS	EPA 8260C	Ethylbenzene
GC / MS	EPA 8260C	Hexachlorobutadiene

Non-Potable Water		
Technology	Method	Analyte
GC / MS	EPA 8260C	Iodomethane
GC / MS	EPA 8260C	Isopropylbenzene
GC / MS	EPA 8260C	M+P-Xylene
GC / MS	EPA 8260C	Methyl Tertiary Butyl Ether
GC / MS	EPA 8260C	Methylene Chloride
GC / MS	EPA 8260C	Naphthalene
GC / MS	EPA 8260C	N-Butylbenzene
GC / MS	EPA 8260C	N-Propylbenzene
GC / MS	EPA 8260C	O-Xylene
GC / MS	EPA 8260C	P-Isopropyltoluene
GC / MS	EPA 8260C	Sec-Butylbenzene
GC / MS	EPA 8260C	Styrene
GC / MS	EPA 8260C	Tert-Butylbenzene
GC / MS	EPA 8260C	Tetrachloroethene
GC / MS	EPA 8260C	Toluene
GC / MS	EPA 8260C	Total Xylenes
GC / MS	EPA 8260C	Trans-1,2-Dichloroethene
GC / MS	EPA 8260C	Trans-1,3-Dichloropropene
GC / MS	EPA 8260C	Trichloroethene
GC / MS	EPA 8260C	Trichlorofluoromethane
GC / MS	EPA 8260C	Vinyl Acetate
GC / MS	EPA 8260C	Vinyl Chloride
GC / MS	EPA 8270D	1,2,4-Trichlorobenzene
GC / MS	EPA 8270D	1,2-Dichlorobenzene
GC / MS	EPA 8270D	1,3-Dichlorobenzene
GC / MS	EPA 8270D	1,4-Dichlorobenzene
GC / MS	EPA 8270D	1,4-Dioxane
GC / MS	EPA 8270D	2,3,4,6-Tetrachlorophenol
GC / MS	EPA 8270D	2,4,5-Trichlorophenol
GC / MS	EPA 8270D	2,4,6-Trichlorophenol
GC / MS	EPA 8270D	2,4-Dichlorophenol
GC / MS	EPA 8270D	2,4-Dimethylphenol
GC / MS	EPA 8270D	2,4-Dinitrophenol

Non-Potable Water		
Technology	Method	Analyte
GC / MS	EPA 8270D	2,4-Dinitrotoluene
GC / MS	EPA 8270D	2,6-Dinitrotoluene
GC / MS	EPA 8270D	2-Chloronaphthalene
GC / MS	EPA 8270D	2-Chlorophenol
GC / MS	EPA 8270D	2-Methylnaphthalene
GC / MS	EPA 8270D	2-Methylphenol
GC / MS	EPA 8270D	2-Nitroaniline
GC / MS	EPA 8270D	2-Nitrophenol
GC / MS	EPA 8270D	3,3'-Dichlorobenzidine
GC / MS	EPA 8270D	3+4-Methylphenol
GC / MS	EPA 8270D	4,6-Dinitro-2-Methylphenol
GC / MS	EPA 8270D	4-Aminobiphenyl
GC / MS	EPA 8270D	4-Bromophenyl Phenyl Ether
GC / MS	EPA 8270D	4-Chloro-3-Methylphenol
GC / MS	EPA 8270D	4-Chloroaniline
GC / MS	EPA 8270D	4-Chlorophenyl Phenyl Ether
GC / MS	EPA 8270D	4-Nitroaniline
GC / MS	EPA 8270D	4-Nitrophenol
GC / MS	EPA 8270D	Acenaphthene
GC / MS	EPA 8270D	Acenaphthylene
GC / MS	EPA 8270D	Aniline
GC / MS	EPA 8270D	Anthracene
GC / MS	EPA 8270D	Azobenzene
GC / MS	EPA 8270D	Benzo(A)Anthracene
GC / MS	EPA 8270D	Benzo(A)Pyrene
GC / MS	EPA 8270D	Benzo(B)Fluoranthene
GC / MS	EPA 8270D	Benzo(G,H,I)Perylene
GC / MS	EPA 8270D	Benzo(K)Fluoranthene
GC / MS	EPA 8270D	Benzoic Acid
GC / MS	EPA 8270D	Benzyl Alcohol
GC / MS	EPA 8270D	Bis(2-Chloroethoxy)Methane
GC / MS	EPA 8270D	Bis(2-Chloroisopropyl)Ether
GC / MS	EPA 8270D	Bis(2-Ethylhexyl)Phthalate

Non-Potable Water		
Technology	Method	Analyte
GC / MS	EPA 8270D	Butyl Benzyl Phthalate
GC / MS	EPA 8270D	Carbazole
GC / MS	EPA 8270D	Chrysene
GC / MS	EPA 8270D	Dibenzo(A,H)Anthracene
GC / MS	EPA 8270D	Dibenzofuran
GC / MS	EPA 8270D	Diethyl Phthalate
GC / MS	EPA 8270D	Dimethyl Phthalate
GC / MS	EPA 8270D	Di-N-Butyl Phthalate
GC / MS	EPA 8270D	Di-N-Octyl Phthalate
GC / MS	EPA 8270D	Fluoranthene
GC / MS	EPA 8270D	Fluorene
GC / MS	EPA 8270D	Hexachlorobenzene
GC / MS	EPA 8270D	Hexachlorobutadiene
GC / MS	EPA 8270D	Hexachlorocyclopentadiene
GC / MS	EPA 8270D	Hexachloroethane
GC / MS	EPA 8270D	Indeno(1,2,3-Cd)Pyrene
GC / MS	EPA 8270D	Isophorone
GC / MS	EPA 8270D	Naphthalene
GC / MS	EPA 8270D	Nitrobenzene
GC / MS	EPA 8270D	N-Nitrosodimethylamine
GC / MS	EPA 8270D	N-Nitroso-Di-N-Propylamine
GC / MS	EPA 8270D	N-Nitrosodiphenylamine
GC / MS	EPA 8270D	Pentachlorophenol
GC / MS	EPA 8270D	Phenanthrene
GC / MS	EPA 8270D	Phenol
GC / MS	EPA 8270D	Pyrene
GC / MS	EPA 8270D	Pyridine
Gas Proportional Counting	EPA 900 / 9310	Gross Alpha
Gas Proportional Counting	EPA 900 / 9310	Gross Beta
Gas Proportional Counting	EPA 904 / 9320	Ra228
Gas Proportional Counting	HASL300Sr01 / Sr02	Strontium 89/90
Gas Proportional Counting	ASTM D5811	Strontium 90
Gas Proportional Counting	EPA 902.0 ALS SOP 753	Iodine-129

Non-Potable Water		
Technology	Method	Analyte
Liquid Scintillation Counting	EPA 906.0 SM 7500 3H	Tritium
Liquid Scintillation Counting	EPA C-01	Carbon-14
Liquid Scintillation Counting	DOE RP550 / RS551	Technicium-99
Liquid Scintillation Counting	Horwitz, Chiariza, Dietz 1992	Lead-210
Liquid Scintillation Counting	ALS SOP 704	Pu241, Pm147
Liquid Scintillation Counting	ALS SOP 774	Nickle-63
Emanation	EPA 903.1 SM 7500-Ra C	Radium 226
Gas Proportional Counting	EPA 903.0 / 9315	Total Radium
Liquid Scintillation Counting	SM 7500-Rn B ASTM D 5072	Rn-222
Gas Proportional Counting	EPA 903.0 / 9315	Radium-226
Alpha-Spec	HASL 300 U02 ASTM D 3972	Ac-227
Alpha-Spec	HASL 300 U02 ASTM D 3972	Am-241
Alpha-Spec	HASL 300 U02 ASTM D 3972	Am-242/243
Alpha-Spec	HASL 300 U02 ASTM D 3972	Am-243
Alpha-Spec	HASL 300 U02 ASTM D 3972	Cm-242
Alpha-Spec	HASL 300 U02 ASTM D 3972	Cm-243/244
Alpha-Spec	HASL 300 U02 ASTM D 3972	Cm-244
Alpha-Spec	HASL 300 U02 ASTM D 3972	Cm-245/246
Alpha-Spec	HASL 300 U02 ASTM D 3972	Np-237
Alpha-Spec	HASL 300 U02 ASTM D 3972	Po-210
Alpha-Spec	HASL 300 U02 ASTM D 3972	Pu-238
Alpha-Spec	HASL 300 U02 ASTM D 3972	Pu-239
Alpha-Spec	HASL 300 U02 ASTM D 3972	Pu-239/240

Non-Potable Water		
Technology	Method	Analyte
Alpha-Spec	HASL 300 U02 ASTM D 3972	Pu-242
Alpha-Spec	ALS-SOP 701	Ra-226
Alpha-Spec	HASL 300 U02 ASTM D 3972	Th-227
Alpha-Spec	HASL 300 U02 ASTM D 3972	Th-228
Alpha-Spec	HASL 300 U02 ASTM D 3972	Th-230
Alpha-Spec	HASL 300 U02 ASTM D 3972	Th-232
Alpha-Spec	HASL 300 U02 ASTM D 3972	U-232
Alpha-Spec	HASL 300 U02 ASTM D 3972	U-233/234
Alpha-Spec	HASL 300 U02 ASTM D 3972	U-234
Alpha-Spec	HASL 300 U02 ASTM D 3972	U-235
Alpha-Spec	HASL 300 U02 ASTM D 3972	U-235/236
Alpha-Spec	HASL 300 U02 ASTM D 3972	U-238
Alpha-Spec	HASL 300 U02 ASTM D 3972	Uranium, Total
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ac-227
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ac-228
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ag-108m
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ag-110m
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Al-26

Non-Potable Water		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Am-241
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Am-243
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	As-72
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	As-73
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	As-74
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ba-133
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ba-140
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Be-7
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Bi-211
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Bi-212
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Bi-214
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Br-76
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Br-77
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Br-82

Non-Potable Water		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cd-109
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ce-139
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ce-141
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ce-144
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cf-249
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cf-251
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cl-39
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	CM-243
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Co-56
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Co-57
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Co-58
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Co-60
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cr-51
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cs-134

Non-Potable Water		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cs-135
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cs-136
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cs-137
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Eu-152
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Eu-154
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Eu-155
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Fe-59
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Gd-153
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ge-68
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Hf-181
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Hg-197m
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Hg-203
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	I-131
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ir-192

Non-Potable Water		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	K-40
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Kr-85
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	La-140
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Mn-54
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Na-22
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Na-24
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Nb-94
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Nb-95
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Nd-147
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Np-236
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Np-237
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Np-239
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Os-191
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pa-231

Non-Potable Water		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pa-234m
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pb-210
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pb-211
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pb-212
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pb-214
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pm-144
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pm-146
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Po-209
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ra-223
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ra-224
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ra-226
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ra-228
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Rb-83
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Rb-86

Non-Potable Water		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Rh-101
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Rh-106
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ru-103
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ru-106
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sb-124
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sb-125
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sc-46
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Se-75
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sn-113
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sn-126
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sr-85
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ta-182
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Tb-160
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-227

Non-Potable Water		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-228
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-230
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-231
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-232
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-234
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Tl-208
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	U-235
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Uranium, Total
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	V-48
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Y-88
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Zn-65
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Zr-95
GC/FID	RSK-175	Methane
GC/FID	RSK-175	Ethane

Non-Potable Water		
Technology	Method	Analyte
GC/FID	RSK-175	Ethene
GC/FID	RSK-175	Propane
Preparation	Method	Type
Preparation	EPA 3005A	Acid Digestion Total Recoverable or Dissolved Metals
Preparation	EPA 3010A	Acid Digestion for Total Metals
Leaching Procedure	EPA 1311	Toxicity Characteristic Leaching Procedure Metals
Leaching Procedure	EPA 1311	Toxicity Characteristic Leaching Procedure Semi-Volatiles
Leaching Procedure	EPA 1311	Toxicity Characteristic Leaching Procedure Volatiles
Preparation	EPA 3520C	Continuous Liquid-Liquid Extraction
Cleanup Procedure	EPA 3620B	Florisil Cleanup
Cleanup Procedure	EPA 3630C	Silica Gel Cleanup
Cleanup Procedure	EPA 3640A	Gel Permeation Cleanup
Cleanup Procedure	EPA 3660A	Sulfur Cleanup
Purge and Trap	EPA 5030C	Purge-and-Trap for Aqueous Samples

Solid and Chemical Materials		
Technology	Method	Analyte
Ion Chromatography	EPA 300.0 / 9056A	Bromide
Ion Chromatography	EPA 300.0 / 9056A	Chloride
Ion Chromatography	EPA 300.0 / 9056A	Fluoride
Ion Chromatography	EPA 300.0 / 9056A	Nitrate as N
Ion Chromatography	EPA 300.0 / 9056A	Nitrite as N
Ion Chromatography	EPA 300.0 / 9056A	Orthophosphate as P
Ion Chromatography	EPA 300.0 / 9056A	Sulfate
Analyzer	Whakley Black	TOC
ICP - AES	EPA 6010B	Aluminum
ICP - AES	EPA 6010B	Antimony
ICP - AES	EPA 6010B	Arsenic

Solid and Chemical Materials		
Technology	Method	Analyte
ICP - AES	EPA 6010B	Barium
ICP - AES	EPA 6010B	Beryllium
ICP - AES	EPA 6010B	Bismuth
ICP - AES	EPA 6010B	Boron
ICP - AES	EPA 6010B	Cadmium
ICP - AES	EPA 6010B	Calcium
ICP - AES	EPA 6010B	Chromium
ICP - AES	EPA 6010B	Cobalt
ICP - AES	EPA 6010B	Copper
ICP - AES	EPA 6010B	Iron
ICP - AES	EPA 6010B	Lead
ICP - AES	EPA 6010B	Lithium
ICP - AES	EPA 6010B	Magnesium
ICP - AES	EPA 6010B	Manganese
ICP - AES	EPA 6010B	Molybdenum
ICP - AES	EPA 6010B	Nickel
ICP - AES	EPA 6010B	Phosphorus
ICP - AES	EPA 6010B	Potassium
ICP - AES	EPA 6010B	Selenium
ICP - AES	EPA 6010B	Silicon
ICP - AES	EPA 6010B	Silicon as SiO ₂
ICP - AES	EPA 6010B	Silver
ICP - AES	EPA 6010B	Sodium
ICP - AES	EPA 6010B	Strontium
ICP - AES	EPA 6010B	Sulfur
ICP - AES	EPA 6010B	Thallium
ICP - AES	EPA 6010B	Tin
ICP - AES	EPA 6010B	Titanium
ICP - AES	EPA 6010B	Uranium
ICP - AES	EPA 6010B	Vanadium
ICP - AES	EPA 6010B	Zinc
ICP - AES	EPA 6010B	Zirconium
ICP / MS	EPA 6020A	Aluminum

Solid and Chemical Materials		
Technology	Method	Analyte
ICP / MS	EPA 6020A	Antimony
ICP / MS	EPA 6020A	Arsenic
ICP / MS	EPA 6020A	Barium
ICP / MS	EPA 6020A	Beryllium
ICP / MS	EPA 6020A	Cadmium
ICP / MS	EPA 6020A	Calcium
ICP / MS	EPA 6020A	Cerium
ICP / MS	EPA 6020A	Chromium
ICP / MS	EPA 6020A	Cobalt
ICP / MS	EPA 6020A	Copper
ICP / MS	EPA 6020A	Iron
ICP / MS	EPA 6020A	Lanthanum
ICP / MS	EPA 6020A	Lead
ICP / MS	EPA 6020A	Magnesium
ICP / MS	EPA 6020A	Manganese
ICP / MS	EPA 6020A	Molybdenum
ICP / MS	EPA 6020A	Neodymium
ICP / MS	EPA 6020A	Nickel
ICP / MS	EPA 6020A	Potassium
ICP / MS	EPA 6020A	Praseodymium
ICP / MS	EPA 6020A	Selenium
ICP / MS	EPA 6020A	Silver
ICP / MS	EPA 6020A	Sodium
ICP / MS	EPA 6020A	Strontium
ICP / MS	EPA 6020A	Thallium
ICP / MS	EPA 6020A	Thorium
ICP / MS	EPA 6020A	Tin
ICP / MS	EPA 6020A	Titanium
ICP / MS	EPA 6020A	U-235
ICP / MS	EPA 6020A	U-238
ICP / MS	EPA 6020A	Uranium
ICP / MS	EPA 6020A	Vanadium
ICP / MS	EPA 6020A	Yttrium

Solid and Chemical Materials		
Technology	Method	Analyte
ICP / MS	EPA 6020A	Zinc
CVAA	EPA 7471	Mercury
ISE	EPA 9045D	pH
Titrimetric	EPA 9013 / 9014	Cyanide
UV-Vis	EPA 9010C	Cyanide (Total and Amenable)
UV-Vis	EPA 7196A	Hexavalent Chromium (Cr ^{VI})
Gravimetric	EPA 9071B	HEM/Oil And Grease
Wet Chemistry	SW846 7.3.3.2 / 7.3.4.1	Reactivity
Flash Point Tester	EPA 1010A	Ignitability
GC / ECD	EPA 8081A	4,4'-DDD
GC / ECD	EPA 8081A	4,4'-DDE
GC / ECD	EPA 8081A	4,4'-DDT
GC / ECD	EPA 8081A	Aldrin
GC / ECD	EPA 8081A	Alpha-BHC
GC / ECD	EPA 8081A	Alpha-Chlordane
GC / ECD	EPA 8081A	Beta-BHC
GC / ECD	EPA 8081A	Chlordane
GC / ECD	EPA 8081A	Delta-BHC
GC / ECD	EPA 8081A	Dieldrin
GC / ECD	EPA 8081A	Endosulfan I
GC / ECD	EPA 8081A	Endosulfan II
GC / ECD	EPA 8081A	Endosulfan Sulfate
GC / ECD	EPA 8081A	Endrin
GC / ECD	EPA 8081A	Endrin Aldehyde
GC / ECD	EPA 8081A	Endrin Ketone
GC / ECD	EPA 8081A	Gamma-BHC (Lindane)
GC / ECD	EPA 8081A	Gamma-Chlordane
GC / ECD	EPA 8081A	Heptachlor
GC / ECD	EPA 8081A	Heptachlor Epoxide
GC / ECD	EPA 8081A	Methoxychlor
GC / ECD	EPA 8081A	Toxaphene
GC / ECD	EPA 8082	Aroclor-1016
GC / ECD	EPA 8082	Aroclor-1221

Solid and Chemical Materials		
Technology	Method	Analyte
GC / ECD	EPA 8082	Aroclor-1232
GC / ECD	EPA 8082	Aroclor-1242
GC / ECD	EPA 8082	Aroclor-1248
GC / ECD	EPA 8082	Aroclor-1254
GC / ECD	EPA 8082	Aroclor-1260
GC / ECD	EPA 8082	Aroclor-1262
GC / ECD	EPA 8082	Aroclor-1268
GC / ECD	EPA 8151A	2,4,5-T
GC / ECD	EPA 8151A	2,4-D
GC / ECD	EPA 8151A	2,4-DB
GC / ECD	EPA 8151A	Dalapon
GC / ECD	EPA 8151A	Dicamba
GC / ECD	EPA 8151A	Dichloroprop
GC / ECD	EPA 8151A	Dinoseb
GC / ECD	EPA 8151A	MCPA
GC / ECD	EPA 8151A	MCPD
GC / ECD	EPA 8151A	Silvex
GC / FPD	EPA 8141A	Chlorpyrifos
GC / FPD	EPA 8141A	Coumaphos
GC / FPD	EPA 8141A	Demeton O + S
GC / FPD	EPA 8141A	Diazinon
GC / FPD	EPA 8141A	Dichlorvos
GC / FPD	EPA 8141A	Disulfoton
GC / FPD	EPA 8141A	Ethoprop
GC / FPD	EPA 8141A	Fensulfothion
GC / FPD	EPA 8141A	Fenthion
GC / FPD	EPA 8141A	Malathion
GC / FPD	EPA 8141A	Merphos A + B
GC / FPD	EPA 8141A	Methyl Azinphos
GC / FPD	EPA 8141A	Methyl Parathion
GC / FPD	EPA 8141A	Mevinphos
GC / FPD	EPA 8141A	Naled
GC / FPD	EPA 8141A	Phorate

Solid and Chemical Materials		
Technology	Method	Analyte
GC / FPD	EPA 8141A	Ronnel
GC / FPD	EPA 8141A	Sulprofos
GC / FPD	EPA 8141A	Tetrachlorvinphos
GC / FPD	EPA 8141A	Tokuthion
GC / FPD	EPA 8141A	Trichloronate
GC / FID	EPA 8015B	GRO
GC / FID	EPA 8015B	DRO
GC / MS	EPA 8260C	Chloroacetonitrile
GC / MS	EPA 8260C	1-chlorobutane
GC / MS	EPA 8260C	Methyl acrylate
GC / MS	EPA 8260C	Pentafluorobenzene
GC / MS	EPA 8260C	1,1,1,2-Tetrachloroethane
GC / MS	EPA 8260C	1,1,1-Trichloroethane
GC / MS	EPA 8260C	1,1,2,2-Tetrachloroethane
GC / MS	EPA 8260C	1,1,2-Trichloro-1,2,2-Trifluoroethane
GC / MS	EPA 8260C	1,1,2-Trichloroethane
GC / MS	EPA 8260C	1,1-Dichloroethane
GC / MS	EPA 8260C	1,1-Dichloroethene
GC / MS	EPA 8260C	1,1-Dichloropropene
GC / MS	EPA 8260C	1,2,3-Trichlorobenzene
GC / MS	EPA 8260C	1,2,3-Trichloropropane
GC / MS	EPA 8260C	1,2,4-Trichlorobenzene
GC / MS	EPA 8260C	1,2,4-Trimethylbenzene
GC / MS	EPA 8260C	1,2-Dibromo-3-Chloropropane
GC / MS	EPA 8260C	1,2-Dibromoethane
GC / MS	EPA 8260C	1,2-Dichlorobenzene
GC / MS	EPA 8260C	1,2-Dichloroethane
GC / MS	EPA 8260C	1,2-Dichloroethene (Total)
GC / MS	EPA 8260C	1,2-Dichloropropane
GC / MS	EPA 8260C	1,3,5-Trimethylbenzene
GC / MS	EPA 8260C	1,3-Dichlorobenzene
GC / MS	EPA 8260C	1,3-Dichloropropane
GC / MS	EPA 8260C	1,4-Dichlorobenzene

Solid and Chemical Materials		
Technology	Method	Analyte
GC / MS	EPA 8260C	1-Chlorohexane
GC / MS	EPA 8260C	2,2-Dichloropropane
GC / MS	EPA 8260C	2-Butanone
GC / MS	EPA 8260C	2-Chlorotoluene
GC / MS	EPA 8260C	2-Hexanone
GC / MS	EPA 8260C	4-Chlorotoluene
GC / MS	EPA 8260C	4-Methyl-2-Pentanone
GC / MS	EPA 8260C	Acetone
GC / MS	EPA 8260C	Benzene
GC / MS	EPA 8260C	Bromobenzene
GC / MS	EPA 8260C	Bromochloromethane
GC / MS	EPA 8260C	Bromodichloromethane
GC / MS	EPA 8260C	Bromoform
GC / MS	EPA 8260C	Bromomethane
GC / MS	EPA 8260C	Carbon Disulfide
GC / MS	EPA 8260C	Carbon Tetrachloride
GC / MS	EPA 8260C	Chlorobenzene
GC / MS	EPA 8260C	Chloroethane
GC / MS	EPA 8260C	Chloroform
GC / MS	EPA 8260C	Chloromethane
GC / MS	EPA 8260C	Cis-1,2-Dichloroethene
GC / MS	EPA 8260C	Cis-1,3-Dichloropropene
GC / MS	EPA 8260C	Dibromochloromethane
GC / MS	EPA 8260C	Dibromomethane
GC / MS	EPA 8260C	Dichlorodifluoromethane
GC / MS	EPA 8260C	Ethylbenzene
GC / MS	EPA 8260C	Hexachlorobutadiene
GC / MS	EPA 8260C	Iodomethane
GC / MS	EPA 8260C	Isopropylbenzene
GC / MS	EPA 8260C	M+P-Xylene
GC / MS	EPA 8260C	Methyl Tertiary Butyl Ether
GC / MS	EPA 8260C	Methylene Chloride
GC / MS	EPA 8260C	Naphthalene

Solid and Chemical Materials		
Technology	Method	Analyte
GC / MS	EPA 8260C	N-Butanol
GC / MS	EPA 8260C	N-Butylbenzene
GC / MS	EPA 8260C	N-Propylbenzene
GC / MS	EPA 8260C	O-Xylene
GC / MS	EPA 8260C	P-Isopropyltoluene
GC / MS	EPA 8260C	Sec-Butylbenzene
GC / MS	EPA 8260C	Styrene
GC / MS	EPA 8260C	Tert-Butylbenzene
GC / MS	EPA 8260C	Tetrachloroethene
GC / MS	EPA 8260C	Toluene
GC / MS	EPA 8260C	Total Xylenes
GC / MS	EPA 8260C	Trans-1,2-Dichloroethene
GC / MS	EPA 8260C	Trans-1,3-Dichloropropene
GC / MS	EPA 8260C	Trichloroethene
GC / MS	EPA 8260C	Trichlorofluoromethane
GC / MS	EPA 8260C	Vinyl Acetate
GC / MS	EPA 8260C	Vinyl Chloride
GC / MS	EPA 8270D	1,2,4-Trichlorobenzene
GC / MS	EPA 8270D	1,2-Dichlorobenzene
GC / MS	EPA 8270D	1,3-Dichlorobenzene
GC / MS	EPA 8270D	1,4-Dichlorobenzene
GC / MS	EPA 8270D	1,4-Dioxane
GC / MS	EPA 8270D	2,3,4,6-Tetrachlorophenol
GC / MS	EPA 8270D	2,4,5-Trichlorophenol
GC / MS	EPA 8270D	2,4,6-Trichlorophenol
GC / MS	EPA 8270D	2,4-Dichlorophenol
GC / MS	EPA 8270D	2,4-Dimethylphenol
GC / MS	EPA 8270D	2,4-Dinitrophenol
GC / MS	EPA 8270D	2,4-Dinitrotoluene
GC / MS	EPA 8270D	2-Chloronaphthalene
GC / MS	EPA 8270D	2-Chlorophenol
GC / MS	EPA 8270D	2-Methylnaphthalene
GC / MS	EPA 8270D	2-Methylphenol

Solid and Chemical Materials		
Technology	Method	Analyte
GC / MS	EPA 8270D	2-Nitroaniline
GC / MS	EPA 8270D	2-Nitrophenol
GC / MS	EPA 8270D	3,3'-Dichlorobenzidine
GC / MS	EPA 8270D	3+4-Methylphenol
GC / MS	EPA 8270D	4,6-Dinitro-2-Methylphenol
GC / MS	EPA 8270D	4-Aminobiphenyl
GC / MS	EPA 8270D	4-Bromophenyl Phenyl Ether
GC / MS	EPA 8270D	4-Chloro-3-Methylphenol
GC / MS	EPA 8270D	4-Chloroaniline
GC / MS	EPA 8270D	4-Chlorophenyl Phenyl Ether
GC / MS	EPA 8270D	4-Nitroaniline
GC / MS	EPA 8270D	4-Nitrophenol
GC / MS	EPA 8270D	Acenaphthene
GC / MS	EPA 8270D	Acenaphthylene
GC / MS	EPA 8270D	Aniline
GC / MS	EPA 8270D	Anthracene
GC / MS	EPA 8270D	Azobenzene
GC / MS	EPA 8270D	Benzo(A)Anthracene
GC / MS	EPA 8270D	Benzo(A)Pyrene
GC / MS	EPA 8270D	Benzo(B)Fluoranthene
GC / MS	EPA 8270D	Benzo(G,H,I)Perylene
GC / MS	EPA 8270D	Benzo(K)Fluoranthene
GC / MS	EPA 8270D	Benzoic Acid
GC / MS	EPA 8270D	Benzyl Alcohol
GC / MS	EPA 8270D	Bis(2-Chloroethoxy)Methane
GC / MS	EPA 8270D	Bis(2-Chloroethyl)Ether
GC / MS	EPA 8270D	Bis(2-Ethylhexyl) Adipate
GC / MS	EPA 8270D	Butyl Benzyl Phthalate
GC / MS	EPA 8270D	Carbazole
GC / MS	EPA 8270D	Chrysene
GC / MS	EPA 8270D	Dibenzo(A,H)Anthracene
GC / MS	EPA 8270D	Dibenzofuran
GC / MS	EPA 8270D	Diethyl Phthalate

Solid and Chemical Materials		
Technology	Method	Analyte
GC / MS	EPA 8270D	Dimethyl Phthalate
GC / MS	EPA 8270D	Di-N-Butyl Phthalate
GC / MS	EPA 8270D	Di-N-Octyl Phthalate
GC / MS	EPA 8270D	Fluoranthene
GC / MS	EPA 8270D	Fluorene
GC / MS	EPA 8270D	Hexachlorobenzene
GC / MS	EPA 8270D	Hexachlorobutadiene
GC / MS	EPA 8270D	Hexachlorocyclopentadiene
GC / MS	EPA 8270D	Hexachloroethane
GC / MS	EPA 8270D	Indeno(1,2,3-Cd)Pyrene
GC / MS	EPA 8270D	Isophorone
GC / MS	EPA 8270D	Naphthalene
GC / MS	EPA 8270D	Nitrobenzene
GC / MS	EPA 8270D	N-Nitrosodimethylamine
GC / MS	EPA 8270D	N-Nitroso-Di-N-Propylamine
GC / MS	EPA 8270D	N-Nitrosodiphenylamine
GC / MS	EPA 8270D	Pentachlorophenol
GC / MS	EPA 8270D	Phenanthrene
GC / MS	EPA 8270D	Phenol
GC / MS	EPA 8270D	Pyrene
GC / MS	EPA 8270D	Pyridine
Gas Proportional Counting	EPA 900 / 9310	Gross Alpha
Gas Proportional Counting	EPA 900 / 9310	Gross Beta
Gas Proportional Counting	EPA 904 / 9320	Ra228
Gas Proportional Counting	HASL300Sr01/Sr02 ASTM D5811	Strontium 89/90
Gas Proportional Counting	HASL300Sr01/Sr02 ASTM D5811	Strontium 90
Liquid Scintillation Counting	EPA 906.0 SM 7500 3H	Tritium
Liquid Scintillation Counting	EPA C-01	Carbon-14
Liquid Scintillation Counting	DOE RP550/RS551	Technicium-99
Liquid Scintillation Counting	Horwitz, Chiariza, Dietz 1992	Lead-210
Liquid Scintillation Counting	ALS SOP 704	Pu241, Pm147
Liquid Scintillation Counting	ALS SOP 774	Nickle-63

Solid and Chemical Materials		
Technology	Method	Analyte
Emanation	EPA 903.1 SM 7500-Ra C	Radium-226
Gas Proportional Counting	EPA 903.0 / 9315	Total Radium
Gas Proportional Counting	EPA 903.0 / 9315	Radium-226
Gas Proportional Counting	EPA 902.0 ALS SOP 753	Iodine-129
Alpha-Spec	HASL 300 U02 ASTM D3972	Ac-227
Alpha-Spec	HASL 300 U02 ASTM D3972	Am-241
Alpha-Spec	HASL 300 U02 ASTM D3972	Am-242/243
Alpha-Spec	HASL 300 U02 ASTM D3972	Am-243
Alpha-Spec	HASL 300 U02 ASTM D3972	Cm-242
Alpha-Spec	HASL 300 U02 ASTM D3972	Cm-243/244
Alpha-Spec	HASL 300 U02 ASTM D3972	Cm-244
Alpha-Spec	HASL 300 U02 ASTM D3972	Cm-245/246
Alpha-Spec	HASL 300 U02 ASTM D3972	Np-237
Alpha-Spec	HASL 300 U02 ASTM D3972	Po-210
Alpha-Spec	HASL 300 U02 ASTM D3972	Pu-238
Alpha-Spec	HASL 300 U02 ASTM D3972	Pu-239
Alpha-Spec	HASL 300 U02 ASTM D3972	Pu-239/240
Alpha-Spec	HASL 300 U02 ASTM D3972	Pu-242
Alpha-Spec	ALSLG-SOP 701	Ra-226
Alpha-Spec	HASL 300 U02 ASTM D3972	Th-227
Alpha-Spec	HASL 300 U02 ASTM D3972	Th-228
Alpha-Spec	HASL 300 U02 ASTM D3972	Th-230

Solid and Chemical Materials		
Technology	Method	Analyte
Alpha-Spec	HASL 300 U02 ASTM D3972	Th-232
Alpha-Spec	HASL 300 U02 ASTM D3972	U-232
Alpha-Spec	HASL 300 U02 ASTM D3972	U-233/234
Alpha-Spec	HASL 300 U02 ASTM D3972	U-234
Alpha-Spec	HASL 300 U02 ASTM D3972	U-235
Alpha-Spec	HASL 300 U02 ASTM D3972	U-235/236
Alpha-Spec	HASL 300 U02 ASTM D3972	U-238
Alpha-Spec	HASL 300 U02 ASTM D3972	Uranium, Total
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ac-227
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ac-228
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ag-108m
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ag-110m
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Al-26
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Am-241
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Am-243
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	As-72

Solid and Chemical Materials		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	As-73
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	As-74
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ba-133
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ba-140
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Be-7
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Bi-211
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Bi-212
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Bi-214
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Br-76
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Br-77
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Br-82
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cd-109
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ce-139
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ce-141

Solid and Chemical Materials		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ce-144
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cf-249
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cf-251
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cl-39
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cm-243
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Co-56
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Co-57
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Co-58
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Co-60
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cr-51
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cs-134
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cs-135
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cs-136
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Cs-137

Solid and Chemical Materials		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Eu-152
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Eu-154
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Eu-155
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Fe-59
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Gd-153
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ge-68
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Hf-181
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Hg-197m
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Hg-203
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	I-131
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ir-192
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	K-40
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Kr-85
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	La-140

Solid and Chemical Materials		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Mn-54
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Na-22
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Na-24
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Nb-94
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Nb-95
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Nd-147
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Np-236
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Np-237
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Np-239
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Os-191
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pa-231
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pa-234m
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pb-210
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pb-211

Solid and Chemical Materials		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pb-212
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pb-214
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pm-144
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Pm-146
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Po-209
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ra-223
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ra-224
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ra-226
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ra-228
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Rb-83
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Rb-86
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Rh-101
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Rh-106
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Rn-222

Solid and Chemical Materials		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ru-103
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ru-106
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sb-124
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sb-125
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sc-46
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Se-75
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sn-113
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sn-126
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Sr-85
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Ta-182
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Tb-160
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-227
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-228
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-230

Solid and Chemical Materials		
Technology	Method	Analyte
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-231
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-232
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Th-234
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Tl-208
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	U-235
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Uranium, Total
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	V-48
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Y-88
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Zn-65
Gamma Spec	EPA 901.1 HASL 300 Ga-01-R EML 4.5.2.3	Zr-95
Preparation	Method	Type
Preparation	EPA 3060 A	Alkaline Digestion For Hexavalent Chromium
Preparation	EPA 3050 B	Acid Digestion Of Sediments, Sludges And Soils
Leaching Procedure	EPA 1311	Toxicity Characteristic Leaching Procedure Metals
Leaching Procedure	EPA 1311	Toxicity Characteristic Leaching Procedure Semi-Volatiles
Leaching Procedure	EPA 1311	Toxicity Characteristic Leaching Procedure Volatiles
Preparation	EPA 3540C	Soxhlet Extraction
Preparation	EPA 3580A	Waste Dilution

Solid and Chemical Materials		
Technology	Method	Analyte
Cleanup Procedure	EPA 3620B	Florisil Cleanup
Cleanup Procedure	EPA 3630C	Silica Gel Cleanup
Cleanup Procedure	EPA 3640A	Gel Permeation Cleanup
Cleanup Procedure	EPA 3660A	Sulfur Cleanup
Purge and Trap	EPA 5035A	Purge-And-Trap And Extraction For Volatile Organics
Preparation	EPA-3546 for EPA 8081 A	Microwave Extraction
Preparation	EPA-3546 for EPA 8082	Microwave Extraction
Preparation	EPA-3546 for EPA 8270 D	Microwave Extraction

Notes:

- 1) This laboratory offers commercial testing service.

Approved by: _____



R. Douglas Leonard
Chief Technical Officer

Date: April 15, 2013

Re-issued: 4/15/13

State of Utah

Department of Health

Environmental Laboratory Certification Program

Certification is hereby granted to

ALS Environmental - Fort Collins

225 Commerce Drive
Fort Collins, CO 80524

*Has conformed with the
2009 TNI Standard*

*Scope of accreditation is limited to the
State of Utah Accredited Fields of Accreditation
Which accompanies this Certificate*

EPA Number: CO01099

Expiration Date: 11/30/2014

Certificate Number: CO010992013-9



Robyn M. Atkinson, Ph.D, HC LD
Director, Utah Public Health Laboratory



Continued accredited status depends on successful ongoing participation in the program.



State of Utah
Gary R Herbert
Governor
Gregory S Bell
Lieutenant Governor

Utah Department of Health

W. David Patton Ph.D

Executive Director

Disease Control and Prevention

Robyn M. Atkinson, Ph.D, HCLD

Director, Utah Public Health Laboratory

Bureau of Laboratory Improvement



EPA Number: **CO01099**

Attachment to Certificate Number: **CO010992013-9**

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ALS Environmental - Fort Collins

	Start Date	Expires	AB
Program/Matrix: CWA (Non Potable Water)			
Method EPA 120.1			
Conductivity	7/1/2012	11/30/2014	UT
Method EPA 150.1			
pH	7/1/2012	11/30/2014	UT
Method EPA 160.1			
Residue-filterable (TDS)	7/1/2012	11/30/2014	UT
Method EPA 160.2			
Residue-nonfilterable (TSS)	7/1/2012	11/30/2014	UT
Method EPA 160.3			
Residue-total	7/1/2012	11/30/2014	UT
Method EPA 1664A (HEM)			
Oil & Grease	7/1/2012	11/30/2014	UT
Method EPA 200.7			
Aluminum	7/1/2012	11/30/2014	UT
Antimony	7/1/2012	11/30/2014	UT
Arsenic	7/1/2012	11/30/2014	UT
Barium	7/1/2012	11/30/2014	UT
Beryllium	7/1/2012	11/30/2014	UT
Boron	7/1/2012	11/30/2014	UT
Cadmium	7/1/2012	11/30/2014	UT
Calcium	7/1/2012	11/30/2014	UT
Chromium	7/1/2012	11/30/2014	UT
Cobalt	7/1/2012	11/30/2014	UT
Copper	7/1/2012	11/30/2014	UT
Iron	7/1/2012	11/30/2014	UT
Lead	7/1/2012	11/30/2014	UT
Lithium	7/1/2012	11/30/2014	UT
Magnesium	7/1/2012	11/30/2014	UT
Manganese	7/1/2012	11/30/2014	UT
Molybdenum	7/1/2012	11/30/2014	UT
Nickel	7/1/2012	11/30/2014	UT
Potassium	7/1/2012	11/30/2014	UT
Selenium	7/1/2012	11/30/2014	UT
Silica as SiO2	7/1/2012	11/30/2014	UT
Silver	7/1/2012	11/30/2014	UT

ALS Environmental - Fort Collins

	Start Date	Expires	AB
Program/Matrix: CWA (Non Potable Water)			
Sodium	7/1/2012	11/30/2014	UT
Strontium	7/1/2012	11/30/2014	UT
Thallium	7/1/2012	11/30/2014	UT
Tin	7/1/2012	11/30/2014	UT
Titanium	7/1/2012	11/30/2014	UT
Total hardness as CaCO3	7/1/2012	11/30/2014	UT
Vanadium	7/1/2012	11/30/2014	UT
Zinc	7/1/2012	11/30/2014	UT
Method EPA 200.8			
Aluminum	7/1/2012	11/30/2014	UT
Antimony	7/1/2012	11/30/2014	UT
Arsenic	7/1/2012	11/30/2014	UT
Barium	7/1/2012	11/30/2014	UT
Beryllium	7/1/2012	11/30/2014	UT
Cadmium	7/1/2012	11/30/2014	UT
Calcium	7/1/2012	11/30/2014	UT
Chromium	7/1/2012	11/30/2014	UT
Cobalt	7/1/2012	11/30/2014	UT
Copper	7/1/2012	11/30/2014	UT
Iron	7/1/2012	11/30/2014	UT
Lead	7/1/2012	11/30/2014	UT
Magnesium	7/1/2012	11/30/2014	UT
Manganese	7/1/2012	11/30/2014	UT
Molybdenum	7/1/2012	11/30/2014	UT
Nickel	7/1/2012	11/30/2014	UT
Potassium	7/1/2012	11/30/2014	UT
Selenium	7/1/2012	11/30/2014	UT
Silver	7/1/2012	11/30/2014	UT
Sodium	7/1/2012	11/30/2014	UT
Strontium	7/1/2012	11/30/2014	UT
Thallium	7/1/2012	11/30/2014	UT
Thorium	7/1/2012	11/30/2014	UT
Tin	7/1/2012	11/30/2014	UT
Uranium	7/1/2012	11/30/2014	UT
Vanadium	7/1/2012	11/30/2014	UT
Zinc	7/1/2012	11/30/2014	UT
Method EPA 245.1			
Mercury	7/1/2012	11/30/2014	UT
Method EPA 300.0			
Bromide	7/1/2012	11/30/2014	UT
Chloride	7/1/2012	11/30/2014	UT
Fluoride	7/1/2012	11/30/2014	UT
Nitrate as N	7/1/2012	11/30/2014	UT
Nitrite as N	7/1/2012	11/30/2014	UT
Orthophosphate as P	7/1/2012	11/30/2014	UT
Sulfate	7/1/2012	11/30/2014	UT
Method EPA 310.1			
Alkalinity as CaCO3	7/1/2012	11/30/2014	UT

ALS Environmental - Fort Collins

Start Date	Expires	AB
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Program/Matrix: CWA (Non Potable Water)**Method EPA 335.2**

Cyanide	7/1/2012	11/30/2014	UT
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Method EPA 340.2

Fluoride	7/1/2012	11/30/2014	UT
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Method EPA 350.1

Ammonia as N	7/1/2012	11/30/2014	UT
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Method EPA 353.2

Nitrate-nitrite	7/1/2012	11/30/2014	UT
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Method EPA 354.1

Nitrite as N	7/1/2012	11/30/2014	UT
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Method EPA 365.2

Orthophosphate as P	7/1/2012	11/30/2014	UT
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Phosphorus, total	7/1/2012	11/30/2014	UT
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Method EPA 376.1

Sulfide	7/1/2012	11/30/2014	UT
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Method EPA 415.1

Total organic carbon	7/1/2012	11/30/2014	UT
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Method EPA 608

4,4'-DDD	7/1/2012	11/30/2014	UT
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4,4'-DDE	7/1/2012	11/30/2014	UT
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4,4'-DDT	7/1/2012	11/30/2014	UT
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Aldrin	7/1/2012	11/30/2014	UT
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alpha-BHC (alpha-Hexachlorocyclohexane)	7/1/2012	11/30/2014	UT
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Aroclor-1016 (PCB-1016)	7/1/2012	11/30/2014	UT
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Aroclor-1221 (PCB-1221)	7/1/2012	11/30/2014	UT
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Aroclor-1232 (PCB-1232)	7/1/2012	11/30/2014	UT
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Aroclor-1242 (PCB-1242)	7/1/2012	11/30/2014	UT
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Aroclor-1248 (PCB-1248)	7/1/2012	11/30/2014	UT
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Aroclor-1254 (PCB-1254)	7/1/2012	11/30/2014	UT
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Aroclor-1260 (PCB-1260)	7/1/2012	11/30/2014	UT
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beta-BHC (beta-Hexachlorocyclohexane)	7/1/2012	11/30/2014	UT
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Chlordane (tech.)	7/1/2012	11/30/2014	UT
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delta-BHC	7/1/2012	11/30/2014	UT
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Dieldrin	7/1/2012	11/30/2014	UT
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Endosulfan I	7/1/2012	11/30/2014	UT
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Endosulfan II	7/1/2012	11/30/2014	UT
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Endosulfan sulfate	7/1/2012	11/30/2014	UT
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Endrin	7/1/2012	11/30/2014	UT
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Endrin aldehyde	7/1/2012	11/30/2014	UT
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Endrin ketone	7/1/2012	11/30/2014	UT
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gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	7/1/2012	11/30/2014	UT
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Heptachlor	7/1/2012	11/30/2014	UT
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Heptachlor epoxide	7/1/2012	11/30/2014	UT
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Methoxychlor	7/1/2012	11/30/2014	UT
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Toxaphene (Chlorinated camphene)	7/1/2012	11/30/2014	UT
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Method EPA 615

ALS Environmental - Fort Collins

	Start Date	Expires	AB
Program/Matrix: CWA (Non Potable Water)			
2,4,5-T	7/1/2012	11/30/2014	UT
2,4-D	7/1/2012	11/30/2014	UT
2,4-DB	7/1/2012	11/30/2014	UT
Dalapon	7/1/2012	11/30/2014	UT
Dicamba	7/1/2012	11/30/2014	UT
Dichloroprop (Dichlorprop)	7/1/2012	11/30/2014	UT
MCPA	7/1/2012	11/30/2014	UT
MCPP	7/1/2012	11/30/2014	UT
Silvex (2,4,5-TP)	7/1/2012	11/30/2014	UT
Method EPA 900			
Gross-alpha	7/1/2012	11/30/2014	UT
Gross-beta	7/1/2012	11/30/2014	UT
Method EPA 901.1			
Gamma Emitters	7/1/2012	11/30/2014	UT
Method EPA 903			
Radium-226	7/1/2012	11/30/2014	UT
Total radium	7/1/2012	11/30/2014	UT
Method EPA 903.1			
Radium-226	7/1/2012	11/30/2014	UT
Method EPA 904			
Radium-228	7/1/2012	11/30/2014	UT
Method EPA 906.0			
Tritium	7/1/2012	11/30/2014	UT
Method HASL 300 U-02-RC			
Uranium	7/1/2012	11/30/2014	UT
Method SM 2320 B			
Alkalinity as CaCO ₃	7/1/2012	11/30/2014	UT
Method SM 2340 B			
Total hardness as CaCO ₃	7/1/2012	11/30/2014	UT
Method SM 2510 B			
Conductivity	7/1/2012	11/30/2014	UT
Method SM 2540 B			
Residue-total	7/1/2012	11/30/2014	UT
Method SM 2540 C			
Residue-filterable (TDS)	7/1/2012	11/30/2014	UT
Method SM 2540 D			
Residue-nonfilterable (TSS)	7/1/2012	11/30/2014	UT
Method SM 3500-Cr D			
Chromium VI	7/1/2012	11/30/2014	UT
Method SM 4500-CN⁻ C			
Cyanide	7/1/2012	11/30/2014	UT
Method SM 4500-CN⁻ E			
Cyanide	7/1/2012	11/30/2014	UT
Method SM 4500-CN⁻ G			
Cyanide	7/1/2012	11/30/2014	UT

ALS Environmental - Fort Collins

Start Date Expires AB**Program/Matrix: CWA (Non Potable Water)****Method SM 4500-F⁻ C**

Fluoride

7/1/2012 11/30/2014 UT

Method SM 4500-H⁺ B

pH

7/1/2012 11/30/2014 UT

Method SM 4500-NH₃ H

Ammonia as N

7/1/2012 11/30/2014 UT

Method SM 4500-NO₂⁻ B

Nitrite as N

7/1/2012 11/30/2014 UT

Method SM 4500-P E

Orthophosphate as P

7/1/2012 11/30/2014 UT

Phosphorus, total

7/1/2012 11/30/2014 UT

Method SM 4500-S₂⁻ F

Sulfide

7/1/2012 11/30/2014 UT

Method SM 5310 C

Total organic carbon

7/1/2012 11/30/2014 UT

Method SM 7500-3H B

Tritium

7/1/2012 11/30/2014 UT

Method SM 7500-Rn B

Radon-222

7/1/2012 11/30/2014 UT

ALS Environmental - Fort Collins

Start Date	Expires	AB
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Program/Matrix: RCRA (Non Potable Water)**Method ASTM D3972-90**

Thorium-228	7/1/2012	11/30/2014	UT
Thorium-230	7/1/2012	11/30/2014	UT
Thorium-232	7/1/2012	11/30/2014	UT

Method CA Waste Extraction Test (WET)

Preparation/Extraction	11/1/2013	11/30/2014	UT
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Method EPA 053917 p. 33 EMSL LV

Thorium-228	7/1/2012	11/30/2014	UT
Thorium-230	7/1/2012	11/30/2014	UT
Thorium-232	7/1/2012	11/30/2014	UT

Method EPA 1010A

Ignitability	7/1/2012	11/30/2014	UT
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Method EPA 1110A

Corrosivity toward steel	7/1/2012	11/30/2014	UT
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Method EPA 1311

Toxicity Characteristic Leaching Procedure Metals	7/1/2012	11/30/2014	UT
Toxicity Characteristic Leaching Procedure Semi-Volatiles	7/1/2012	11/30/2014	UT
Toxicity Characteristic Leaching Procedure Volatiles	7/1/2012	11/30/2014	UT

Method EPA 1312

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 1664A

Total recoverable petroleum hydrocarbons (TRPH)	7/1/2012	11/30/2014	UT
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Method EPA 1664A (HEM)

Oil & Grease	7/1/2012	11/30/2014	UT
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Method EPA 3005A

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3010A

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3510C

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3520C

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3620B

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3630C

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3640A

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3660A

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 5030C

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 6010B

Aluminum	7/1/2012	11/30/2014	UT
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ALS Environmental - Fort Collins

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
Antimony	7/1/2012	11/30/2014	UT
Arsenic	7/1/2012	11/30/2014	UT
Barium	7/1/2012	11/30/2014	UT
Beryllium	7/1/2012	11/30/2014	UT
Boron	7/1/2012	11/30/2014	UT
Cadmium	7/1/2012	11/30/2014	UT
Calcium	7/1/2012	11/30/2014	UT
Chromium	7/1/2012	11/30/2014	UT
Cobalt	7/1/2012	11/30/2014	UT
Copper	7/1/2012	11/30/2014	UT
Iron	7/1/2012	11/30/2014	UT
Lead	7/1/2012	11/30/2014	UT
Lithium	7/1/2012	11/30/2014	UT
Magnesium	7/1/2012	11/30/2014	UT
Manganese	7/1/2012	11/30/2014	UT
Molybdenum	7/1/2012	11/30/2014	UT
Nickel	7/1/2012	11/30/2014	UT
Phosphorus, total	7/1/2012	11/30/2014	UT
Potassium	7/1/2012	11/30/2014	UT
Selenium	7/1/2012	11/30/2014	UT
Silica as SiO ₂	7/1/2012	11/30/2014	UT
Silicon	7/1/2012	11/30/2014	UT
Silver	7/1/2012	11/30/2014	UT
Sodium	7/1/2012	11/30/2014	UT
Strontium	7/1/2012	11/30/2014	UT
Thallium	7/1/2012	11/30/2014	UT
Tin	7/1/2012	11/30/2014	UT
Titanium	7/1/2012	11/30/2014	UT
Vanadium	7/1/2012	11/30/2014	UT
Zinc	7/1/2012	11/30/2014	UT
Method EPA 6020A			
Aluminum	7/1/2012	11/30/2014	UT
Antimony	7/1/2012	11/30/2014	UT
Arsenic	7/1/2012	11/30/2014	UT
Cadmium	7/1/2012	11/30/2014	UT
Calcium	7/1/2012	11/30/2014	UT
Copper	7/1/2012	11/30/2014	UT
Iron	7/1/2012	11/30/2014	UT
Lead	7/1/2012	11/30/2014	UT
Magnesium	7/1/2012	11/30/2014	UT
Molybdenum	7/1/2012	11/30/2014	UT
Nickel	7/1/2012	11/30/2014	UT
Potassium	7/1/2012	11/30/2014	UT
Selenium	7/1/2012	11/30/2014	UT
Silver	7/1/2012	11/30/2014	UT
Strontium	7/1/2012	11/30/2014	UT
Thallium	7/1/2012	11/30/2014	UT
Thorium	7/1/2012	11/30/2014	UT

ALS Environmental - Fort Collins

	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
Uranium	7/1/2012	11/30/2014	UT
Vanadium	7/1/2012	11/30/2014	UT
Method EPA 7196A			
Chromium VI	7/1/2012	11/30/2014	UT
Method EPA 7470A			
Mercury	7/1/2012	11/30/2014	UT
Method EPA 8015D			
Diesel range organics (DRO)	7/1/2012	11/30/2014	UT
Ethylene glycol	7/1/2012	11/30/2014	UT
Gasoline range organics (GRO)	7/1/2012	11/30/2014	UT
Method EPA 8081A			
4,4'-DDD	7/1/2012	11/30/2014	UT
4,4'-DDE	7/1/2012	11/30/2014	UT
4,4'-DDT	7/1/2012	11/30/2014	UT
Aldrin	7/1/2012	11/30/2014	UT
alpha-BHC (alpha-Hexachlorocyclohexane)	7/1/2012	11/30/2014	UT
alpha-Chlordane	7/1/2012	11/30/2014	UT
beta-BHC (beta-Hexachlorocyclohexane)	7/1/2012	11/30/2014	UT
Chlordane (tech.)	7/1/2012	11/30/2014	UT
delta-BHC	7/1/2012	11/30/2014	UT
Dieldrin	7/1/2012	11/30/2014	UT
Endosulfan I	7/1/2012	11/30/2014	UT
Endosulfan II	7/1/2012	11/30/2014	UT
Endosulfan sulfate	7/1/2012	11/30/2014	UT
Endrin	7/1/2012	11/30/2014	UT
Endrin aldehyde	7/1/2012	11/30/2014	UT
Endrin ketone	7/1/2012	11/30/2014	UT
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	7/1/2012	11/30/2014	UT
gamma-Chlordane	7/1/2012	11/30/2014	UT
Heptachlor	7/1/2012	11/30/2014	UT
Heptachlor epoxide	7/1/2012	11/30/2014	UT
Methoxychlor	7/1/2012	11/30/2014	UT
Toxaphene (Chlorinated camphene)	7/1/2012	11/30/2014	UT
Method EPA 8082			
Aroclor-1016 (PCB-1016)	7/1/2012	11/30/2014	UT
Aroclor-1221 (PCB-1221)	7/1/2012	11/30/2014	UT
Aroclor-1232 (PCB-1232)	7/1/2012	11/30/2014	UT
Aroclor-1242 (PCB-1242)	7/1/2012	11/30/2014	UT
Aroclor-1248 (PCB-1248)	7/1/2012	11/30/2014	UT
Aroclor-1254 (PCB-1254)	7/1/2012	11/30/2014	UT
Aroclor-1260 (PCB-1260)	7/1/2012	11/30/2014	UT
Aroclor-1268 (PCB-1268)	7/1/2012	11/30/2014	UT
PCBs	7/1/2012	11/30/2014	UT
Method EPA 8141A			
Azinphos-methyl (Guthion)	7/1/2012	11/30/2014	UT
Bolstar (Sulprofos)	7/1/2012	11/30/2014	UT
Chlorpyrifos	7/1/2012	11/30/2014	UT

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	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
Coumaphos	7/1/2012	11/30/2014	UT
Demeton-o	7/1/2012	11/30/2014	UT
Demeton-s	7/1/2012	11/30/2014	UT
Diazinon	7/1/2012	11/30/2014	UT
Dichlorovos (DDVP, Dichlorvos)	7/1/2012	11/30/2014	UT
Disulfoton	7/1/2012	11/30/2014	UT
Ethoprop	7/1/2012	11/30/2014	UT
Fensulfothion	7/1/2012	11/30/2014	UT
Fenthion	7/1/2012	11/30/2014	UT
Malathion	7/1/2012	11/30/2014	UT
Merphos	7/1/2012	11/30/2014	UT
Methyl parathion (Parathion, methyl)	7/1/2012	11/30/2014	UT
Mevinphos	7/1/2012	11/30/2014	UT
Naled	7/1/2012	11/30/2014	UT
Phorate	7/1/2012	11/30/2014	UT
Ronnel	7/1/2012	11/30/2014	UT
Tetrachlorvinphos (Stirophos, Gardona) Z-isomer	7/1/2012	11/30/2014	UT
Tokuthion (Prothiophos)	7/1/2012	11/30/2014	UT
Trichloronate	7/1/2012	11/30/2014	UT
Method EPA 8151A			
2,4,5-T	7/1/2012	11/30/2014	UT
2,4-D	7/1/2012	11/30/2014	UT
2,4-DB	7/1/2012	11/30/2014	UT
Dalapon	7/1/2012	11/30/2014	UT
Dicamba	7/1/2012	11/30/2014	UT
Dichloroprop (Dichlorprop)	7/1/2012	11/30/2014	UT
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	7/1/2012	11/30/2014	UT
MCPA	7/1/2012	11/30/2014	UT
MCPP	7/1/2012	11/30/2014	UT
Silvex (2,4,5-TP)	7/1/2012	11/30/2014	UT
Method EPA 8260C			
1,1,1,2-Tetrachloroethane	7/1/2012	11/30/2014	UT
1,1,1-Trichloroethane	7/1/2012	11/30/2014	UT
1,1,2,2-Tetrachloroethane	7/1/2012	11/30/2014	UT
1,1,2-Trichloroethane	7/1/2012	11/30/2014	UT
1,1-Dichloroethane	7/1/2012	11/30/2014	UT
1,1-Dichloroethylene	7/1/2012	11/30/2014	UT
1,2,3-Trichlorobenzene	7/1/2012	11/30/2014	UT
1,2,3-Trichloropropane	7/1/2012	11/30/2014	UT
1,2,3-Trimethylbenzene	7/1/2012	11/30/2014	UT
1,2,4-Trichlorobenzene	7/1/2012	11/30/2014	UT
1,2-Dibromo-3-chloropropane (DBCP)	7/1/2012	11/30/2014	UT
1,2-Dibromoethane (EDB, Ethylene dibromide)	7/1/2012	11/30/2014	UT
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2012	11/30/2014	UT
1,2-Dichloroethane (Ethylene dichloride)	7/1/2012	11/30/2014	UT
1,2-Dichloropropane	7/1/2012	11/30/2014	UT
1,3,5-Trimethylbenzene	7/1/2012	11/30/2014	UT
1,3-Dichlorobenzene	7/1/2012	11/30/2014	UT

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	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
1,3-Dichloropropane	7/1/2012	11/30/2014	UT
1,4-Dichlorobenzene	7/1/2012	11/30/2014	UT
1,4-Dioxane (1,4- Diethyleneoxide)	7/1/2012	11/30/2014	UT
1-Chlorobutane	1/23/2013	11/30/2014	UT
1-Chlorohexane	7/1/2012	11/30/2014	UT
2,2-Dichloropropane	7/1/2012	11/30/2014	UT
2-Butanone (Methyl ethyl ketone, MEK)	7/1/2012	11/30/2014	UT
2-Chloroethyl vinyl ether	7/1/2012	11/30/2014	UT
2-Chlorotoluene	7/1/2012	11/30/2014	UT
2-Hexanone	7/1/2012	11/30/2014	UT
4-Chlorotoluene	7/1/2012	11/30/2014	UT
4-Isopropyltoluene (p-Cymene,p-Isopropyltoluene)	7/1/2012	11/30/2014	UT
4-Methyl-2-pentanone (MIBK)	7/1/2012	11/30/2014	UT
Acetone	7/1/2012	11/30/2014	UT
Acetonitrile	7/1/2012	11/30/2014	UT
Acrolein (Propenal)	7/1/2012	11/30/2014	UT
Acrylonitrile	7/1/2012	11/30/2014	UT
Allyl chloride (3-Chloropropene)	7/1/2012	11/30/2014	UT
Benzene	7/1/2012	11/30/2014	UT
Bromobenzene	7/1/2012	11/30/2014	UT
Bromochloromethane	7/1/2012	11/30/2014	UT
Bromodichloromethane	7/1/2012	11/30/2014	UT
Bromoform	7/1/2012	11/30/2014	UT
Carbon disulfide	7/1/2012	11/30/2014	UT
Carbon tetrachloride	7/1/2012	11/30/2014	UT
Chloroacetonitrile	1/23/2013	11/30/2014	UT
Chlorobenzene	7/1/2012	11/30/2014	UT
Chlorodibromomethane	7/1/2012	11/30/2014	UT
Chloroethane (Ethyl chloride)	7/1/2012	11/30/2014	UT
Chloroform	7/1/2012	11/30/2014	UT
Chloroprene (2-Chloro-1,3-butadiene)	7/1/2012	11/30/2014	UT
cis-1,2-Dichloroethylene	7/1/2012	11/30/2014	UT
cis-1,3-Dichloropropene	7/1/2012	11/30/2014	UT
Dibromomethane (Methylene bromide)	7/1/2012	11/30/2014	UT
Dichlorodifluoromethane (Freon-12)	7/1/2012	11/30/2014	UT
Diethyl ether	7/1/2012	11/30/2014	UT
Ethanol	7/1/2012	11/30/2014	UT
Ethyl methacrylate	7/1/2012	11/30/2014	UT
Ethylbenzene	7/1/2012	11/30/2014	UT
Hexachlorobutadiene	7/1/2012	11/30/2014	UT
Hexachloroethane	7/1/2012	11/30/2014	UT
Iodomethane (Methyl iodide)	7/1/2012	11/30/2014	UT
Isobutyl alcohol (2-Methyl-1-propanol)	7/1/2012	11/30/2014	UT
Isopropylbenzene	7/1/2012	11/30/2014	UT
Methacrylonitrile	7/1/2012	11/30/2014	UT
Methyl acrylate	1/23/2013	11/30/2014	UT
Methyl bromide (Bromomethane)	7/1/2012	11/30/2014	UT
Methyl chloride (Chloromethane)	7/1/2012	11/30/2014	UT
Methyl methacrylate	7/1/2012	11/30/2014	UT

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	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
Methyl tert-butyl ether (MTBE)	7/1/2012	11/30/2014	UT
Methylene chloride (Dichloromethane)	7/1/2012	11/30/2014	UT
m-Xylene	7/1/2012	11/30/2014	UT
Naphthalene	7/1/2012	11/30/2014	UT
n-Butyl alcohol (1-Butanol, n-Butanol)	7/1/2012	11/30/2014	UT
n-Butylbenzene	7/1/2012	11/30/2014	UT
n-Propylbenzene	7/1/2012	11/30/2014	UT
o-Xylene	7/1/2012	11/30/2014	UT
Pentafluorobenzene	1/23/2013	11/30/2014	UT
Propionitrile (Ethyl cyanide)	7/1/2012	11/30/2014	UT
p-Xylene	7/1/2012	11/30/2014	UT
sec-Butylbenzene	7/1/2012	11/30/2014	UT
Styrene	7/1/2012	11/30/2014	UT
Tetrachloroethylene (Perchloroethylene)	7/1/2012	11/30/2014	UT
Toluene	7/1/2012	11/30/2014	UT
trans-1,2-Dichloroethylene	7/1/2012	11/30/2014	UT
trans-1,3-Dichloropropylene	7/1/2012	11/30/2014	UT
trans-1,4-Dichloro-2-butene	7/1/2012	11/30/2014	UT
Trichloroethene (Trichloroethylene)	7/1/2012	11/30/2014	UT
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	7/1/2012	11/30/2014	UT
Vinyl acetate	7/1/2012	11/30/2014	UT
Vinyl chloride	7/1/2012	11/30/2014	UT
Xylene (total)	7/1/2012	11/30/2014	UT
Method EPA 8270D			
1,2,4,5-Tetrachlorobenzene	7/1/2012	11/30/2014	UT
1,2,4-Trichlorobenzene	7/1/2012	11/30/2014	UT
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2012	11/30/2014	UT
1,2-Dinitrobenzene	7/1/2012	11/30/2014	UT
1,3,5-Trinitrobenzene (1,3,5-TNB)	7/1/2012	11/30/2014	UT
1,3-Dichlorobenzene	7/1/2012	11/30/2014	UT
1,3-Dinitrobenzene (1,3-DNB)	7/1/2012	11/30/2014	UT
1,4-Dichlorobenzene	7/1/2012	11/30/2014	UT
1,4-Dinitrobenzene	7/1/2012	11/30/2014	UT
1-Methylnaphthalene	7/1/2012	11/30/2014	UT
1-Naphthylamine	7/1/2012	11/30/2014	UT
2,3,4,6-Tetrachlorophenol	7/1/2012	11/30/2014	UT
2,4,5-Trichlorophenol	7/1/2012	11/30/2014	UT
2,4,6-Trichlorophenol	7/1/2012	11/30/2014	UT
2,4-Dichlorophenol	7/1/2012	11/30/2014	UT
2,4-Dimethylphenol	7/1/2012	11/30/2014	UT
2,4-Dinitrophenol	7/1/2012	11/30/2014	UT
2,4-Dinitrotoluene (2,4-DNT)	7/1/2012	11/30/2014	UT
2,6-Dichlorophenol	7/1/2012	11/30/2014	UT
2,6-Dinitrotoluene (2,6-DNT)	7/1/2012	11/30/2014	UT
2-Acetylaminofluorene	7/1/2012	11/30/2014	UT
2-Chloronaphthalene	7/1/2012	11/30/2014	UT
2-Chlorophenol	7/1/2012	11/30/2014	UT
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	7/1/2012	11/30/2014	UT

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	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
2-Methylnaphthalene	7/1/2012	11/30/2014	UT
2-Methylphenol (o-Cresol)	7/1/2012	11/30/2014	UT
2-Naphthylamine	7/1/2012	11/30/2014	UT
2-Nitroaniline	7/1/2012	11/30/2014	UT
2-Nitrophenol	7/1/2012	11/30/2014	UT
3,3'-Dichlorobenzidine	7/1/2012	11/30/2014	UT
3-Methylcholanthrene	7/1/2012	11/30/2014	UT
3-Methylphenol (m-Cresol)	7/1/2012	11/30/2014	UT
3-Nitroaniline	7/1/2012	11/30/2014	UT
4-Bromophenyl phenyl ether	7/1/2012	11/30/2014	UT
4-Chloro-3-methylphenol	7/1/2012	11/30/2014	UT
4-Chloroaniline	7/1/2012	11/30/2014	UT
4-Chlorophenyl phenylether	7/1/2012	11/30/2014	UT
4-Methylphenol (p-Cresol)	7/1/2012	11/30/2014	UT
4-Nitroaniline	7/1/2012	11/30/2014	UT
4-Nitrophenol	7/1/2012	11/30/2014	UT
5-Nitro-o-toluidine	7/1/2012	11/30/2014	UT
7,12-Dimethylbenz(a) anthracene	7/1/2012	11/30/2014	UT
Acenaphthene	7/1/2012	11/30/2014	UT
Acenaphthylene	7/1/2012	11/30/2014	UT
Acetophenone	7/1/2012	11/30/2014	UT
Aniline	7/1/2012	11/30/2014	UT
Anthracene	7/1/2012	11/30/2014	UT
Azobenzene (1,2-Diphenylhydrazine)	7/1/2012	11/30/2014	UT
Benzidine	7/1/2012	11/30/2014	UT
Benzo(a)anthracene	7/1/2012	11/30/2014	UT
Benzo(a)pyrene	7/1/2012	11/30/2014	UT
Benzo(b)fluoranthene	7/1/2012	11/30/2014	UT
Benzo(g,h,i)perylene	7/1/2012	11/30/2014	UT
Benzo(k)fluoranthene	7/1/2012	11/30/2014	UT
Benzoic acid	7/1/2012	11/30/2014	UT
Benzyl alcohol	7/1/2012	11/30/2014	UT
bis(2-Chloroethoxy)methane	7/1/2012	11/30/2014	UT
bis(2-Chloroethyl) ether	7/1/2012	11/30/2014	UT
bis(2-Chloroisopropyl) ether	7/1/2012	11/30/2014	UT
bis(2-Ethylhexyl) phthalate (DEHP)	7/1/2012	11/30/2014	UT
Butyl benzyl phthalate	7/1/2012	11/30/2014	UT
Carbazole	7/1/2012	11/30/2014	UT
Chrysene	7/1/2012	11/30/2014	UT
Dibenz(a,h) anthracene	7/1/2012	11/30/2014	UT
Dibenzofuran	7/1/2012	11/30/2014	UT
Diethyl phthalate	7/1/2012	11/30/2014	UT
Dimethyl phthalate	7/1/2012	11/30/2014	UT
Di-n-butyl phthalate	7/1/2012	11/30/2014	UT
Di-n-octyl phthalate	7/1/2012	11/30/2014	UT
Ethyl methanesulfonate	7/1/2012	11/30/2014	UT
Fluoranthene	7/1/2012	11/30/2014	UT
Fluorene	7/1/2012	11/30/2014	UT
Hexachlorobenzene	7/1/2012	11/30/2014	UT

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	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
Hexachlorobutadiene	7/1/2012	11/30/2014	UT
Hexachlorocyclopentadiene	7/1/2012	11/30/2014	UT
Hexachloroethane	7/1/2012	11/30/2014	UT
Hexachloropropene	7/1/2012	11/30/2014	UT
Indeno(1,2,3-cd) pyrene	7/1/2012	11/30/2014	UT
Isophorone	7/1/2012	11/30/2014	UT
Isosafrole	7/1/2012	11/30/2014	UT
Methyl methanesulfonate	7/1/2012	11/30/2014	UT
Naphthalene	7/1/2012	11/30/2014	UT
Nitrobenzene	7/1/2012	11/30/2014	UT
n-Nitrosodiethylamine	7/1/2012	11/30/2014	UT
n-Nitrosodimethylamine	7/1/2012	11/30/2014	UT
n-Nitroso-di-n-butylamine	7/1/2012	11/30/2014	UT
n-Nitrosodi-n-propylamine	7/1/2012	11/30/2014	UT
n-Nitrosodiphenylamine	7/1/2012	11/30/2014	UT
n-Nitrosomethylethylamine	7/1/2012	11/30/2014	UT
n-Nitrosomorpholine	7/1/2012	11/30/2014	UT
n-Nitrosopiperidine	7/1/2012	11/30/2014	UT
n-Nitrosopyrrolidine	7/1/2012	11/30/2014	UT
Pentachlorobenzene	7/1/2012	11/30/2014	UT
Pentachloronitrobenzene	7/1/2012	11/30/2014	UT
Pentachlorophenol	7/1/2012	11/30/2014	UT
Phenacetin	7/1/2012	11/30/2014	UT
Phenanthrene	7/1/2012	11/30/2014	UT
Phenol	7/1/2012	11/30/2014	UT
Pyrene	7/1/2012	11/30/2014	UT
Pyridine	7/1/2012	11/30/2014	UT
Safrole	7/1/2012	11/30/2014	UT
Method EPA 901.1			
Cesium-134	7/1/2012	11/30/2014	UT
Cesium-137	7/1/2012	11/30/2014	UT
Cobalt-60	7/1/2012	11/30/2014	UT
Method EPA 9010C			
Cyanide	7/1/2012	11/30/2014	UT
Method EPA 9013A			
Preparation/Extraction	7/1/2012	11/30/2014	UT
Method EPA 9014			
Cyanide	7/1/2012	11/30/2014	UT
Method EPA 9034			
Total sulfides	7/1/2012	11/30/2014	UT
Method EPA 9040C			
pH	7/1/2012	11/30/2014	UT
Method EPA 9050A			
Conductivity	7/1/2012	11/30/2014	UT
Method EPA 9056A			
Bromide	7/1/2012	11/30/2014	UT
Chloride	7/1/2012	11/30/2014	UT

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	Start Date	Expires	AB
Program/Matrix: RCRA (Non Potable Water)			
Fluoride	7/1/2012	11/30/2014	UT
Nitrate as N	7/1/2012	11/30/2014	UT
Nitrite as N	7/1/2012	11/30/2014	UT
Orthophosphate as P	7/1/2012	11/30/2014	UT
Sulfate	7/1/2012	11/30/2014	UT
Method EPA 906.0			
Tritium	7/1/2012	11/30/2014	UT
Method EPA 9060A			
Total organic carbon	7/1/2012	11/30/2014	UT
Method EPA 9214			
Fluoride	7/1/2012	11/30/2014	UT
Method EPA 9310			
Gross alpha-beta	7/1/2012	11/30/2014	UT
Method EPA 9315			
Total alpha radium	7/1/2012	11/30/2014	UT
Method EPA 9320			
Radium-228	7/1/2012	11/30/2014	UT
Method EPA RSK-175 (GC/FID)			
Ethane	7/1/2012	11/30/2014	UT
Ethene	7/1/2012	11/30/2014	UT
Methane	7/1/2012	11/30/2014	UT
n-Propane	7/1/2012	11/30/2014	UT
Method HASL 300 Ga-01-R sec 4.5.2.3			
Cesium-134	7/1/2012	11/30/2014	UT
Cesium-137	7/1/2012	11/30/2014	UT
Cobalt-60	7/1/2012	11/30/2014	UT
Method HASL 300 Sr-01-RC (GPC)			
Strontium-89, 90	7/1/2012	11/30/2014	UT
Method HASL 300 U-02-RC			
Americium-241	7/1/2012	11/30/2014	UT
Plutonium	7/1/2012	11/30/2014	UT
Thorium-228	7/1/2012	11/30/2014	UT
Thorium-230	7/1/2012	11/30/2014	UT
Thorium-232	7/1/2012	11/30/2014	UT
Method LUFT GC			
Diesel range organics (DRO)	11/1/2013	11/30/2014	UT
Gasoline range organics (GRO)	11/1/2013	11/30/2014	UT
Method SM 7500-Ra C (SC)			
Radium-226	7/1/2012	11/30/2014	UT

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Start Date	Expires	AB
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Program/Matrix: RCRA (Solid & Hazardous Material)**Method ASTM D3972-90**

Thorium-228	7/1/2012	11/30/2014	UT
Thorium-230	7/1/2012	11/30/2014	UT
Thorium-232	7/1/2012	11/30/2014	UT

Method CA Waste Extraction Test (WET)

Preparation/Extraction	11/1/2013	11/30/2014	UT
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Method EPA 053917 p. 33 EMSL LV

Thorium-228	7/1/2012	11/30/2014	UT
Thorium-230	7/1/2012	11/30/2014	UT
Thorium-232	7/1/2012	11/30/2014	UT

Method EPA 1010A

Ignitability	7/1/2012	11/30/2014	UT
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Method EPA 1110A

Corrosivity toward steel	7/1/2012	11/30/2014	UT
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Method EPA 1311

Toxicity Characteristic Leaching Procedure Metals	7/1/2012	11/30/2014	UT
Toxicity Characteristic Leaching Procedure Semi-Volatiles	7/1/2012	11/30/2014	UT
Toxicity Characteristic Leaching Procedure Volatiles	7/1/2012	11/30/2014	UT

Method EPA 1312

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3050B

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3060A

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3540C

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3580A

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3620B

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3630C

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3640A

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 3660A

Preparation/Extraction	7/1/2012	11/30/2014	UT
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Method EPA 5035A

Preparation/Extraction	1/23/2013	11/30/2014	UT
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Method EPA 6010B

Aluminum	7/1/2012	11/30/2014	UT
Antimony	7/1/2012	11/30/2014	UT
Arsenic	7/1/2012	11/30/2014	UT
Barium	7/1/2012	11/30/2014	UT
Beryllium	7/1/2012	11/30/2014	UT
Boron	7/1/2012	11/30/2014	UT

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	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
Cadmium	7/1/2012	11/30/2014	UT
Calcium	7/1/2012	11/30/2014	UT
Chromium	7/1/2012	11/30/2014	UT
Cobalt	7/1/2012	11/30/2014	UT
Copper	7/1/2012	11/30/2014	UT
Iron	7/1/2012	11/30/2014	UT
Lead	7/1/2012	11/30/2014	UT
Lithium	7/1/2012	11/30/2014	UT
Magnesium	7/1/2012	11/30/2014	UT
Manganese	7/1/2012	11/30/2014	UT
Molybdenum	7/1/2012	11/30/2014	UT
Nickel	7/1/2012	11/30/2014	UT
Phosphorus, total	7/1/2012	11/30/2014	UT
Potassium	7/1/2012	11/30/2014	UT
Selenium	7/1/2012	11/30/2014	UT
Silica as SiO2	7/1/2012	11/30/2014	UT
Silicon	7/1/2012	11/30/2014	UT
Silver	7/1/2012	11/30/2014	UT
Sodium	7/1/2012	11/30/2014	UT
Strontium	7/1/2012	11/30/2014	UT
Thallium	7/1/2012	11/30/2014	UT
Tin	7/1/2012	11/30/2014	UT
Titanium	7/1/2012	11/30/2014	UT
Vanadium	7/1/2012	11/30/2014	UT
Zinc	7/1/2012	11/30/2014	UT
Method EPA 6020A			
Aluminum	7/1/2012	11/30/2014	UT
Antimony	7/1/2012	11/30/2014	UT
Arsenic	7/1/2012	11/30/2014	UT
Cadmium	7/1/2012	11/30/2014	UT
Calcium	7/1/2012	11/30/2014	UT
Copper	7/1/2012	11/30/2014	UT
Iron	7/1/2012	11/30/2014	UT
Lead	7/1/2012	11/30/2014	UT
Magnesium	7/1/2012	11/30/2014	UT
Molybdenum	7/1/2012	11/30/2014	UT
Nickel	7/1/2012	11/30/2014	UT
Potassium	7/1/2012	11/30/2014	UT
Selenium	7/1/2012	11/30/2014	UT
Silver	7/1/2012	11/30/2014	UT
Strontium	7/1/2012	11/30/2014	UT
Thallium	7/1/2012	11/30/2014	UT
Thorium	7/1/2012	11/30/2014	UT
Uranium	7/1/2012	11/30/2014	UT
Vanadium	7/1/2012	11/30/2014	UT
Method EPA 7196A			
Chromium VI	7/1/2012	11/30/2014	UT
Method EPA 7471A			

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	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
Mercury	7/1/2012	11/30/2014	UT
Method EPA 8015D			
Diesel range organics (DRO)	7/1/2012	11/30/2014	UT
Ethylene glycol	7/1/2012	11/30/2014	UT
Gasoline range organics (GRO)	7/1/2012	11/30/2014	UT
Method EPA 8081A			
4,4'-DDD	7/1/2012	11/30/2014	UT
4,4'-DDE	7/1/2012	11/30/2014	UT
4,4'-DDT	7/1/2012	11/30/2014	UT
Aldrin	7/1/2012	11/30/2014	UT
alpha-BHC (alpha-Hexachlorocyclohexane)	7/1/2012	11/30/2014	UT
alpha-Chlordane	7/1/2012	11/30/2014	UT
beta-BHC (beta-Hexachlorocyclohexane)	7/1/2012	11/30/2014	UT
Chlordane (tech.)	7/1/2012	11/30/2014	UT
delta-BHC	7/1/2012	11/30/2014	UT
Dieldrin	7/1/2012	11/30/2014	UT
Endosulfan I	7/1/2012	11/30/2014	UT
Endosulfan II	7/1/2012	11/30/2014	UT
Endosulfan sulfate	7/1/2012	11/30/2014	UT
Endrin	7/1/2012	11/30/2014	UT
Endrin aldehyde	7/1/2012	11/30/2014	UT
Endrin ketone	7/1/2012	11/30/2014	UT
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	7/1/2012	11/30/2014	UT
gamma-Chlordane	7/1/2012	11/30/2014	UT
Heptachlor	7/1/2012	11/30/2014	UT
Heptachlor epoxide	7/1/2012	11/30/2014	UT
Methoxychlor	7/1/2012	11/30/2014	UT
Toxaphene (Chlorinated camphene)	7/1/2012	11/30/2014	UT
Method EPA 8082			
Aroclor-1016 (PCB-1016)	7/1/2012	11/30/2014	UT
Aroclor-1221 (PCB-1221)	7/1/2012	11/30/2014	UT
Aroclor-1232 (PCB-1232)	7/1/2012	11/30/2014	UT
Aroclor-1242 (PCB-1242)	7/1/2012	11/30/2014	UT
Aroclor-1248 (PCB-1248)	7/1/2012	11/30/2014	UT
Aroclor-1254 (PCB-1254)	7/1/2012	11/30/2014	UT
Aroclor-1260 (PCB-1260)	7/1/2012	11/30/2014	UT
Aroclor-1268 (PCB-1268)	7/1/2012	11/30/2014	UT
PCBs	7/1/2012	11/30/2014	UT
Method EPA 8141A			
Azinphos-methyl (Guthion)	7/1/2012	11/30/2014	UT
Bolstar (Sulprofos)	7/1/2012	11/30/2014	UT
Chlorpyrifos	7/1/2012	11/30/2014	UT
Coumaphos	7/1/2012	11/30/2014	UT
Demeton-o	7/1/2012	11/30/2014	UT
Demeton-s	7/1/2012	11/30/2014	UT
Diazinon	7/1/2012	11/30/2014	UT
Dichlorovos (DDVP, Dichlorvos)	7/1/2012	11/30/2014	UT
Disulfoton	7/1/2012	11/30/2014	UT

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	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
Ethoprop	7/1/2012	11/30/2014	UT
Fensulfothion	7/1/2012	11/30/2014	UT
Fenthion	7/1/2012	11/30/2014	UT
Malathion	7/1/2012	11/30/2014	UT
Merphos	7/1/2012	11/30/2014	UT
Methyl parathion (Parathion, methyl)	7/1/2012	11/30/2014	UT
Mevinphos	7/1/2012	11/30/2014	UT
Naled	7/1/2012	11/30/2014	UT
Phorate	7/1/2012	11/30/2014	UT
Ronnel	7/1/2012	11/30/2014	UT
Tetrachlorvinphos (Stirophos, Gardona) Z-isomer	7/1/2012	11/30/2014	UT
Tokuthion (Prothiophos)	7/1/2012	11/30/2014	UT
Trichloronate	7/1/2012	11/30/2014	UT
Method EPA 8151A			
2,4,5-T	7/1/2012	11/30/2014	UT
2,4-D	7/1/2012	11/30/2014	UT
2,4-DB	7/1/2012	11/30/2014	UT
Dalapon	7/1/2012	11/30/2014	UT
Dicamba	7/1/2012	11/30/2014	UT
Dichloroprop (Dichlorprop)	7/1/2012	11/30/2014	UT
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	7/1/2012	11/30/2014	UT
MCPA	7/1/2012	11/30/2014	UT
MCPP	7/1/2012	11/30/2014	UT
Silvex (2,4,5-TP)	7/1/2012	11/30/2014	UT
Method EPA 8260C			
1,1,1,2-Tetrachloroethane	7/1/2012	11/30/2014	UT
1,1,1-Trichloroethane	7/1/2012	11/30/2014	UT
1,1,2,2-Tetrachloroethane	7/1/2012	11/30/2014	UT
1,1,2-Trichloroethane	7/1/2012	11/30/2014	UT
1,1-Dichloroethane	7/1/2012	11/30/2014	UT
1,1-Dichloroethylene	7/1/2012	11/30/2014	UT
1,2,3-Trichlorobenzene	7/1/2012	11/30/2014	UT
1,2,3-Trichloropropane	7/1/2012	11/30/2014	UT
1,2,3-Trimethylbenzene	7/1/2012	11/30/2014	UT
1,2,4-Trichlorobenzene	7/1/2012	11/30/2014	UT
1,2-Dibromo-3-chloropropane (DBCP)	7/1/2012	11/30/2014	UT
1,2-Dibromoethane (EDB, Ethylene dibromide)	7/1/2012	11/30/2014	UT
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2012	11/30/2014	UT
1,2-Dichloroethane (Ethylene dichloride)	7/1/2012	11/30/2014	UT
1,2-Dichloropropane	7/1/2012	11/30/2014	UT
1,3,5-Trimethylbenzene	7/1/2012	11/30/2014	UT
1,3-Dichlorobenzene	7/1/2012	11/30/2014	UT
1,3-Dichloropropene	7/1/2012	11/30/2014	UT
1,4-Dichlorobenzene	7/1/2012	11/30/2014	UT
1,4-Dioxane (1,4- Diethyleneoxide)	7/1/2012	11/30/2014	UT
1-Chlorobutane	1/23/2013	11/30/2014	UT
1-Chlorohexane	7/1/2012	11/30/2014	UT
2,2-Dichloropropane	7/1/2012	11/30/2014	UT

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	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
2-Butanone (Methyl ethyl ketone, MEK)	7/1/2012	11/30/2014	UT
2-Chloroethyl vinyl ether	7/1/2012	11/30/2014	UT
2-Chlorotoluene	7/1/2012	11/30/2014	UT
2-Hexanone	7/1/2012	11/30/2014	UT
4-Chlorotoluene	7/1/2012	11/30/2014	UT
4-Isopropyltoluene (p-Cymene,p-Isopropyltoluene)	7/1/2012	11/30/2014	UT
4-Methyl-2-pentanone (MIBK)	7/1/2012	11/30/2014	UT
Acetone	7/1/2012	11/30/2014	UT
Acetonitrile	7/1/2012	11/30/2014	UT
Acrolein (Propenal)	7/1/2012	11/30/2014	UT
Acrylonitrile	7/1/2012	11/30/2014	UT
Allyl chloride (3-Chloropropene)	7/1/2012	11/30/2014	UT
Benzene	7/1/2012	11/30/2014	UT
Bromobenzene	7/1/2012	11/30/2014	UT
Bromochloromethane	7/1/2012	11/30/2014	UT
Bromodichloromethane	7/1/2012	11/30/2014	UT
Bromoform	7/1/2012	11/30/2014	UT
Carbon disulfide	7/1/2012	11/30/2014	UT
Carbon tetrachloride	7/1/2012	11/30/2014	UT
Chloroacetonitrile	1/23/2013	11/30/2014	UT
Chlorobenzene	7/1/2012	11/30/2014	UT
Chlorodibromomethane	7/1/2012	11/30/2014	UT
Chloroethane (Ethyl chloride)	7/1/2012	11/30/2014	UT
Chloroform	7/1/2012	11/30/2014	UT
Chloroprene (2-Chloro-1,3-butadiene)	7/1/2012	11/30/2014	UT
cis-1,2-Dichloroethylene	7/1/2012	11/30/2014	UT
cis-1,3-Dichloropropene	7/1/2012	11/30/2014	UT
Dibromomethane (Methylene bromide)	7/1/2012	11/30/2014	UT
Dichlorodifluoromethane (Freon-12)	7/1/2012	11/30/2014	UT
Diethyl ether	7/1/2012	11/30/2014	UT
Ethanol	7/1/2012	11/30/2014	UT
Ethyl methacrylate	7/1/2012	11/30/2014	UT
Ethylbenzene	7/1/2012	11/30/2014	UT
Hexachlorobutadiene	7/1/2012	11/30/2014	UT
Hexachloroethane	7/1/2012	11/30/2014	UT
Iodomethane (Methyl iodide)	7/1/2012	11/30/2014	UT
Isobutyl alcohol (2-Methyl-1-propanol)	7/1/2012	11/30/2014	UT
Isopropylbenzene	7/1/2012	11/30/2014	UT
Methacrylonitrile	7/1/2012	11/30/2014	UT
Methyl acrylate	1/23/2013	11/30/2014	UT
Methyl bromide (Bromomethane)	7/1/2012	11/30/2014	UT
Methyl chloride (Chloromethane)	7/1/2012	11/30/2014	UT
Methyl methacrylate	7/1/2012	11/30/2014	UT
Methyl tert-butyl ether (MTBE)	7/1/2012	11/30/2014	UT
Methylene chloride (Dichloromethane)	7/1/2012	11/30/2014	UT
m-Xylene	7/1/2012	11/30/2014	UT
Naphthalene	7/1/2012	11/30/2014	UT
n-Butyl alcohol (1-Butanol, n-Butanol)	7/1/2012	11/30/2014	UT
n-Butylbenzene	7/1/2012	11/30/2014	UT

ALS Environmental - Fort Collins

Start Date	Expires	AB
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Program/Matrix: RCRA (Solid & Hazardous Material)

n-Propylbenzene	7/1/2012	11/30/2014	UT
o-Xylene	7/1/2012	11/30/2014	UT
Pentafluorobenzene	1/23/2013	11/30/2014	UT
Propionitrile (Ethyl cyanide)	7/1/2012	11/30/2014	UT
p-Xylene	7/1/2012	11/30/2014	UT
sec-Butylbenzene	7/1/2012	11/30/2014	UT
Styrene	7/1/2012	11/30/2014	UT
Tetrachloroethylene (Perchloroethylene)	7/1/2012	11/30/2014	UT
Toluene	7/1/2012	11/30/2014	UT
trans-1,2-Dichloroethylene	7/1/2012	11/30/2014	UT
trans-1,3-Dichloropropylene	7/1/2012	11/30/2014	UT
trans-1,4-Dichloro-2-butene	7/1/2012	11/30/2014	UT
Trichloroethene (Trichloroethylene)	7/1/2012	11/30/2014	UT
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	7/1/2012	11/30/2014	UT
Vinyl acetate	7/1/2012	11/30/2014	UT
Vinyl chloride	7/1/2012	11/30/2014	UT
Xylene (total)	7/1/2012	11/30/2014	UT

Method EPA 8270D

1,2,4,5-Tetrachlorobenzene	7/1/2012	11/30/2014	UT
1,2,4-Trichlorobenzene	7/1/2012	11/30/2014	UT
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2012	11/30/2014	UT
1,2-Dinitrobenzene	7/1/2012	11/30/2014	UT
1,3,5-Trinitrobenzene (1,3,5-TNB)	7/1/2012	11/30/2014	UT
1,3-Dichlorobenzene	7/1/2012	11/30/2014	UT
1,3-Dinitrobenzene (1,3-DNB)	7/1/2012	11/30/2014	UT
1,4-Dichlorobenzene	7/1/2012	11/30/2014	UT
1,4-Dinitrobenzene	7/1/2012	11/30/2014	UT
1-Methylnaphthalene	7/1/2012	11/30/2014	UT
1-Naphthylamine	7/1/2012	11/30/2014	UT
2,3,4,6-Tetrachlorophenol	7/1/2012	11/30/2014	UT
2,4,5-Trichlorophenol	7/1/2012	11/30/2014	UT
2,4,6-Trichlorophenol	7/1/2012	11/30/2014	UT
2,4-Dichlorophenol	7/1/2012	11/30/2014	UT
2,4-Dimethylphenol	7/1/2012	11/30/2014	UT
2,4-Dinitrophenol	7/1/2012	11/30/2014	UT
2,4-Dinitrotoluene (2,4-DNT)	7/1/2012	11/30/2014	UT
2,6-Dichlorophenol	7/1/2012	11/30/2014	UT
2,6-Dinitrotoluene (2,6-DNT)	7/1/2012	11/30/2014	UT
2-Acetylaminofluorene	7/1/2012	11/30/2014	UT
2-Chloronaphthalene	7/1/2012	11/30/2014	UT
2-Chlorophenol	7/1/2012	11/30/2014	UT
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	7/1/2012	11/30/2014	UT
2-Methylnaphthalene	7/1/2012	11/30/2014	UT
2-Methylphenol (o-Cresol)	7/1/2012	11/30/2014	UT
2-Naphthylamine	7/1/2012	11/30/2014	UT
2-Nitroaniline	7/1/2012	11/30/2014	UT
2-Nitrophenol	7/1/2012	11/30/2014	UT
3,3'-Dichlorobenzidine	7/1/2012	11/30/2014	UT

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	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
3-Methylcholanthrene	7/1/2012	11/30/2014	UT
3-Methylphenol (m-Cresol)	7/1/2012	11/30/2014	UT
3-Nitroaniline	7/1/2012	11/30/2014	UT
4-Bromophenyl phenyl ether	7/1/2012	11/30/2014	UT
4-Chloro-3-methylphenol	7/1/2012	11/30/2014	UT
4-Chloroaniline	7/1/2012	11/30/2014	UT
4-Chlorophenyl phenylether	7/1/2012	11/30/2014	UT
4-Methylphenol (p-Cresol)	7/1/2012	11/30/2014	UT
4-Nitroaniline	7/1/2012	11/30/2014	UT
4-Nitrophenol	7/1/2012	11/30/2014	UT
5-Nitro-o-toluidine	7/1/2012	11/30/2014	UT
7,12-Dimethylbenz(a) anthracene	7/1/2012	11/30/2014	UT
Acenaphthene	7/1/2012	11/30/2014	UT
Acenaphthylene	7/1/2012	11/30/2014	UT
Acetophenone	7/1/2012	11/30/2014	UT
Aniline	7/1/2012	11/30/2014	UT
Anthracene	7/1/2012	11/30/2014	UT
Azobenzene (1,2-Diphenylhydrazine)	7/1/2012	11/30/2014	UT
Benzidine	7/1/2012	11/30/2014	UT
Benzo(a)anthracene	7/1/2012	11/30/2014	UT
Benzo(a)pyrene	7/1/2012	11/30/2014	UT
Benzo(b)fluoranthene	7/1/2012	11/30/2014	UT
Benzo(g,h,i)perylene	7/1/2012	11/30/2014	UT
Benzo(k)fluoranthene	7/1/2012	11/30/2014	UT
Benzoic acid	7/1/2012	11/30/2014	UT
Benzyl alcohol	7/1/2012	11/30/2014	UT
bis(2-Chloroethoxy)methane	7/1/2012	11/30/2014	UT
bis(2-Chloroethyl) ether	7/1/2012	11/30/2014	UT
bis(2-Chloroisopropyl) ether	7/1/2012	11/30/2014	UT
bis(2-Ethylhexyl) phthalate (DEHP)	7/1/2012	11/30/2014	UT
Butyl benzyl phthalate	7/1/2012	11/30/2014	UT
Carbazole	7/1/2012	11/30/2014	UT
Chrysene	7/1/2012	11/30/2014	UT
Dibenz(a,h) anthracene	7/1/2012	11/30/2014	UT
Dibenzofuran	7/1/2012	11/30/2014	UT
Diethyl phthalate	7/1/2012	11/30/2014	UT
Dimethyl phthalate	7/1/2012	11/30/2014	UT
Di-n-butyl phthalate	7/1/2012	11/30/2014	UT
Di-n-octyl phthalate	7/1/2012	11/30/2014	UT
Ethyl methanesulfonate	7/1/2012	11/30/2014	UT
Fluoranthene	7/1/2012	11/30/2014	UT
Fluorene	7/1/2012	11/30/2014	UT
Hexachlorobenzene	7/1/2012	11/30/2014	UT
Hexachlorobutadiene	7/1/2012	11/30/2014	UT
Hexachlorocyclopentadiene	7/1/2012	11/30/2014	UT
Hexachloroethane	7/1/2012	11/30/2014	UT
Hexachloropropene	7/1/2012	11/30/2014	UT
Indeno(1,2,3-cd) pyrene	7/1/2012	11/30/2014	UT
Isophorone	7/1/2012	11/30/2014	UT

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	Start Date	Expires	AB
Program/Matrix: RCRA (Solid & Hazardous Material)			
Isosafrole	7/1/2012	11/30/2014	UT
Methyl methanesulfonate	7/1/2012	11/30/2014	UT
Naphthalene	7/1/2012	11/30/2014	UT
Nitrobenzene	7/1/2012	11/30/2014	UT
n-Nitrosodiethylamine	7/1/2012	11/30/2014	UT
n-Nitrosodimethylamine	7/1/2012	11/30/2014	UT
n-Nitroso-di-n-butylamine	7/1/2012	11/30/2014	UT
n-Nitrosodi-n-propylamine	7/1/2012	11/30/2014	UT
n-Nitrosodiphenylamine	7/1/2012	11/30/2014	UT
n-Nitrosomethylethylamine	7/1/2012	11/30/2014	UT
n-Nitrosomorpholine	7/1/2012	11/30/2014	UT
n-Nitrosopiperidine	7/1/2012	11/30/2014	UT
n-Nitrosopyrrolidine	7/1/2012	11/30/2014	UT
Pentachlorobenzene	7/1/2012	11/30/2014	UT
Pentachloronitrobenzene	7/1/2012	11/30/2014	UT
Pentachlorophenol	7/1/2012	11/30/2014	UT
Phenacetin	7/1/2012	11/30/2014	UT
Phenanthrene	7/1/2012	11/30/2014	UT
Phenol	7/1/2012	11/30/2014	UT
Pyrene	7/1/2012	11/30/2014	UT
Pyridine	7/1/2012	11/30/2014	UT
Safrole	7/1/2012	11/30/2014	UT
Method EPA 901.1			
Cesium-134	7/1/2012	11/30/2014	UT
Cesium-137	7/1/2012	11/30/2014	UT
Cobalt-60	7/1/2012	11/30/2014	UT
Method EPA 9010C			
Cyanide	7/1/2012	11/30/2014	UT
Method EPA 9014			
Cyanide	7/1/2012	11/30/2014	UT
Method EPA 903.1			
Radium-226	1/23/2013	11/30/2014	UT
Method EPA 9034			
Total sulfides	7/1/2012	11/30/2014	UT
Method EPA 9045C			
pH	7/1/2012	11/30/2014	UT
Method EPA 9056A			
Bromide	7/1/2012	11/30/2014	UT
Chloride	7/1/2012	11/30/2014	UT
Fluoride	7/1/2012	11/30/2014	UT
Nitrate as N	7/1/2012	11/30/2014	UT
Nitrite as N	7/1/2012	11/30/2014	UT
Orthophosphate as P	7/1/2012	11/30/2014	UT
Sulfate	7/1/2012	11/30/2014	UT
Method EPA 9071B			
Oil & Grease	7/1/2012	11/30/2014	UT

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Start Date	Expires	AB
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Program/Matrix: RCRA (Solid & Hazardous Material)**Method EPA 9095B**

Free liquid	7/1/2012	11/30/2014	UT
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Method EPA 9310

Gross alpha-beta	7/1/2012	11/30/2014	UT
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Method EPA 9315

Total alpha radium	7/1/2012	11/30/2014	UT
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Method EPA 9320

Radium-228	7/1/2012	11/30/2014	UT
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Method EPA H2S Test Method

Reactive sulfide	7/1/2012	11/30/2014	UT
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Method EPA HCN Test Method

Reactive Cyanide	7/1/2012	11/30/2014	UT
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Method HASL 300 Ga-01-R sec 4.5.2.3

Cesium-134	7/1/2012	11/30/2014	UT
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Cesium-137	7/1/2012	11/30/2014	UT
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Cobalt-60	7/1/2012	11/30/2014	UT
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Method HASL 300 Sr-01-RC (GPC)

Strontium-89, 90	7/1/2012	11/30/2014	UT
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Method HASL 300 U-02-RC

Americium-241	7/1/2012	11/30/2014	UT
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Plutonium	7/1/2012	11/30/2014	UT
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Thorium-228	7/1/2012	11/30/2014	UT
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Thorium-230	7/1/2012	11/30/2014	UT
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Thorium-232	7/1/2012	11/30/2014	UT
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Method LUFT GC

Diesel range organics (DRO)	11/1/2013	11/30/2014	UT
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Gasoline range organics (GRO)	11/1/2013	11/30/2014	UT
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Method SM 7500-Ra C (SC)

Radium-226	7/1/2012	11/30/2014	UT
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ALS Environmental - Fort Collins

Start Date	Expires	AB
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Program/Matrix: SDWA (Potable Water)**Method ASTM D3972-90**

Uranium	7/1/2012	11/30/2014	UT
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Method ASTM D5811-00

Strontium-90	7/1/2012	11/30/2014	UT
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Method EPA 120.1

Conductivity	7/1/2012	11/30/2014	UT
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Method EPA 150.1

pH	7/1/2012	11/30/2014	UT
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Method EPA 160.1

Residue-filterable (TDS)	7/1/2012	11/30/2014	UT
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Method EPA 200.7

Aluminum	7/1/2012	11/30/2014	UT
Antimony	7/1/2012	11/30/2014	UT
Arsenic	7/1/2012	11/30/2014	UT
Barium	7/1/2012	11/30/2014	UT
Beryllium	7/1/2012	11/30/2014	UT
Boron	7/1/2012	11/30/2014	UT
Cadmium	7/1/2012	11/30/2014	UT
Calcium	7/1/2012	11/30/2014	UT
Chromium	7/1/2012	11/30/2014	UT
Cobalt	7/1/2012	11/30/2014	UT
Copper	7/1/2012	11/30/2014	UT
Iron	7/1/2012	11/30/2014	UT
Lead	7/1/2012	11/30/2014	UT
Lithium	7/1/2012	11/30/2014	UT
Magnesium	7/1/2012	11/30/2014	UT
Manganese	7/1/2012	11/30/2014	UT
Molybdenum	7/1/2012	11/30/2014	UT
Nickel	7/1/2012	11/30/2014	UT
Potassium	7/1/2012	11/30/2014	UT
Selenium	7/1/2012	11/30/2014	UT
Silica as SiO ₂	7/1/2012	11/30/2014	UT
Silver	7/1/2012	11/30/2014	UT
Sodium	7/1/2012	11/30/2014	UT
Strontium	7/1/2012	11/30/2014	UT
Thallium	7/1/2012	11/30/2014	UT
Tin	7/1/2012	11/30/2014	UT
Titanium	7/1/2012	11/30/2014	UT
Vanadium	7/1/2012	11/30/2014	UT
Zinc	7/1/2012	11/30/2014	UT

Method EPA 200.8

Aluminum	7/1/2012	11/30/2014	UT
Antimony	7/1/2012	11/30/2014	UT
Arsenic	7/1/2012	11/30/2014	UT
Barium	7/1/2012	11/30/2014	UT
Beryllium	7/1/2012	11/30/2014	UT
Cadmium	7/1/2012	11/30/2014	UT

ALS Environmental - Fort Collins

	Start Date	Expires	AB
Program/Matrix: SDWA (Potable Water)			
Calcium	7/1/2012	11/30/2014	UT
Chromium	7/1/2012	11/30/2014	UT
Copper	7/1/2012	11/30/2014	UT
Iron	7/1/2012	11/30/2014	UT
Lead	7/1/2012	11/30/2014	UT
Magnesium	7/1/2012	11/30/2014	UT
Manganese	7/1/2012	11/30/2014	UT
Molybdenum	7/1/2012	11/30/2014	UT
Nickel	7/1/2012	11/30/2014	UT
Potassium	7/1/2012	11/30/2014	UT
Selenium	7/1/2012	11/30/2014	UT
Silver	7/1/2012	11/30/2014	UT
Sodium	7/1/2012	11/30/2014	UT
Strontium	7/1/2012	11/30/2014	UT
Thallium	7/1/2012	11/30/2014	UT
Thorium	7/1/2012	11/30/2014	UT
Tin	7/1/2012	11/30/2014	UT
Uranium	7/1/2012	11/30/2014	UT
Vanadium	7/1/2012	11/30/2014	UT
Zinc	7/1/2012	11/30/2014	UT
Method EPA 245.1			
Mercury	7/1/2012	11/30/2014	UT
Method EPA 300.0			
Bromide	7/1/2012	11/30/2014	UT
Chloride	7/1/2012	11/30/2014	UT
Fluoride	7/1/2012	11/30/2014	UT
Nitrate as N	7/1/2012	11/30/2014	UT
Nitrite as N	7/1/2012	11/30/2014	UT
Orthophosphate as P	7/1/2012	11/30/2014	UT
Sulfate	7/1/2012	11/30/2014	UT
Method EPA 310.1			
Alkalinity as CaCO3	7/1/2012	11/30/2014	UT
Method EPA 314			
Perchlorate	7/1/2012	11/30/2014	UT
Method EPA 335.2			
Cyanide	7/1/2012	11/30/2014	UT
Method EPA 524.2			
1,1,1-Trichloroethane	7/1/2012	11/30/2014	UT
1,1,2-Trichloroethane	7/1/2012	11/30/2014	UT
1,1-Dichloroethylene	7/1/2012	11/30/2014	UT
1,2,4-Trichlorobenzene	7/1/2012	11/30/2014	UT
1,2-Dichlorobenzene (o-Dichlorobenzene)	7/1/2012	11/30/2014	UT
1,2-Dichloroethane (Ethylene dichloride)	7/1/2012	11/30/2014	UT
1,2-Dichloropropane	7/1/2012	11/30/2014	UT
1,4-Dichlorobenzene	7/1/2012	11/30/2014	UT
Benzene	7/1/2012	11/30/2014	UT
Carbon tetrachloride	7/1/2012	11/30/2014	UT

ALS Environmental - Fort Collins

	Start Date	Expires	AB
Program/Matrix: SDWA (Potable Water)			
Chlorobenzene	7/1/2012	11/30/2014	UT
cis-1,2-Dichloroethylene	7/1/2012	11/30/2014	UT
Ethylbenzene	7/1/2012	11/30/2014	UT
Methylene chloride (Dichloromethane)	7/1/2012	11/30/2014	UT
m-Xylene	7/1/2012	11/30/2014	UT
o-Xylene	7/1/2012	11/30/2014	UT
p-Xylene	7/1/2012	11/30/2014	UT
Styrene	7/1/2012	11/30/2014	UT
Tetrachloroethylene (Perchloroethylene)	7/1/2012	11/30/2014	UT
Toluene	7/1/2012	11/30/2014	UT
trans-1,2-Dichloroethylene	7/1/2012	11/30/2014	UT
Trichloroethene (Trichloroethylene)	7/1/2012	11/30/2014	UT
Vinyl chloride	7/1/2012	11/30/2014	UT
Xylene (total)	7/1/2012	11/30/2014	UT
Method EPA 900.0			
Gross-alpha	7/1/2012	11/30/2014	UT
Gross-beta	7/1/2012	11/30/2014	UT
Method EPA 901.1			
Cesium-134	7/1/2012	11/30/2014	UT
Cesium-137	7/1/2012	11/30/2014	UT
Cobalt-60	7/1/2012	11/30/2014	UT
Gamma Emitters	7/1/2012	11/30/2014	UT
Method EPA 903			
Radium-226	7/1/2012	11/30/2014	UT
Total radium	7/1/2012	11/30/2014	UT
Method EPA 903.1			
Radium-226	7/1/2012	11/30/2014	UT
Method EPA 904			
Radium-228	7/1/2012	11/30/2014	UT
Method EPA 906			
Tritium	7/1/2012	11/30/2014	UT
Method HASL 300 Ga-01-R sec 4.5.2.3			
Cesium-134	7/1/2012	11/30/2014	UT
Cesium-137	7/1/2012	11/30/2014	UT
Cobalt-60	7/1/2012	11/30/2014	UT
Gamma Emitters	7/1/2012	11/30/2014	UT
Method HASL 300 Sr-01-RC (GPC)			
Strontium-89, 90	7/1/2012	11/30/2014	UT
Method HASL 300 Sr-02-RC (GPC)			
Strontium-89, 90	7/1/2012	11/30/2014	UT
Method HASL 300 U-02-RC			
Americium-241	7/1/2012	11/30/2014	UT
Isotopic uranium	7/1/2012	11/30/2014	UT
Plutonium	7/1/2012	11/30/2014	UT
Uranium	7/1/2012	11/30/2014	UT
Method SM 2320 B			

ALS Environmental - Fort Collins

	Start Date	Expires	AB
Program/Matrix: SDWA (Potable Water)			
Alkalinity as CaCO ₃	7/1/2012	11/30/2014	UT
Method SM 2340 B			
Total hardness as CaCO ₃	7/1/2012	11/30/2014	UT
Method SM 2510 B			
Conductivity	7/1/2012	11/30/2014	UT
Method SM 2540 B			
Residue-total	7/1/2012	11/30/2014	UT
Method SM 2540 C			
Residue-filterable (TDS)	7/1/2012	11/30/2014	UT
Method SM 2540 D			
Residue-nonfilterable (TSS)	7/1/2012	11/30/2014	UT
Method SM 4500-H+ B			
pH	7/1/2012	11/30/2014	UT
Method SM 5310 C			
Total organic carbon	7/1/2012	11/30/2014	UT
Method SM 7500-3H B			
Tritium	7/1/2012	11/30/2014	UT
Method SM 7500-Ra C (SC)			
Radium-226	7/1/2012	11/30/2014	UT
Method SM 7500-Rn B			
Radon-222	7/1/2012	11/30/2014	UT

The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method.

The analytes by method which a laboratory is authorized to perform at any given time will be those indicated in the most recent certificate letter. The most recent certification letter supersedes all previous certification or authorization letters. It is the certified laboratory's responsibility to review this letter for discrepancies. The certified laboratory must document any discrepancies in this letter and send notice to this bureau within 15 days of receipt. This certificate letter will be recalled in the event your laboratory's certification is revoked.



Laboratory Quality Assurance
Plan
(LQAP)

Laboratory Quality Assurance Plan (LQAP)

Revision 16

August 16, 2012

ALS

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Approved by:



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BIBLIOGRAPHY

Appendices use in conjunction with the LQAP are documents routinely revised and do not constitute a revision to the LQAP. If you require an appendix referenced in this document please contact your project manager or quality assurance department for the most current version.

1. INTRODUCTION

This Laboratory Quality Assurance Plan (LQAP) describes the policies, procedures and accountabilities established by the ALS Environmental (ALS) to ensure that the environmental test results reported from the analysis of air, water, soil, waste, and other matrices are reliable and of known and documented quality. This document describes the quality assurance and quality control procedures followed to generate reliable analytical data.

This LQAP is designed to be an overview of ALS operations. Detailed methodologies and practices are written in ALS Standard Operating Procedures (SOPs). Where appropriate, ALS SOPs are referenced in this document to direct the reader to more complete information. A list of current SOPs is found in Appendix H.

ALS maintains certifications pertaining to various commercial and government entities. Each certification requires that the laboratory continue to perform at levels specified by the programs issuing certification. Program requirements can be rigorous; they include semiannual performance evaluations as well as annual audits of the laboratory to verify compliance.

The State of Utah has primacy in administering certification of this laboratory to perform EPA methods. Thus, the Utah State Health Department certifies ALS to perform EPA methods under Utah Rule R444-14. For that reason, reference is made to Utah Rule R444-14 in this LQAP.

ALS is a full service environmental and radiochemistry laboratory, performing analyses for organic, inorganic, and radiological constituents in a variety of matrices. ALS specializes in serving the Department of Energy (DOE), Department of Defense (DoD), and architect-engineering firms. ALS routinely provides hardcopy data packages and electronic data deliverables that are easily validated by external validators.

The management team at ALS applies an integrated approach to quality assurance, client service, and efficient operations, that enables ALS to produce compliant data that meet or exceed all technical and service requirements as prescribed by our clients. This Laboratory Quality Assurance Plan (LQAP) defines ALS's quality assurance (QA) program, and communicates ALS's goals, values and policies regarding quality, ethical conduct, data integrity, and optimized operations. ALS management is committed to continual improvement by implementing the management systems set forth in this LQAP and the following documents ISO 17025;2005, TNI 2009, DoD QSM and DOE QSAS.

Documents and forms used in the laboratory may still have previous ownership names like ATI, PAI, Paragon Analytical, DataChem or DCL. These former names can be used until revisions to specific documents are needed.

1.1 MISSION STATEMENT

To provide analytical services to help our customers make informed decisions.

1.2 VISION STATEMENT

To be recognized as a global market leader.

1.3 QUALITY POLICY

ALS is committed to producing legally defensible analytical data of known and documented quality acceptable for its intended use and in compliance with the Safe Drinking Water Act, the Clean Water Act, and the Resource Conservation and Recovery Act. This LQAP is designed to satisfy the applicable requirements of the State of Utah and other state certification programs. ALS complies with the National Environmental Laboratory Accreditation Conference (TNI) standards.

ALS corporate management has committed its full support to provide the personnel, facilities, equipment, and procedures required by this LQAP.

ALS management is committed to improvements of the management systems through compliance with TNI 2009 and ISO 17025:2005. ALS management is also committed to compliance with project related requirements including DOECAP QSAS and DoD QSM 4.2 Gray Boxes.

ALS management reviews its operations on an ongoing basis and seeks input from staff and clients to make improvements. See section 12.1.5 of this plan for details.

It is the policy of ALS that all employees shall be familiar with all Quality documentation.

Within this framework, ALS performs analyses in strict accordance with promulgated methodologies, including:

- USEPA, SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods;
- USEPA, Methods for Chemical Analysis of Waters and Wastes (MCAWW);
- USEPA, Methods for Determination of Metals in Environmental Samples;
- American Public Health Association (APHA), Standard Methods for the Examination of Water and Wastewater (SM);
- USEPA, Methods for Determination of Organic Compounds in Drinking Water;
- American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Volume 11 – Water and Environmental Technology;

- American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Volume 12 – Nuclear Energy;
- USDOE, Environmental Measurements Laboratory (EML), Procedures Manual (HASL-300);
- USEPA, Eastern Environmental Radiation Facility (EERF), Radiochemistry Procedures Manual;
- USDOE, Radiological and Environmental Sciences (RESL), Procedures Manual;
- USEPA, Prescribed Procedures for Measurement of Radioactivity in Drinking Water; and
- US, Code of Federal Regulations (40 CFR).

1.4 STATEMENT ON WASTE, ABUSE AND FRAUD

ALS is committed to achieving our goals in the most efficient and effective manner possible, thus avoiding wasteful use of resources. This is accomplished by assuring the proper utilization of ALS's purchased materials and equipment, and time and ability of our personnel. *Any ALS employee who has any suggestion or concern regarding ALS's practices, is encouraged to discuss his/her idea or question with their Operations Department Manager, the Quality Assurance Manager, and/or the Laboratory Director.* A means of confidentially reporting concerns anonymously is also available. Grievances and allegations of unethical conduct will be fully investigated, and appropriate actions taken.

Training regarding ALS's Waste, Abuse and Fraud policies is provided to every new staff member, and to all employees lab-wide as an annual refresher. ALS's policies regarding waste, abuse and fraud are included in ALS SOP 143 and CE-GEN-001.

1.5 CODE OF ETHICS AND DATA INTEGRITY STATEMENTS

ALS is responsible for creating a work environment that enables all employees to perform their duties in an ethical manner. *It is ALS's expectation that all employees exhibit professionalism and respect for clients and each other in all interactions and tasks.* ALS requires that each employee abide by the following guidelines:

- Every ALS employee is responsible for the propriety and consequences of his or her actions. Each employee shall conduct him or herself in a professional manner towards all clients, regulators, auditors, vendors, and other employees. Professional conduct relates to honesty, integrity, respect, and tolerance for cultural diversity.

- Every ALS employee shall perform all assigned duties in accordance with ALS's established quality assurance policies and quality control procedures that have been developed to ensure conformance with contractual and regulatory requirements.
- ALS expects all employees to use professional judgment and to document all situations thoroughly. It is the responsibility of each ALS employee to consult the Department Operations Manager or Quality Assurance Manager when atypical or unusual situations occur and to disclose and document the decision-making process. Every employee must disclose any instance of noncompliance. ALS reports all noncompliance issues affecting data to the client.
- It is the responsibility of each ALS employee to report any suspicion of unethical conduct to the Quality Assurance Manager or the Laboratory Director.

Procedures addressing Ethics and Data integrity procedures provide assurance that a highly ethical approach to testing is a key component of all laboratory planning, training and implementation of methods. See ALS SOPs 143 and CE-GEN-001. The following list provides examples of improper, unethical, or illegal practices that ALS **does not** tolerate:

- Falsification of records to meet method requirements (e.g., sample records, logbooks, sample results, electronic records). This includes intentional misrepresentation of the date or time of analysis (e.g., intentionally resetting a computer system's or instrument's date and/or time to make it appear that a date/time requirement has been achieved); and unwarranted manipulation of computer software (e.g., improper background subtraction to meet ion abundance criteria for GC/MS tuning compounds).
- Improper use of manual integrations performed to meet calibration or method quality control criteria (e.g., peak shaving or peak enhancement performed solely to meet quality control requirements).
- Selective exclusion of data to meet quality control criteria (e.g., eliminating initial calibration points without technical justification).
- Misrepresentation of quality control samples (e.g., adding surrogates or tracers after sample extraction, omitting preparation steps for quality control samples; over- or under- spiking).
- Reporting results without analyses to support the results (i.e., dry-labbing).
- Notation of matrix interference as basis for exceeding acceptance limits in interference-free matrices.

- Intentional plagiarism or willful misrepresentation of another employee's work as one's own (e.g., Initial or Continuing Demonstration of Capability study (IDOC, CDOC) or Proficiency Testing (PT) study).

Strict adherence to ALS's Code of Ethics and Data Integrity is essential to the reputation and continued health of our business. All ALS employees are required to acknowledge their responsibility and intent to behave in an ethical manner by attesting to the requirements described in procedures and annual refresher training is conducted above upon joining the ALS staff, and annually thereafter.

1.6 REVIEW, REVISION, DISTRIBUTION AND HIERARCHY OF QA DOCUMENTS

Current copies of pertinent quality assurance guidance documents, such as ALS's LQAP, the TNI Standards, ISO 17025:2005, the US DOE Quality Systems for Analytical Services (QSAS), the US DoD Quality Systems Manual (QSM) and others, are posted to the ALS network so that they are accessible to every employee. Laboratory Standard Operating Procedures (SOPs) and other method references are also posted to the network for lab-wide employee access. Project-specific requirements are disseminated to the laboratory via Laboratory Information Management Systems (LIMS) program specifications (discussed further below).

ALS Laboratory Group - Fort Collins recognizes a hierarchy of guidance that provides for comprehensive definition, yet flexible coverage, thus enabling both overall program and site-specific needs to be met. An overview explaining this hierarchy is given below and in ALS SOP 143. **SOP 926** provides detailed guidance on the review, revision, and distribution of laboratory-generated controlled documents.

1.6.1 LABORATORY QUALITY ASSURANCE PLAN

The LQAP is an encompassing controlled-document that describes the ALS's quality assurance programs and policies. All systems, policies, and procedures have been developed and implemented in accordance with applicable USEPA requirements, regulations, and guidance; the current TNI standards; and requirements set forth in various client quality assurance documents and contractual specifications. This document has been prepared in accordance with these referenced documents, as well as others, cited in the attached **Bibliography**. The LQAP is intended to provide a 'quality requirements framework', including quality control (QC) procedures to be followed in the absence of project-specific requirements (note that project-specific requirements are communicated to laboratory staff via LIMS program specifications, which are discussed subsequently).

The Quality Assurance Manager (QAM) bears primary responsibility for ensuring that the LQAP meets industry standards. Proposed revisions to the LQAP are approved by key laboratory personnel. Following approval, the QAM posts the revised LQAP to the ALS network and revision, revised to LQAP is documented in LIMS. The LIMS notifies personnel of all revised documents. It is the requirement of all employee to read and update reading records for all assigned controlled documents. Archival records of all LQAP iterations are maintained by the Quality Assurance Department.

1.6.2 STANDARD OPERATING PROCEDURES

The second kind of controlled-document in the hierarchy of quality assurance guidance are the Standard Operating Procedures (SOPs). An SOP defines the QA/QC requirements for each method and describes in detail how personnel perform procedures and evaluate data. SOPs pertaining to general practices (e.g., standards, temperature monitoring, etc.), administrative procedures (e.g., procurement of supplies and materials, etc.) and health & safety requirements (e.g., ALS Safety Modules and the Chemical Hygiene Plan), are also maintained by ALS. It is ALS's intent that the information contained in our SOPs are both method-compliant, and accurately reflect actual practice. *Suggestions for SOP content clarification or revision are encouraged.* SOPS are published to the network when approved.

The LIMS notifies personnel of all revised documents. It is the requirement of all employees to read and update reading records for all assigned controlled documents

This process of revision, approval and distribution is established in the ALS SOP 926. A list of current SOPs is provided in **Appendix H**. The Quality Assurance Department manages the review, revision and controlled distribution of documents and maintains associated records.

1.6.3 LABORATORY MANAGEMENT INFORMATION SYSTEMS (LIMS) PROGRAM SPECIFICATION

The last and most specific controlled-document in this hierarchy is the LIMS program specification. The LIMS program specification is a distillation of client Quality Assurance Project Plan (QAPjP) or contractual requirements, prepared electronically by the ALS Project Manager (PM), in collaboration with the QAM and applicable Department Managers operations management. This custom program specification, along with the associated LIMS test code nicknames, contain directives and controls that govern testing and reporting data. The program specification is often limited in scope and addresses only those QA/QC criteria required for a specific project. *When the client's requirements differ from those stated in the SOPs and/or LQAP, the*

project-specific LIMS program specification requirements supersede the others. It is the responsibility of all personnel who work with samples or data to consult the applicable LIMS program specification for client-specific requirements prior to initiating handling of the samples or data.

2. LABORATORY ORGANIZATION AND RESPONSIBILITIES

This section provides an overview of ALS organization and defines key personnel, their responsibilities, and the lines of communication between these employees. An organization chart that illustrates reporting relationships is provided in **Appendix B**.

ALS policy is to perform work for clients in the most efficient manner possible, avoiding waste of resources and undue pressure on employees. It is the role of both ALS management and employees to ensure that work for clients is performed most efficiently and effectively by properly utilizing ALS purchased materials, equipment, and the time and ability of personnel..

2.1 GENERAL REQUIREMENTS FOR LABORATORY PERSONNEL

ALS maintains sufficient personnel to perform analytical services for our clients. Each employee must have a combination of experience and education that enables him or her to demonstrate a specific knowledge of his or her job function, and a general knowledge of laboratory operations, test methods, QA/QC procedures, and records management. *All personnel are responsible for complying with the requirements that pertain to his/her assigned duties.*

2.2 KEY PERSONNEL

Education, experience and skill requirements for these positions are addressed in job descriptions (Title). Functional responsibilities are further discussed below.

In the event of a temporary absence, key personnel must notify other key staff of their absence and reassign their duties to another employee (deputy) who will perform the assigned duties. For example, a PM may assign another PM to cover his or her duties; a Department Manager Group Leader may assign a senior chemist to cover his or her duties within the Department; and the Operations Manager Laboratory Director may assign a Manager(?) to cover his or her duties.

2.1.1 LABORATORY DIRECTOR

The Laboratory Director (Laboratory Director) is responsible for:

- All laboratory operations, including: business functions such as marketing, sales and financial issues; technical functions such as sample control, preparation, analysis, data management; and quality assurance;

- Providing input and support to proposal processes, including interacting with the Sales, Technical and Quality Assurance staff, to ensure that the laboratory is capable of complying with client and regulatory requirements;
- Supervising all personnel through Management staff, who ensure that QA/QC procedures are being performed and that any nonconformances or discrepancies are documented and remedied properly and promptly;
- Ensuring that corrective actions relating to Findings from internal and external audits are completed in a timely fashion;
- Ensuring that the laboratory has the appropriate resources and facilities to perform analytical services;
- Ensuring that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory;
- Defining the minimum level of education, experience, and skills necessary for all positions in the laboratory;
- Ensuring that only those vendors and supplies that are of adequate quality are used; and
- Directing the performance of the annual Managerial Review.

2.1.2 TECHNICAL OR DEPARTMENT OPERATIONS MANAGER

The Operations Manager reports to Technical and Department Managers report to the Laboratory Director, and exercises. These Managers exercise day-to-day supervision of laboratory personnel, procedures, and reporting of results. They maintain technical expertise in their area of specialization (e.g., organics, inorganics, radiochemistry). Technical Managers and Department The Operations Managers (and/or his/her designee) is/are responsible for:

- * T.; technical functions such as sample control, preparation, analysis, data management; and quality assurance;
- * Providing technical education and training to personnel, authorizing personnel with appropriate educational and/or technical background perform all tests for which the laboratory is accredited, and providing documentation of employee capability and training., and ensuring that training and documentation are up to date;

- * Assigning job tasks and prioritizing analyses;
- * Developing and implementing a preventive maintenance program for instrumentation in their laboratory, and ensuring that all equipment is maintained, serviced, and properly calibrated;
- * Monitoring QA/QC standards of performance, including ensuring that corrective actions are developed, documented, and implemented for all external and internal audit Findings, PT study failures, and other corrective actions;
- * Monitoring the validity of the analyses performed and data generated in the laboratory to ensure the production of compliant data, including, contributing to and/or overseeing data review processes;
- * Ensure that SOPs are compliant with promulgated methodologies and reflect current practice;
- * Maintaining current, compliant MDL studies for all methods, matrices, analytes, columns, and instruments;
- * Coordinating and approving the purchase of reagents, standards, glassware, and equipment that meet requirements;
- * Providing input to the Laboratory Director regarding methodologies, personnel resources, software, and instrumentation; and assisting in the evaluation and/or development of new methods and technologies that improve ALS's ability to meet clients' needs;
- * Reviewing RFPs and assisting in the preparation and submission of proposals; and
- * Interacting with the Quality Assurance, Information Systems, and Health and Safety Departments to ensure that the laboratory is capable of complying with client and regulatory requirements.

2.1.3 QUALITY ASSURANCE MANAGER

The Quality Assurance Manager (Manager) reports to the Laboratory Director and is independent of daily operation and production requirements. Therefore, the QAM is able to evaluate data objectively and perform assessments without production influence. *The QAM has authority to stop work if systems are sufficiently out of control to compromise the integrity of the data generated.*

The QAM shall have documented training and/or experience in QA/QC procedures; knowledge of quality systems as defined by TNI and other management systems standards; and a general knowledge of the analytical test methods for which data review is performed.

The QAM (and/or designee) is responsible for:

- Defining and implementing the quality system;
- Developing and maintaining a pro-active program for prevention and detection of improper, unethical, or illegal practices (e.g., single- or double-blind proficiency testing studies, electronic data audits, maintaining documents that identify appropriate and inappropriate laboratory and data manipulation practices);
- Ensuring continuous improvement of laboratory procedures via training, control charts, proficiency testing studies, internal audits, and external audits;
- Coordinating the laboratory's participation in state and Federal certification programs;
- Scheduling the review and distribution and maintaining distribution records of controlled documents, including plans (e.g., LQAP, etc.) and SOPs;
- Reviewing, when requested, Requests For Proposal (RFPs) to ensure ALS compliance with required QA/QC practices;
- Facilitating external audits;
- Overseeing or conducting internal audits of the entire operation annually (technical, management system, data, electronic);
- Coordinating, preparing and approving external and internal audit responses and corrective actions;
- Managing the laboratory's participation in proficiency testing (PT) studies;
- Reviewing nonconformances and approving corrective actions;
- Reviewing QC limits per established procedures;

- Ensuring that Detection Limit studies are performed and documented per requirements;
- Managing the reference standards used in the calibration and/or verification of support equipment (e.g., weights, thermometers, balances);
- Revising the LQAP annually in accordance with industry standards;
- Maintaining an archival system for quality records; and
- Maintaining technical and quality assurance training records, including employee competency to perform testing.

2.1.4 HEALTH & SAFETY MANAGER/RADIATION SAFETY OFFICER (RSO)

The Health & Safety Manager/Radiation Safety Officer (RSO) (Safety Officer) reports to the Laboratory Director. This Manager is responsible for establishing and monitoring adequate systems, procedures and training to ensure that the laboratory staff, facilities and operational activities conducted, function in a manner that minimizes employee risk of illness and injury, is compliant with all applicable regulations pertaining to matters of safety and health, and that limits the financial liability of the corporation as it relates to these matters. As RSO, this Manager is also responsible for discharging the duties and requirements prescribed by ALS's Radioactive Materials License.

Key responsibilities of the Health & Safety Manager/RSO (and/or designee) include:

- Ensuring that all employees have sufficient training to perform their job without unnecessary risk of illness or injury, providing health and safety, including radiation safety, training for new employees, and maintaining health and safety-related training records;
- Providing procedural guidance in the form of the Chemical Hygiene Plan (CHP), Radiation Protection Plan (RPP), Respiratory Protection Plan (ResPP), Emergency and Contingency Plan (ECP) and Health and Safety SOPs, and ensuring that these guidances are reviewed by laboratory staff;
- Ensuring that the laboratory facilities are maintained and operated in a safe manner, including:

- (a) Performing routine safety inspections of all operational areas;
 - (b) Performing routine radiation surveys and managing the radiation dosimetry program; and
 - (c) Performing personal monitoring, as indicated, for chemical and other exposures.
- Maintaining the laboratory's Colorado Radioactive Materials License and ensuring compliance with the terms of the license. Included in this responsibility are:
 - (a) Procuring and managing radioactive sources and standards;
 - (b) Maintaining the laboratory's radioactive materials inventory, which also includes directing prescreen analyses that provide initial characterization of potential sample radioactivity;
 - (c) Overseeing permitted low level radioactive materials releases to the sanitary sewer; and
 - (d) Ensuring that radioactive materials waste are transported in accordance with all Federal and state regulations, and are transferred only to facilities that possess a radioactive materials license.

2.1.5 FACILITIES/WASTE COMPLIANCE MANAGER (SAFETY OFFICER)

The Facilities/Waste Compliance Manager (Safety Officer), reports to the Laboratory Director. This Manager is responsible for day-to-day management of the building and serves as the primary point of contact for all matters related to waste collection and disposal.

The Facilities/Waste Compliance Manager (and/or designee) is responsible for:

- Coordinating heating, ventilation, and air-conditioning (HVAC) systems operation and maintenance;
- Maintaining the uninterruptible power supply (UPS) and coordinating maintenance and repairs to the electrical system;
- Maintaining the in-house vacuum system;

- Coordinating repairs to the building (e.g., doors, locks, windows, cabinetry);
- Maintaining the building's security and fire alarm system;
- Interfacing with fire inspectors; and responding to security and fire alarms on a 24-hour basis;
- Implementing waste reduction procedures;
- Managing the accumulation of radioactive waste in the laboratory;
- Developing and maintaining Satellite Accumulation Areas (SAAs) and 90-Day Storage Areas;
- Overseeing all waste disposal operations performed by ALS, including (1) ensuring compliance with Federal, state, and local regulations for waste handling and disposal in accordance with RCRA, TSCA, and radioactive waste disposal regulations; (2) managing hazardous waste shipments to Temporary Storage and Disposal Facilities (TSDFs); (3) managing sanitary sewer releases; and (4) managing sample archives and the return of samples and sample residues to clients;
- Training personnel on proper techniques for sample handling and waste disposal, according to standards implemented by Federal, state, and local authorities and maintaining associated training records; and
- Supervising the Sample Receiving Department.

2.1.6 INFORMATION SYSTEMS MANAGER

The Information Systems (IS) Manager (Manager) reports to the Laboratory Director. This Manager is responsible for administering the network, maintaining data recovery systems, and for managing personal computing (PC) equipment and peripherals, thus supporting instrumentation and LIMS. The IS Manager (and/or designee) is responsible for:

- Managing and maintaining the laboratory computer system. This function includes determining and purchasing appropriate hardware and verifying that its function meets intended objectives, establishing network server structure, and

developing and implementing proper maintenance and backup procedures;

- Procuring, configuring and maintaining all printers and copiers;
- Serving as a technical resource on computer-related issues;
- Documenting related operating procedures through SOPs, manuals or other proprietary documentation;
- Supervising recovery of all systems in the event of a disaster;
- Along with the Laboratory Information Systems Manager, analyzing information flow in the laboratory and suggesting the most effective hardware, applications software, and/or programming changes as solutions to meet long-term customer requirements; also, implementing those changes in data acquisition and management by purchasing hardware or software, where software is not developed internally; and
- Maintaining and implementing existing and future communications systems, including all internet and telephone systems.

2.1.7 LABORATORY INFORMATION MANAGEMENT SYSTEMS MANAGER

The Laboratory Information Management Systems (LIMS) Manager reports to the Laboratory Director, and bears the primary responsibility for the LIMS, which serves the needs of the technical, business, and management functions of the laboratory.

Key responsibilities of the LIMS Manager (and/or designee) include:

- Designing and developing information systems that relate to data capture and reporting;
- Maintaining and supporting applications that access LIMS and maintaining and supporting database back-end applications used for LIMS;
- Documenting changes and procedures through SOPs, manuals or other proprietary documentation;
- Developing software, as needed, using the appropriate tools, and per industry standard methodologies and validations;

- Overseeing and assisting with the implementation, testing and verification of upgrades made to instrument software;
- Coordinating all efforts to automate and improve electronic systems and processes throughout the laboratory;
- Developing interfaces necessary to achieve the requirements for client-specified electronic data deliverables (EDDs), and managing all deliverable formats provided to clients (hardcopy, electronic); and
- Providing training, as applicable, for all LIMS-related applications.

2.1.8 PROJECT MANAGER

- Project Managers report to the Client Services Manager . *The Project Manager serves as the primary point of contact between clients and ALS.* Each PM (and/or designee) is responsible for:
- Managing and coordinating the laboratory's performance after contract award, by defining technical and service requirements for personnel via LIMS, and interacting with clients and laboratory personnel to ensure that technical criteria and client service needs are met, including monitoring holding times (if appropriate) and deliverable deadlines, for all project sample analyses;
- Reviewing and approving any nonconformances reported by the laboratory and notifying the client, if appropriate, and communicating with clients pro-actively to ensure that all client service and technical concerns are resolved promptly;
- Reviewing all final reports for completeness, compliance with project requirements, clerical accuracy, and reasonableness;
- Generating, as directed by prompts provided in ALS's proprietary EDD generator, and transmitting EDDs to their clients as required;
- Ensure communications with the clients are in compliance with ALS SOP 997 "Client Communication"; and

- Communicating to the Operation Manager/Laboratory Director any potential need for new or improved capabilities based on clients' feedback.

2.1.9 GROUP LEADER

- Coordinating and approving the purchase of reagents, standards, glassware, and equipment that meet requirements
- Maintaining current, compliant MDL studies for all methods, matrices, analytes, columns, and instruments
- Assigning job tasks and prioritizing analyses;
- Developing and implementing a preventive maintenance program for instrumentation in their laboratory, and ensuring that all equipment is maintained, serviced, and properly calibrated;

2.2 GENERAL TECHNICAL PERSONNEL

A chemist (analyst) or technician reports to the a Technical or Operations/Department Manager or Group Leader. This employee performs work in accordance with ALS's controlled documents (e.g., SOPs, LQAP, etc.) and project-specific requirements as defined by the applicable LIMS specification. *ALS believes that quality begins at the bench.* Accordingly, these employees are key contributors to ALS's success.

A chemist or technician is responsible for:

- * Demonstrating proficiency in the analyses for which they are responsible **before** analyzing samples (e.g., performing acceptable Initial Demonstration of Capability), and documenting this demonstration of proficiency in accordance with ALS Procedure 150;
- * Performing analyses, recording all data accurately, directly, and promptly, and interpreting and reviewing data according to established procedures;
- * Read and understand all assigned SOPs and plan documents;
- * Complying with all QA/QC requirements that pertain to their job function;
- * Complying with all health, safety, and waste disposal requirements, as applicable;
- * Maintaining and repairing instrumentation;

- * Demonstrating good house-keeping practices;
- * Disclosing all instances of nonconformances promptly and in writing using the NCR process (**SOP 928**); and
- * Participating in training sessions.

3. QUALITY ASSURANCE INDICATORS AND OTHER MEASUREMENT PARAMETERS

ALS' objective is the development and implementation of policies and procedures that provide results of known, documented, and appropriate quality. This LQAP defines general policies for the analysis, documentation, evaluation, validation, and reporting of data. Specific, detailed procedures for chain-of-custody, calibration of instruments, analysis, reporting, quality control, audits, preventative maintenance, and corrective actions, are provided in SOPs as listed in **Appendix H**.

In order to produce data of known, documented, and appropriate quality, ALS:

- maintains an effective quality assurance program that measures and verifies laboratory performance;
- provides for a Quality Assurance Department that is independent of the operational groups and that has stop-work authority, and that has the responsibility and authority to audit the laboratory and develop and enforce corrective actions;
- evaluates technical and service requirements of all analytical services requests before accepting samples from a client/project. This evaluation includes a review of facilities, instrumentation, staffing, turnaround times, and any project-specific quality control or reporting requirements;
- provides sufficient flexibility to allow controlled changes in routine methodology in order to achieve client-specific data requirements as prescribed in client documents and contracts;
- documents initial demonstration of capability (IDOC) and continuing demonstration of capability (CDOC) for all methods according to Appendix C of the TNI standards;
- performs all analyses according to promulgated methods or methods developed and validated by ALS and documented in SOPs;
- recognizes as soon as possible and discloses and corrects any factors that adversely affect data quality; and
- maintains complete records of sample submittal, raw data, laboratory performance, and completed analyses to support reported data.

3.1 DATA QUALITY INDICATORS

Data Quality Indicators (DQIs) are qualitative and quantitative statements developed by data users that specify the quality of data from field and laboratory data collection activities in order to support specific decisions or regulatory actions. The DQIs describe *what* data are needed, *why* the data are needed, and *how* the data will be used to address the problem being investigated. DQIs also establish qualitative and quantitative goals that allow the data user to determine whether the data are of sufficient quality for the intended application.

The principal DQIs are **precision**, **accuracy** (bias), **representativeness**, **completeness**, and **comparability** (i.e., the PARCC parameters). The following sections define and describe the application of these parameters. The QA/QC protocols used for the majority of analyses are adopted from SW-846 and 40 CFR methodologies, the USEPA Organics and Inorganics CLP SOWs, and various radiochemistry guidances, which contain detailed descriptions of the quality control measures routinely employed.

3.1.1 PRECISION

Precision is an expression of the reproducibility or degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. Precision refers to the distribution of a set of reported values about the mean, or the closeness of agreement between individual test results obtained under prescribed conditions. Precision reflects random error and may be affected by systematic error. Precision characterizes the natural variation of the matrix and the contamination that may vary within that matrix. For chemical parameters that do not allow homogenization prior to analysis (e.g., volatile organics analysis), one must review precision values carefully.

Analytical precision is a measurement of the variability associated with duplicate or replicate analyses of the same sample in the laboratory. Analytical precision is determined by the analysis of matrix spike/matrix spike duplicates (MS/MSD), laboratory control sample pairs (LCS/LCSD), or by unspiked duplicate samples (DUPs). Total precision is a measurement of the variability associated with the entire sampling and analysis process, and is determined by analysis of duplicate or replicate *field* samples, thus incorporating the variability introduced by both the field and laboratory operations.

Precision is independent of bias or accuracy, and reflects only the degree to which the measurements agree *with one another*, not the degree to which they agree with the true or accepted value of the parameter measured. Precision for stable chemistry analyses is typically expressed as relative percent difference (RPD), as defined below:

$$RPD(\%) = \frac{X_1 - X_2}{(X_1 + X_2) / 2} (100)$$

where:

RPD = Relative Percent Difference

X₁, X₂ = analyte value of sample 1 and sample 2

Precision, for radiochemical analyses, is typically measured in terms of Duplicate Error Ratio (DER), calculated as follows:

$$DER = \frac{|S - D|}{2 * \sqrt{\sigma^2_S + \sigma^2_D}}$$

where:

DER = Duplicate Error Ratio

S, D = analyte values of (S)ample and (D)uplicate

σ = One Sigma error value associated with sample result

RPDs or DERs are compared to the control limits established for the analysis method, or other quality control criteria as prescribed in the applicable LIMS program specification. Precision objectives vary per analytical method. Sample homogeneity/non-homogeneity is an important factor that influences the precision of duplicate sample results.

3.1.2 ACCURACY

Accuracy is an expression of agreement between the measured and known or accepted reference values. Accuracy is the measure of the closeness of an observed value to the “true” value (e.g., theoretical or reference value or population mean). Accuracy is influenced by random error and systematic error (bias) that occur during sampling and analytical procedures; therefore, accuracy reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ significantly from the known concentration of the spike or standard.

Accuracy is typically measured by determining the percent recovery of known target analytes (i.e., a surrogate or matrix spike) that are spiked into a field sample or reagent water or simulated solid matrix (laboratory control sample). Surrogate recovery is reported and is used to assess method performance for each sample analyzed for volatile and semivolatile organic compounds. For organic and inorganic parameters, the stated accuracy objectives apply to spiking levels at or near the midpoint of the calibration curve. For radiochemical analyses,

the spiking levels for the control spikes may vary from five to fifty times the method reporting limit.

Percent recovery is calculated as:

$$R(\%) = \frac{(C_1 - C_2)(100)}{C_3}$$

where:

R% = Spike amount recovered

C₁ = Concentration of analyte in spiked sample

C₂ = Concentration of analyte in unspiked sample

C₃ = Concentration of spike added

Acceptance limits are usually based upon established laboratory performance for similar samples. Other quality control criteria may be prescribed in the applicable LIMS program specification. Recoveries outside the established limits may indicate some assignable cause other than normal measurement error, and the need for corrective action. This corrective action may include reanalysis of the quality control sample, recalibration of the instrument, reanalysis of the affected samples in the batch, re-preparation of samples in the batch, or flagging and qualifying the data as suspect if the problem cannot be resolved. For contaminated samples, recovery of matrix spikes may depend on homogeneity, matrix interference, and dilution requirements for quantitation.

Both accuracy and precision are calculated for each batch and the associated sample results must be interpreted by considering these specific measures. The quality assurance objectives for precision and accuracy are to achieve the quality control acceptance criteria specified in the appropriate analytical procedure.

For organic analyses, precision and accuracy are determined by using matrix spike and matrix spike duplicate samples and/or surrogate spike compounds and laboratory control samples. For inorganic analyses, precision and accuracy are determined by using duplicate samples or matrix spike duplicate samples (precision) and matrix spike and laboratory control samples (accuracy). For radiological analyses, precision and accuracy are determined from the results of duplicate samples or matrix spike duplicate samples (precision), laboratory control sample duplicates (precision) and laboratory control samples (accuracy).

Samples identified as field blanks cannot be used for duplicate or matrix spike sample analyses.

QC limits for accuracy and precision may be developed from intra-laboratory historical data or adopted from prescribed limits required by the client. If quality control acceptance criteria do not exist for a given method, then the laboratory may establish advisory control limits derived from a minimum of four data points. Until verified by a statistically significant data population, the control limits will be considered as advisory limits only, and the laboratory will not automatically initiate reanalysis if these limits are not achieved. See Section 9.3 for further discussion of control limits and control charts.

Bias describes the systematic error of a measurement process that causes errors in one direction from the true value. Sources of bias include incomplete homogenization before subsampling and incomplete extraction of target analytes. Calibration drift, which is the nonrandom change in a measurement system over time, is another example of systematic error, and is detectable by the periodic measurement of calibration check standards. *Bias is **not** equivalent to accuracy.*

3.1.3 REPRESENTATIVENESS

Representativeness is a qualitative element. It expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary.

Sample handling protocols (e.g., holding times, storage, preservation and transportation) have been developed to preserve the representativeness of the samples. Proper documentation establishes that quality control protocols have been followed, and sample identification and integrity are ensured. *ALS makes every attempt to ensure that the aliquots taken for analysis are homogenous and representative of the samples received.*

3.1.4 COMPARABILITY

Comparability is a qualitative expression of the confidence with which one data set can be compared to another. Comparability is achieved by:

- following established, standardized, and approved sample collection techniques and analytical methods;
- achieving holding times;
- reporting results in common units;
- using consistent detection levels; and

- reporting data according to consistent rules.

See Chapter 10 of this LQAP for further discussion of standard units typically used to report various analytical parameters.

3.1.5 COMPLETENESS

Completeness is an expression of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Completeness is the percentage of measurements that are judged to be usable (i.e., that meet project-specific requirements). Completeness goals are defined in the site sampling and analysis plan, QAPjP or contract, and vary with the size and complexity of the project. Completeness goals of 80-95% are traditionally accepted as realistic. ALS's objective is 100% completeness for samples unaffected by matrix interferences.

It is recognized that some samples are highly contaminated with target and/or non-target compounds, which necessitate cleanups, multiple analyses, and/or extensive dilutions. In these instances, the internal QC results for a sample help to demonstrate the impact upon recoveries and detection limits due to these atypical situations.

Factors that adversely affect completeness include:

- receipt of samples in which chain-of-custody or sample integrity is compromised in some manner (e.g., broken containers, improperly preserved);
- receipt of insufficient volume to perform initial analyses or repeat analysis if initial efforts do not meet QC acceptance criteria;
- receipt of samples for which more than 50% of the holding time has expired; and
- receipt of samples that contain high levels of contamination that can cause persistent effects on instrumentation designed for trace-level analyses.

The equation used to calculate completeness is:

$$C\% = \frac{S}{R} (100)$$

where:

C = completeness

S = number of successful analyses

R = number of requested analyses

The USEPA has established that there is a 5% probability that the results obtained for any one analyte will exceed the control limits established for the test as a result of random error, assuming the confidence interval is established at 95% (preamble to 40 CFR Part 136, Vol. 49, No. 209, October 26, 1984). As the number of compounds measured increases in a given sample, the probability for realizing statistical error also increases. The number of compounds present in various methods (e.g., GC/MS Methods SW8260B and SW8270C, ICAP Method SW6010B and Gamma Spectroscopy Method EPA 901.1), increases the probability that one or more analytes will not meet acceptance criteria, to significantly more than the 5% per analyte frequency. The number of target analytes included in these methods can be used to show that a minimum of four to seven target analytes will exceed the control limits established for these methods as a result of the statistical probability for random error. *Establishing quality control criteria that are not consistent with the measurement of the quality objectives for which they are intended is discouraged.*

3.2 TRACEABILITY

Traceability is the extent to which results can be substantiated by hard-copy documentation, electronic or computer-generated data calculations, computer software, and data generation. Traceability documentation exists in two forms: (1) that which links final numerical results to authoritative measurement standards, and (2) that which explicitly describes the history of each sample from collection to analysis. Measurement traceability is further discussed in Chapter 7 of this LQAP.

3.3 SENSITIVITY (STABLE CHEMISTRY)

The term sensitivity is used in a broad sense to describe the various limits that enable a laboratory to meet project-specific data quality objectives (DQOs). These limit types include: instrument detection limit (IDL), method detection limit (MDL), method quantitation limit (MQL) or method reporting limit (RL), contract-required detection limit (CRDL), and contract-required quantitation limit (CRQL).

3.3.1 IDL AND LOD

The IDL is a minimum value that addresses the detection capability of the ICP instrument *only*, hence IDL studies are performed on a per analyte per instrument basis. IDL studies are particularly important to metals analyses. These IDL studies must be conducted on an whenever there is a significant change in instrument components or reagents.

The LOD (Detection Limit or MDL) is a minimum value that addresses the detection capability for the sample preparation procedures and the instrument. Hence, ALS performs LOD studies for each preparatory and determinative method combination, matrix, instrument, and analytical column. LOD studies are ongoing in each batch of samples tested. LOD studies are also required for method validation, and whenever the basic chemistry of a procedure changes.

LOD (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. LODs are determined using ALS SOP 329.

An MDL study is not performed for radiological analyses, or any components for which spiking solutions are not available or relevant (e.g., pH, ignitability, etc.). Reporting limits for these kinds of parameters, where applicable, are established based on the laboratory's knowledge of extraction efficiency, instrument sensitivity, and experience with the procedure. **SOP 329** provides additional information about LOD studies.

Results calculated between the MDL and the LOQ/MDL (RL) contain a significant amount of error. Therefore, values reported between the LOD and LOQ(RL) are qualified as estimated – 'J' flagged for organic parameters, 'B' flagged for inorganic parameters. Also, LOD values are based on an interference-free matrix, and cannot evaluate the effects of sample matrix. Therefore, established LODs/MDLs may not be achievable in some environmental matrices.

3.3.2 LOQ (MDL, RL)

ALS defines LOQ as the analyte concentration at or above which the laboratory's precision and accuracy requirements can be routinely demonstrated and achieved. The statistical error associated with this region of a calibration curve is significantly smaller than that associated with the region near the MDL. The LOQ values for most analytes reported by ALS are numbers that are approximately 30% to 5 times the values of the LOD for those analytes. It is ALS's policy to analyze a calibration standard at or below the LOQ when performing an initial calibration.

The LOQ is the lowest level that can be reliably measured by a laboratory with defined limits of precision and bias. The precision and bias at the LOQ is associated with Reporting Limits verification (RVS) samples analyzed. The USEPA CLP SOW uses the terms CRDL and CRQL to describe *contractually-required* levels of reporting. These reporting terms do not describe instrument sensitivity.

3.4 MINIMUM DETECTABLE CONCENTRATION (RADIOCHEMISTRY)

The minimum detectable concentration (MDC) is used for radiochemical procedures and is defined as the concentration at which there is a 95% confidence that an analyte signal will be distinguishable from an analyte-free sample.

The general formula for calculating the MDC is based on calculations derived by Curie (Curie, L.A., "Limits for Qualitative Detection and Quantitative Determination," Analytical Chemistry 40(3); pp. 586-693; 1968) and is calculated as follows:

$$MDC = \frac{(4.65 \times \sigma_b) + 2.71}{T * K}$$

where:

MDC = Minimum Detectable Concentration

σ_b = Standard deviation of the measurement background

T = Sample count time

K = Factor for incorporating efficiency, abundance, aliquot yield, ingrowth and decay, and activity conversion factors

3.5 MEASUREMENT UNCERTAINTY

3.5.1 ANALYTICAL UNCERTAINTY FOR STABLE CHEMISTRY

Uncertainty is associated with most of the results obtained in the laboratory testing conducted by ALS. It is meaningful to estimate the extent of the uncertainty associated with each result generated by the laboratory. It is also useful to recognize that this measurement uncertainty is likely to be much less than that associated with sample collection activities. In practice, the uncertainty of a result may arise from many possible sources. ALS has considered the relative contribution of major sources of error. The approach adopted by the laboratory to estimate uncertainty resulted in the conclusion that many sources of error are insignificant compared to the processes of sample preparation, calibration, and instrumental measurement. The uncertainty associated with these processes can be estimated from quality control data. Accordingly, ALS estimates uncertainty from data derived from quality control samples carried through the entire analytical process. Each estimate of uncertainty is associated with a specific combination of analytical method and sample matrix.

The ALS Standard Operating Procedure 998 gives details of how uncertainty in the analytical process is estimated, calculated and reported if required.

3.5.2 TOTAL PROPAGATED UNCERTAINTY FOR RADIOCHEMISRY

Total propagated uncertainty (TPU), is a summation of the various uncertainties present in a measurement process, and is an integral part of every reported radiochemical value. TPU, reported as \pm TPU, is the expressed estimated measure of the total uncertainty inherent in that reported radiochemical result.

The components of the TPU are classified as either random or systematic. Random uncertainties, also called counting uncertainties (CU), derive from the statistically random (normally distributed) nature of radioactive decay, and are estimated as the square root of the total number of counts acquired during analysis. In cases where the chemical yield is determined by the analysis of a radioactive tracer, the yield uncertainty (YU) is also a random uncertainty, and is estimated as the square root of the total number of tracer counts acquired. CU and YU are calculated in activity units to afford comparability to the sample result.

Systematic uncertainties are attributable to actual errors in the measurement of a physical quantity. For example, if a balance has an accuracy of $\pm 0.1\%$, the results of those gravimetric measurements are not normally distributed, but rather are assumed to be biased by that amount. Estimates of systematic uncertainties in laboratory processes are somewhat subjective, but should be supported by empirical data whenever possible. Systematic uncertainties associated with the preparation of a sample are called preparation uncertainties (PU), and are defined based on the number of volumetric and gravimetric measurements, quantitative transfers, etc. Systematic uncertainties associated with the analysis, called instrument uncertainties (IU), include biases associated with sample positioning, standard values, calibration coefficients, etc. PU and IU are typically provided as a percentage of the final result. To afford comparability to sample results, PU and IU are expressed in activity units by multiplying the percentage by the sample activity (A).

All contributions to TPU are considered to be independent of each other, and the individual contributions are combined as the square root of the sum of the squares (see equation below). The final TPU result is expressed in activity units, such as

pCi/g or pCi/L.

$$TPU = \sqrt{CU^2 + YU^2 + (A * PU)^2 + (A * IU)^2}$$

TPU is expressed as a value at a specific confidence interval. The default convention at ALS is to provide the TPU at the 2-sigma confidence interval. This asserts approximately a 96% confidence level that the actual sample value is within the reported uncertainty range of the calculated result. **SOP 708** provides more information about the calculation and use of TPU.

3.6 QUALITY ASSURANCE PROJECT PLAN (QAPjP) EXCEPTIONS

As a result of the unknown nature of environmental samples prior to analysis, ALS has minimal control over analytical and quality control complications that result from sample matrix conditions. These conditions may include highly concentrated samples that contain target compounds of interest and/or non-target components; high organic content (both natural and synthetic); and extremes in pH, viscosity, solubility, etc. Each of these conditions may require a different approach.

Analysis for some samples may be achieved through the use of reduced aliquot sizes. Some sample matrices may require the laboratory to use cleanup and/or dilution techniques in order to analyze the sample by the desired protocol.

Unfortunately, reduction of analysis aliquot or diluting a sample necessitates raising reporting limits (RLs) or MDCs, and often adversely impacts the calculation of surrogate, tracer, and matrix spike compound recoveries.

ALS has the responsibility to identify matrix interferences that preclude the generation of ‘compliant’ data. This determination may be made by demonstrating reproducibility (i.e., reanalysis of the affected sample) to show that the quality control measurement failure resulted from sample matrix conditions beyond the laboratory’s control and not as a result of analytical error. For example, if the surrogate or tracer recoveries are outside of control limits, then samples may be re-extracted and/or reanalyzed. Repeated non-compliant results indicate that sample matrix probably prevented the laboratory from reporting results deemed compliant.

Analytical projects containing particularly “dirty” samples (i.e., highly contaminated with target compounds and/or matrix co-extractives) will often fail to meet pre-established completeness goals (set forth in the QAPjP), when prior site history does not reveal the matrix constituents issues. Although the laboratory performs all analytical testing and cleanup procedures by the prescribed protocols, the results obtained may not meet validation criteria as a result of elevated reporting limits or the frequency at which surrogate, internal, tracer, or matrix spike recoveries fail to meet acceptance limits. In cases where the laboratory is unable to meet quality control criteria as a result of sample matrix complications, results that are qualified by data validation guidelines may still be useful to the end user of the data.

ALS is committed to adhering to the method requirements and quality control procedures prescribed by our clients. ALS strives to produce compliant data, however, uncertainties associated with environmental samples may preclude the laboratory’s ability to generate fully compliant data. ALS will not assume responsibility for conditions beyond our reasonable control, that directly impact the “validity” versus the usability of the associated analytical data generated by the laboratory.

4. SAMPLE CONTAINERS, PRESERVATION, HANDLING, HOLDING TIMES

Defining the magnitude and nature of an environmental problem, and developing an appropriate solution, requires the collection of representative samples for laboratory analysis and data evaluation. The objective of field sampling is to remove a small portion of an environment that is representative of the entire body. *Analytical methods have been standardized, but the results of analyses are only as good as the sampling protocol and the sample preservation and handling methods.* Defining sampling procedures and the quality elements applicable to environmental testing is beyond the scope of this document, and beyond the responsibility of the laboratory.

Although the laboratory is not responsible for sample collection, it is responsible for maintaining the integrity of the sample after receipt. After the sample has been collected,

the constituents of the sample must remain as close as possible to the field condition (i.e., degradation must be prevented). The length of time that these constituents will remain stable is related to their character and the preservation method used. Preservation is accomplished by the addition of chemical preservatives and/or storage at a controlled temperature, and by the strict observation of prescribed maximum holding time allowances. **Appendix C** lists sample container types, preservation requirements, and holding times.

4.1 FIELD SUPPORT

Unless not required by the client, sample kits are prepared at the laboratory to provide the client with all of the sample containers, preservatives and documentation needed for the analyses needed for a project. ALS provides shipping containers, custody documents, custody seals, clean sample bottles, labels, applicable high-purity chemical preservatives for water samples, and trip blanks, and, upon request, “blue ice” packs to support field-sampling events. Hard-sided, insulated, “picnic” coolers are typically used to transport samples from the field to the laboratory. These coolers meet or exceed all protocol requirements (i.e., USDOT, USEPA, ASTM) for shipping. **ALS SOP 205** provides further information on sample kits.

4.2 SAMPLE CONTAINERS

ALS provides certified clean (I-Chem 300™, Eagle Pitcher Level 1, or equivalent) sample bottles for sample collection. Used sample bottles are never used by the laboratory. The Sample Receiving Department maintains certificates of cleanliness that are provided by the vendor for all sample bottles. These certificates are provided to the client upon request. Containers are stored in clean areas, away from laboratory processes, to prevent exposure to fuels, solvents, and other contaminants.

4.3 SAMPLE PRESERVATION AND HOLDING TIMES

ALS provides the required chemical preservatives for water samples and, upon request, “blue ice” packs, for thermal preservation during transport. Typically, high quality reagent grade chemical preservatives (i.e., acids, solutions, etc.) are added to individual sample bottles, as appropriate per method and US Department of Transportation (DOT) requirements. Only trace metals grade nitric acid is used for preservation of metals or radiochemical samples, as applicable. It is the responsibility of those collecting the samples to properly use these materials (e.g., don’t rinse or overfill container such that the preservative is washed out), and to ensure that chemical preservation requirements are met, and proper preservation techniques (chilling) are performed. Holding times begin with the collection of samples and continue until analysis is complete. See **Appendix C** for a summary of container, preservation and holding time requirements specific to various analyses and matrices.

4.4 SAMPLE RECEIPT SCHEDULE

ALS receives samples six days of the week, Monday through Saturday. ALS requests that clients ship samples for delivery within one day of collection, and give advance notice to the laboratory regarding shipment of RUSH samples or samples with short hold time requirements. Shipping containers received at the laboratory on holidays or after business hours are placed in a walk-in refrigerator and opened on the next business day, unless other arrangements are made in advance.

4.5 CHAIN-OF-CUSTODY

Chain-of-custody (COC) documentation begins with field sampling and continues through laboratory analysis and disposal. A chain-of-custody record that identifies all individuals who handle the sample is used to establish an intact, continuous record of the physical possession, storage, and disposal of collected samples, including their aliquots, extracts or digestates. The chain-of-custody record is initiated in the field by field personnel who complete a COC form listing all samples. This form contains the following information and remains with the samples during transport:

- client project name and project location;
- field sample number/identification;
- date and time of sample collection;
- matrix;
- container type and number of containers for each sample;
- preservative;
- analysis requested;
- sampler's remarks and signature;
- signature of person relinquishing samples and date and time relinquished;
- custody seal number (if applicable); and
- designation of matrix spike/matrix spike duplicate (MS/MSD) samples (optional).

Note that contingent upon the sample matrix and analysis to be performed, additional sample volume may need to be submitted to accommodate MS/MSD analyses.

All transfers of samples, except directly between commercial couriers, must be recorded on the chain-of-custody form via the "relinquished" and "received by" sections. All information, except signatures, should be clearly printed.

The USEPA National Enforcement Investigations Center (NEIC) defines evidence of custody as:

- in one's actual possession, or
- in one's view, after being in one's physical possession, or
- having been in one's possession and then locked or sealed to prevent tampering, or
- kept in a secure area, restricted to authorized personnel only.

To ensure that sample custody objectives of traceability are achieved for every project, the chain-of-custody initiated in the field, is continued and maintained internally throughout the laboratory per the requirements specified in **SOP 318**. Internal chain-of-custody begins with sample acceptance and login (**SOP 202**), is maintained as samples are distributed for use throughout the laboratory (further discussed in LQAP Section 4.10), and concludes with final sample disposition (i.e., return to the client or disposal). ALS applies a unique barcode to each sample bottle received, and maintains several scanners and PCs throughout the laboratory to document and assist with sample, aliquot, extract and digestate movement throughout the facility. This electronic process is accomplished through LIMS, which retains records of all sample and fraction transactions made.

4.6 SAMPLE ACCEPTANCE POLICY

ALS' sample acceptance policy requires that a sample meet the following conditions:

- The sample shall be completely documented (sample identification, location, date and time of collection, collector's name, preservation type, sample type, any special remarks concerning the sample);
- The sample shall be identified by a unique identifier using durable labels completed in indelible ink;
- The sample shall be collected in adequate volume;
- The sample shall be collected in an appropriate container;
- The sample shall be delivered to the laboratory with at least one-half the holding time remaining;
- The sample shall not exceed allowed radioactivity levels; and
- The sample shall not show signs of contamination, breakage, or leakage.

Sample receipt discrepancies are documented by Sample Receiving Department personnel on the Condition of Sample Upon Receipt, Form 201 (SOP 008), which is forwarded to the Project Manager as part of the workorder folder. Where samples do not meet the criteria stated above, the Project Manager requests information from the client before proceeding. If the client can provide the

information and, in cases of compromised sample integrity, directs the laboratory to proceed, then data acquired from the sample(s) analysis is reported and the problems noted during sample receipt are disclosed in the narrative of the final data report.

In support of the protection of employee health and of ALS's radioactive materials license, ALS observes prescreening protocols that designate or determine samples with radioactive content. Detailed procedures for conducting radiological survey of incoming sample packages are given in **SOP 008**, further details regarding prescreening protocols are given in **SOP 703**.

4.7 SAMPLE RECEIPT PROTOCOLS

Upon receipt of the field samples at the laboratory, personnel ensure that sample bottles are maintained according to storage requirements, and in a manner that does not contaminate the samples (see section 4.9 for further details).

Ascension numbers that increment serially each month of the year are applied as workorder number assignments. Following sample arrival and initial screen for USDOT compliance and removable radioactivity, sample receiving personnel inspect the sample and record any discrepancies using Form 201 (**SOP 008**). The following information is documented:

- client and project name, as applicable;
- presence/absence and condition of (i.e., intact, broken) custody seals on the shipping containers;
- presence/absence of chain-of-custody and completeness;
- sample condition (intact, broken, leaking);
- presence/absence of removable sample tags;
- agreement/non-agreement between the sample labels, tags, chain-of-custody, and any other client documentation;
- receipt of adequate sample volume;
- sample temperature, where applicable;
- presence/absence of headspace in VOA and ²²²Radon vials; and
- chemical preservation, where applicable.

Sample temperature is verified upon receipt by measuring the temperature of the temperature blank (if available) or by measuring the temperature of a representative samples(s) with an infrared (IR) temperature device. See **SOP 210** for instructions and procedures related to IR temperature guns. Samples that require thermal preservation are considered acceptable if the temperature upon arrival is between just above freezing to 6°C. Samples that require thermal preservation but are hand-delivered to the laboratory immediately after collection,

may not meet the temperature requirement. If the hand-delivered sample is packed in ice, then Sample Receiving personnel record its temperature and note that the chilling process was initiated.

4.8 SAMPLE LOGIN POLICIES AND PROCEDURES

After completing sample receipt procedures, the following sample information and analytical requests are entered into LIMS under the unique workorder number assigned:

- client name, contact, address, phone number;
- ALS Project Manager;
- date and time of sample receipt;
- unique laboratory identifier for each sample;
- sample description, including date/time of collection;
- analyses requested (LIMS calculates holding times for each analysis);
- program specification or other special instructions, if applicable; and
- due date.

In general, a group of received samples is assigned one workorder number in LIMS. Each sample container is assigned a unique ALS identifier (barcode) that is placed on each container. This unique identification includes all samples, subsamples, and subsequent extracts and/or digestates.

See **SOPs 201 and 202** for additional information about sample login and distribution.

4.9 SAMPLE STORAGE

Samples requiring thermal preservation are stored in designated refrigerated storage areas that are maintained just above freezing to 6°C, centered at 4±2°C. Freezer storage areas are maintained at freezing to -20°C, centered at -15±5°C. The temperature of refrigeration units is monitored continuously using electronic min/max thermometers and recorded each business day, near to the beginning of the work shift. If the temperature exceeds the prescribed range, then corrective action is taken and documented immediately, and the client notified, if appropriate; see **SOP 326** for further details. Directives for corrective action pertaining to catastrophic failure of cooling units (as well as laboratory ovens, etc.) are included in ALS's Emergency and Contingency Plan (ECP).

Samples are stored away from all standards, reagents, food and other sources of contamination. Samples are stored in such a manner as to prevent cross-contamination. For example, pure product or potentially contaminated samples are tagged as "hazardous" and stored within a secured area, separate from other

samples. ALS provides designated sample storage areas according to the following parameter groups: metals, inorganics (WetChem), semivolatile organics, volatile organics, fuels, and radiochemical analyses.

Samples having suspected radioactive activity and scheduled also for stable chemical analyses are refrigerated. Samples to receive tritium analyses are refrigerated. Samples designated for radiochemistry analyses *only*, with the exception of tritium, are segregated and maintained at ambient temperature.

To effectively monitor the storage and potential contamination of volatile organic samples, ALS observes a refrigerator blank program (detailed in **SOPs 511, 512**).

To provide for the safe containment of sample material that could be released as a result of sample container failure, all samples are stored in secondary containment bins. These secondary containment bins are of a sturdy and inert nature, and are sufficient in size to fully contain the sample(s) in the event of a spill, leak or breakage. The bin(s) may be uniquely identified (labeled) to assist in locating samples via the chain-of-custody system. The bins are thoroughly cleaned between uses.

4.10 **SAMPLE ACCESS**

It is ALS's policy that neither samples nor data may be released to unauthorized personnel. In order to ensure that this policy is maintained, the laboratory facilities are maintained under controlled access and are restricted to authorized personnel only (see **SOP 132** for further details pertaining to building security).

As discussed previously in this section, ALS personnel follow strict sample handling and internal chain-of-custody procedures to ensure the integrity of all data generated. Limited access electronic controls in LIMS further protect the validity of the data results. Samples are scanned and transacted in LIMS when they are removed from a storage area for preparation or analysis. The sample ID, analyst, date, time, and location are recorded with each transaction. Likewise, the samples are scanned and transacted in LIMS upon their return to the storage unit. Barcode scanning and LIMS transaction is also observed for the return of sample remainders to the client, and for disposal (see LQAP Section 4.13). **ALS SOP 318** contains internal chain-of-custody details; procedures for sample return to the client are described in **SOP 027**.

4.11 **SAMPLE HOMOGENIZATION AND SUBSAMPLING**

Obtaining a representative aliquot of sample for testing is critical to the representativeness of the analytical results obtained. Proper subsampling techniques, particularly for solid matrices, are a component of each bench employee's technical instruction. Sample homogenization procedures prior to radiochemical analysis are prescribed in **SOP 736**. Representative subsampling procedures for stable chemistry analyses is prescribed in **SOP 336**. Client and

method specified procedures for homogenization or aliquotting may also be defined in the applicable LIMS program specification.

4.12 SUBCONTRACTING ANALYTICAL SERVICES

ALS strives to identify the need to subcontract specific analytical procedures during the bid response process. Analyses may also need to be subcontracted, however, in cases of emergency where the ability to meet sample holding time criteria is endangered. In these instances, ALS compiles a list of qualified subcontract laboratories that are suitable to perform the needed analyses, then submits the list to the client for selection and approval. If TNI certified analyses are to be subcontracted, the subcontract laboratory must also hold TNI certification for the analyses that are to be conducted. The same concept regarding subcontract laboratory qualifications may apply for other program samples (e.g., DOD laboratory approval status is required for the analyses to be conducted in the case of DOD samples that must be subcontracted for analysis). Note that for subcontracted DOD sample analyses, the subcontract laboratory must receive project-specific approval from the DOD client before any samples are analyzed.

ALS's Project Manager must receive permission from the client, in writing, before the subcontract laboratory can be procured and samples forwarded to the laboratory. At a minimum, the specific terms of the subcontract laboratory agreement must include:

- analytical method required (e.g., SW-846, 40 CFR, etc.);
- number and type of samples expected;
- project-specific quality control requirements;
- deliverables required (hardcopy, electronic);
- laboratory certifications required;
- price per analysis; and
- turnaround time requirements.

See **SOP 103** for guidance on evaluating a subcontract laboratory's qualifications. Detailed procedures pertaining to submitting samples to a subcontract laboratory are provided in **SOP 103**.

4.13 SAMPLE DISPOSAL

After completion of sample analysis and submission of the project report, unused portions of samples are retained by the laboratory for a minimum of 30 days or as designated by client and contract requirements from date of invoice. Samples are disposed or returned to the client according to the nature of the samples and the client's specifications. ALS documents and retains all conditions of disposal and correspondence between all parties concerning the final disposition of the sample.

Samples, digestates, leachates, extracts, and process waste that are characterized as hazardous, radioactive, or mixed waste are disposed in accordance with Federal and state laws and regulations. ALS maintains records to demonstrate that all disposal efforts were conducted in compliance with these laws and regulations. This documentation includes the unique sample identity, date of disposal, nature of disposal (e.g., sample depleted, sample disposed in hazardous waste facility, sample disposed in mixed waste facility, sample returned to client); and name of the individual responsible for disposal.

5. LABORATORY FACILITIES

Appendix E contains a diagram of the ALS laboratory facility. ALS maintains constant and consistent test conditions throughout the facility (e.g., temperature, air purification, lighting). All entrances and exits are wired to a laboratory-wide security system that is monitored continuously. Access to the laboratory area from the front offices is restricted by means of keypad locks requiring numeric security code entry. Visitors must sign in at the front desk and must be escorted at all times (some vendors are allowed access without continuous escort, in order to facilitate repairs or deliveries). Further details pertaining to building security are provided in **SOP 132**.

The following sections highlight areas of the laboratory that are involved with sample receipt, handling, preparation, and analysis of samples.

5.1 SAMPLE RECEIPT AREAS

ALS's sample receiving area consists of a large dedicated room of more than 500 ft². It contains two fume extraction hoods and radiation survey equipment to safely handle incoming radioactive and mixed waste samples. There is an outside access door to facilitate sample delivery and shipping of sample kits. Adjacent to the sample receiving area is the bottle storage room and the radioactivity prescreening lab.

5.2 SAMPLE STORAGE AREAS

ALS's sample receiving area has a walk-in cooler and a freezer that are used for temporary storage of samples that require thermal preservation. In addition, there are several designated sample storage locations throughout the laboratory that are used to store samples scheduled for specific analyses (see section 4.9 for further details).

5.3 SAMPLE PREPARATION AREAS

The laboratory has nine sample preparation/extraction/digestion areas. These areas are divided as follows: six radiochemistry preparation laboratories; two organics extraction laboratories; and one metals digestion laboratory. The total floor space of these six laboratories is approximately 4500 ft².

Laboratory preparation procedures are segregated as much as possible to minimize the potential for contamination, maximize processing efficiency, and maintain analytical integrity. Rigorous cleaning of glassware (**SOPs 334** and

720) and apparatus ensures that cross-contamination is minimized. Each laboratory area has a dedicated or locally shared HVAC system that continuously exchanges the laboratory air with filtered and conditioned outside air. There are 34 laboratory hoods in the six sample preparation areas, and each sample preparation area has at least one hood that is capable of maintaining an average face velocity of 100 feet per minute.

5.4 STANDARDS PREPARATION AREAS

A dedicated radiochemical standards preparations room, and an organics standards preparation area are maintained. Metals and inorganic standards are stored independently from sample storage areas and are prepared in their respective laboratory areas.

5.5 ANALYTICAL LABORATORIES

The ALS facility houses a volatile organics analysis (VOAs) laboratory that is on an upper level of the building, away from all other laboratory operations. The ALS facility also houses one general chemistry (WetChem) laboratory, two radiochemical counting rooms, a total organic carbon (TOC) laboratory area, two gas chromatograph (GC)/high performance liquid chromatography (HPLC) laboratory areas, a semivolatile organic compounds (SVOCs) laboratory, and a metals laboratory that contains separate inductively coupled plasma (ICP), mercury, and inductively coupled plasma/mass spectrometry (ICP/MS) rooms.

5.6 OTHER LABORATORY AREAS

Other areas of the ALS facility include a tank room for compressed gasses, several waste management areas, telephone and computer storage rooms, staff offices, Reporting Group and Reports Management data processing rooms, and various scanning/reproduction and supply storage areas.

5.7 DEIONIZED WATER SYSTEM

Within the laboratory, there are two main deionized (DI) water distribution systems available for glassware cleaning, bulk reagent preparation, and general use. One system is located in the janitor's area and serves the radiochemistry side of the facility (ASTM Type II water generated). The other system is located adjacent to the metals laboratory area and serves the stable chemistry side of the facility (ASTM Type I water generated). These DI water systems are capable of continuously delivering water that meets the requirements specified for the ASTM water type, and are monitored and documented each business day to ensure that the water meets these criteria. ALS also maintains a third treated water system that is used to support washing of stable chemistry laboratory glassware.

DI water is defined as municipal tap water that has been treated by passing it through a particulate filter, activated carbon unit, cation exchange resin, anion exchange resin, mixed bed resin, and a final "polishing" cartridge. This water contains no detectable heavy metals or inorganic compounds of interest, and is free of organic compounds of analytical interest above ALS's routine reporting

limits. Additionally, a benchtop Millipore Synergy 185™ unit is available for laboratory use should further finishing be desired.

SOP 319 provides detailed information pertaining to ALS's DI water systems, including discussions of independent monthly testing to verify that electronic readouts of water quality are accurate, maintenance by a vendor contractor, and corrective measures to be taken should water quality degrade to below acceptable limits.

6. ANALYTICAL PROCEDURES

ALS is capable of analyzing various matrices, including surface and groundwater, drinking water, soil, sediment, vegetation, tissue, filter and aqueous and solid wastes. ALS does not routinely perform analyses on air (non-particulate), however, analysis of these matrices may be available through our sister laboratories. Analyses are performed using promulgated methodologies as requested by the client and their regulators, and as required by ALS's certifying authorities. *New iterations of established methodologies are evaluated on an ongoing basis and implemented as client needs dictate.* Analytical procedures are conducted in strict adherence with SOPs that describe the preparation, analysis, review and reporting of samples. In some cases, these SOPs may also describe proprietary methods developed by ALS and used per the client's request. A list of ALS's analytical capabilities is presented in **Appendix C**. A list of ALS's SOPs is provided in **Appendix H**. References for analytical procedures used are presented in the attached **Bibliography**. ALS also, upon request, develops and validates procedures that are more applicable to a specific client objective.

6.1 ANALYTICAL METHODS

Selection of the appropriate method is dependent upon data usage and regulatory requirements. ALS may modify existing methods in order to:

- achieve project-specific objectives;
- incorporate modifications or improvements in analytical technology;
- address unusual matrices not covered in available methods; and
- provide analytical capabilities for an analyte for which there are no promulgated methodologies.

ALS discloses method modifications to our clients by providing the appropriate SOP for review.

6.2 METHOD COMPLIANCE

Compliance is the proper execution of recognized, documented procedures that are either approved or required. Strict adherence to these procedures is necessary to provide data acceptable to a regulatory body of competent jurisdiction in a specific regulatory context.

Compliance is, however, separate from, but not inconsistent with, technical scientific quality. ALS understands that the expectations of our clients commonly include the assumption that data and reports will satisfy a regulatory purpose and will be found acceptable and compliant with regulatory requirements.

6.2.1 UNDERSTANDING THE REGULATORY FRAMEWORK

Compliance is not likely to be achieved in the absence of an understanding of the regulatory framework. Upon receipt of a statement of work (SOW), ALS attempts to ascertain, prior to accepting samples:

- what regulatory jurisdiction pertains to a project (USEPA, State Department of Health, etc.)
- within the regulatory jurisdiction, what body of regulations has primacy (RCRA, SDWA, CWA, etc.); and
- within this context, what QA/QC protocols are required (DOE, DoD -- AFCEE, NFESC, etc.).

ALS works with our clients to achieve a mutual understanding of all requirements and makes the following commitments:

- ALS will proactively attempt to identify and understand the regulatory context of client's needs.
- ALS will strive to be expert in understanding and executing the regulatory requirements for compliance.
- ALS will ensure that we have the capabilities, resources and facilities to perform the requested analyses.
- ALS will identify and disclose to clients instances of non-compliance in a forthright and timely fashion.

6.2.2 RESOLVING COMPLIANCE CONTRADICTIONS

Multiple regulatory jurisdictions may overlap for a specific project, which may cause uncertainty or contradictions to arise. Similarly, methods and protocols may be prescribed in a scope of work or QAPjP that either will not achieve stated or implied DQOs, or that conflict with the regulatory requirements. ALS will attempt to detect these inconsistencies and contradictions and will disclose them to clients in a timely fashion. ALS voluntarily accepts a responsibility to provide information to our clients; however, the primary responsibility for resolving inconsistencies with regulators remains with the client.

6.2.3 DISCLOSURE OF NON-COMPLIANCE

As previously stated, it is ALS's policy to disclose in a forthright manner any detected non-compliance that may affect the usability of data produced by ALS. It is not within our expertise to predict the manner in which a specific regulator or regulatory body will interpret the rules governing analysis; therefore, ALS is unable to guarantee compliance. It is ALS's policy that our responsibility begins with a bona-fide and competent attempt to evaluate potential compliance issues, and ends with disclosure of any findings that may enable our clients to make an informed decision.

Procedures for documenting non-compliances and applying corrective actions are given in **SOP 928**.

6.3 NON-STANDARD METHOD VALIDATION

When a non-promulgated method (i.e., methods other than EPA, ASTM, etc.) is required for specific projects or analytes of interest, or when the laboratory develops a procedure, the laboratory must establish the validity of the method prior to extracting or analyzing a client's samples. *Validity is established by meeting criteria for precision and accuracy. See ALS SOP 999 for method validation protocols.* Method development and validation must include the following:

- Initial Demonstration of Capability (IDOC) for each analyst performing the method;
- MDL studies or MDC determination, as applicable, for every analyte, matrix, instrument, and column (if applicable);
- validated extraction and analytical criteria; and
- SOP generation and approval per established processes.

7. MEASUREMENT TRACEABILITY AND CALIBRATION

ALS follows a well-defined calibration routine for all instruments and equipment. Calibration may be performed by laboratory personnel using certified reference materials traceable to NIST or equivalent certified materials, or by external calibration agencies or equipment manufacturers. The discussion in this section of the LQAP is general in nature because the requirements for calibration are instrument or equipment and method specific. Details of calibration procedures and requirements can be found in ALS's standard operating procedures (SOPs), analytical methods and operations manuals.

A list of all major instrumentation available at ALS is provided in **Appendix G**. The Quality Assurance Department maintains this list.

7.1 TRACEABILITY OF CALIBRATION

ALS's program of calibration and/or verification and validation of equipment must ensure that, wherever possible, measurements performed by the laboratory are traceable to national standards of measurement. ALS requests and maintains

calibration certificates (e.g., weights, thermometers, balances) that demonstrate traceability to national standards of measurement. If traceability to national standards of measurement is not available or applicable, then ALS provides evidence of correlation of results (e.g., verifying an in-line resistivity meter by reading the system's output with a conductivity meter; participating in a PT studies).

7.2 REFERENCE STANDARDS OF MEASUREMENT

ALS uses reference standards of measurement (such as Class S weights or NIST-traceable thermometers) for calibration verification purposes only (i.e., these reference standards are not available to laboratory staff for general use).

Reference standards of measurement are calibrated or verified by an ISO 17025 Calibration Laboratory. qualified vendor that must provide, where possible, traceability to a national standard of measurement. Reference thermometers are calibrated every two years. Thermometer Masters are independently recertified annually, Is this accurate?If so our ref thermometer is out of compliance- last certified Oct of 2010 Reference weights masters are certified independently recertified every five years. Certificates of vendor calibration/verification are for the reference standards recertifications are maintained by the Quality Assurance Department.

The certified reference standards are then used to annually verify other measurement devices (e.g., laboratory thermometers, laboratory weight sets) in-house. The in-house verification efforts are managed by the Quality Assurance Department. All items so verified are tagged with a sticker indicating the unique identity of the device, the date of verification and the initials of the technician who performed the verification, and the date the verification is valid through. Procedures for the in-house verification of thermometers are given in **SOP 923**. Procedures for the verification of weight sets are given in **SOP 901**.

7.3 TRACEABILITY OF STANDARDS, SOLVENTS AND REAGENTS

ALS purchases the highest quality standards, solvents, and reagents appropriate to the analytical methodologies employed. The vendor must supply a Certificate of Analysis, Certificate of Purity, or equivalent. These certificates are maintained by the Department Work Groupdepartment usingwho uses the materials.

With the exception of extraction solvents, each Department Work Groupdepartment documents the date of receipt, date opened and an expiration date for all standards and reagents by labeling the original container, or certificate and/or by entering this information into ALS's Standards and Reagents database. Because of the quantity of solvents consumed in a short time frame, solvents are labeled only with the date received.

Each Department Work Groupdepartment is responsible for the preparation, documentation, storage and disposal of its chemicals. Standards preparation information is documented by entry in a ALS's Standards and Reagents database.

The following information, needed to maintain traceability of the standard, is recorded for each standard:

- date of receipt of reference standard;
- unique internal identification number and traceability to purchased stock or neat compounds, as applicable (i.e., vendor/lot numbers; unique ALS identifier);
- date of preparation;
- name of preparer;
- amount of reference material used;
- volume/identity of reagents and solvents used;
- final volume;
- concentration;
- expiration date of the stock and prepared standards.

See **SOP 300** for additional information about standards preparation, storage, and expiration. Verification (re-verification) of radiochemical standards is also addressed in **SOP 710**.

7.4 GENERAL REQUIREMENTS FOR CALIBRATION

Each calibration is dated and documented to ensure that it is traceable to the method, instrument, date of analysis, analyte, concentration, and response. Sufficient information must be documented to permit reconstruction of the calibration. Acceptance criteria for calibrations must comply with method requirements.

7.5 INSTRUMENT CALIBRATION

This section defines the essential elements of initial instrument calibration (ICAL) and continuing instrument calibration verification (CCV). These procedures ensure that the data will be of known, documented, and appropriate quality for a given application. *Samples yielding concentrations that exceed the upper limit of the calibration curve shall be diluted and reanalyzed, if possible, to bring the results within the calibrated range. Results of samples outside the known calibration range, above or below, must be reported as qualified values and discussed in the case narrative.*

Initial instrument calibration is used for quantitation and continuing instrument calibration verification is used to confirm the validity of the initial calibration. The following items are required of both initial and continuing instrument calibrations:

- The details of the instrument calibration procedures, including evaluation and acceptance criteria, and corrective measures to be taken in the event that these acceptance criteria are not met, must be included or referenced in the test method SOP.
- Sufficient raw data records must be retained to allow reconstruction of the instrument calibration (e.g., calibration date, test method, instrument, date of analysis, name of analyst, concentration of standard(s), response, response factor).

Additional essential elements of initial as well as continuing instrument calibrations are discussed below.

7.5.1 INITIAL INSTRUMENT CALIBRATION

The following items are essential elements of initial instrument calibration:

- Samples must be quantitated from the ICAL, unless the reference method states otherwise.
- The initial calibration range must consist of at least the minimum number of calibration points specified by the reference method. If the reference method does not specify the number of calibration standards, then the minimum number is two, not including blanks or a zero standard. Exception: multi-component analytes, such as chlordane, toxaphene or Aroclors, may be analyzed using a one-point calibration, per SW-846 guidance, if so requested by the client.
- The lowest calibration standard must be above the detection limit (MDL) and at or below the RL (i.e., the method reporting limit must be within the calibrated range of the method).
- Calibration standards must include concentrations at or below the regulatory limits, if these limits are known to the laboratory.
- Criteria for the acceptance of an initial instrument calibration must be established (e.g., RSD, correlation coefficient, etc.).
- If ICAL results are outside acceptance criteria, then corrective action must be performed, and the instrument recalibrated before analyzing samples.

- Exclusion of initial calibration points without technical justification is not allowed (poor injection or power failure are valid reasons to exclude a calibration point).
- All reported target analytes and surrogates must be included in the initial calibration.
- The ICAL must be verified (see section 7.5.3) before samples can be analyzed.

7.5.2 CONTINUING INSTRUMENT CALIBRATION

A continuing calibration verification (CCV) standard must be analyzed with the frequency prescribed in the reference method, or as dictated by the applicable LIMS program specification (typically within every 12hr time period). For example:

- When an ICAL is not performed on the day of analysis, then validity of the initial calibration must be verified with an acceptable CCV prior to sample analysis.
- A CCV must be repeated at the beginning and end of each analytical sequence. (For GC/MS methods that use an internal standard, only one CCV must be analyzed before each analytical sequence). Some methods additionally prescribe that a CCV must be analyzed after every 10 (or 20) samples analyzed.

The following items are essential elements of continuing instrument calibration:

- With the exception of multi-component analytes, all reported target analytes must be included in the continuing instrument calibration standard.
- Criteria for the acceptance of a CCV must be established (e.g., %D, %Drift, from the initial calibration).
- If the CCV results exceed acceptance criteria, then corrective actions must be performed. If routine corrective action procedures do not produce a second consecutive CCV within acceptance criteria, then a new calibration must be performed and successfully verified.

Additional aspects of calibration verification are discussed below.

7.5.3 CALIBRATION VERIFICATIONS

All ICALs must be verified with a *second source* standard obtained from a different manufacturer/vendor and traceable to a national standard, when available. If a different manufacturer/vendor is not available, the laboratory must request a different lot number of the standard.

In most cases, a second-source initial calibration verification (ICV) standard is analyzed immediately after the ICAL and before any samples are analyzed. However, analysis of an ICV is not required, if the continuing calibration verification (CCV) standard is from a second source.

Sample data associated with an unacceptable calibration verification standard may be reported as qualified data in the following cases:

- When the acceptance criteria for the CCV is exceeded high (i.e., high bias), and only non-detects were determined for the affected analyte(s) in associated samples, then those non-detects may be reported.
- When the acceptance criteria for the CCV is exceeded low (i.e., low bias), then these sample results may be reported if they exceed a maximum regulatory limit.
- When the acceptance criteria for the CCV are exceeded (high or low), and the effect on the system from previous sample analysis is substantiated (e.g., by reanalysis or sample response characteristics on a different detector), then the sample results may be reported.

Other levels of concentrations and frequencies of analysis for calibration checks (ICVs, CCVs) may be required by specific client programs. These requirements, which supercede method, SOP or LQAP requirements otherwise stated, are communicated to the laboratory staff via LIMS program specifications.

8. PREVENTIVE MAINTENANCE AND REPAIR OF EQUIPMENT

ALS maintains an organized maintenance program that is broader than the particular instruments or devices a specific employee may operate or is familiar with. The objective of ALS's equipment maintenance program is to provide a structure of care that prevents quality control failures and minimizes lost productivity that results from equipment malfunction or failure. Within this program are provisions for corrective actions, maintaining spare parts, and a contingency plan in the event of catastrophic failure (e.g., loss of power for a significant period of time).

See Appendix G for a comprehensive list of ALS's equipment.

ALS's maintenance program is based on equipment manufacturer's recommendations, operator training guidance, and other considerations (e.g., sample throughput). The established maintenance program applies to all laboratory primary instrumentation, as well as support equipment (see Section 8.6 for a definition of what constitutes support equipment). Provisions for documenting all routine and non-routine instrument equipment maintenance and repairs is also established within the maintenance program.

Responsibilities for applying ALS's maintenance program rests with the Department Work Group department that utilizes the equipment, the Quality Assurance Department bears responsibility for certain support equipment such as balances, ovens, refrigerators, freezers, and temperature measurement devices. Only authorized personnel are permitted to perform maintenance.

Culturally, ALS makes a distinction between 'operational' and 'routine' maintenance, that external parties generally do not. ALS considers the normal/typical things that operators do to keep the equipment functioning properly (e.g., septum replacement, reagent refill, etc.), as 'operational' maintenance, and does not generally view these tasks as routine maintenance events that require specific documentation in a dedicated maintenance log. ALS's view is that the fact that the equipment is performing properly and yielding acceptable QC results, evidences that these maintenance tasks were performed as needed. ALS's maintenance system does, however, provide for attestations that this maintenance was performed, where applicable. In contrast, ALS defines routine maintenance as those things done in-house only periodically (i.e., that are beyond what is performed as usual 'operational' maintenance), that are short of vendor repair (e.g., annual GFPC drawer evaluation).

Documentation requirements are discussed further in Section 8.4 below.

Note that ALS does not consider 'priming', or analysis of solvent blanks, which generally get recorded in the instrument run log, as maintenance.

8.1 MAINTENANCE SCHEDULES

In general, ALS performs maintenance as needed (including preventive considerations). Certain aspects of routine maintenance are considered to be 'operational', and are performed each time the instrument is run. Other maintenance is performed 'periodically' (e.g., roughly monthly, contingent upon sample throughput). Each instrument operator is responsible for the performance of their own instrument, and may perform maintenance duties at their discretion. For these reasons, ALS's culture is not one of 'scheduled' maintenance, in the traditional (calendar) sense. Consequently, although the Department Work Group Manager Leader provides oversight, it is not necessary or practicable to create formal maintenance schedules, or to have maintenance performance synchronized within the Department Work Group department.

ALS maintains service contracts for most major analytical equipment, including gas and high-performance liquid chromatographs, mass spectrometers, liquid scintillation counters, and cold vapor atomic absorption and inductively coupled

plasma spectrophotometers. Preventive maintenance is included in most of these service contracts. Service contracts that include preventive maintenance are also retained for ALS balances and the DI water system.

8.2 SETTINGS

ALS's equipment list (Appendix G) depicts the following information: a) the identity and type of equipment and its software; b) the equipment's serial number or other unique identification; c) the current location; d) the date received and date placed in service (if available); and e) the condition when it was received (e.g., new, used, reconditioned).

While it is true that some settings (e.g., detector wavelength) may be stipulated in reference methods, most instrument settings are not specifically prescribed, as they are instead, dictated by acceptable outcome (e.g., peak resolution, etc.). In a similar vein, ALS provides typical instrument settings in the associated determinative SOP, but actual settings may vary contingent upon instrument performance and contributing factors, such as ambient conditions and operator subjectivity.

For the most part (i.e., not applicable to some types of equipment), instrument configuration and settings information is captured electronically by the instrument's 'method' files. Typically there is an 'acquisition' method file and a 'quantitation' method file that together, control the manner in which the data are obtained and subsequently calculated. These instrument files are archived via established laboratory electronic backup protocols (Form 159 – IS / LIMS Policy Statement), and are retrievable, thus providing for the reconstruction of data. The utilization of proper settings is evidenced by analytical data and QC results that meet performance criteria.

8.3 TRENDS

The dominant focus of trending contained in pertinent guidance documents relates to the generation of acceptable 'at on-set' and 'continuing' method QC checks. Concurrent with these requirements, ALS's culture for trending observation labwide consists of ensuring that acceptable instrument checks are generated, and that the system is not producing any artifacts at levels of concern, prior to analyzing sample sets.

The expertise of the operator is a major component in effective equipment operation. Experienced operators develop an intuitive sense as to how their instrument is performing. Generally this sense is not based on a specific indicator, as there may be many contributing factors to that particular indicator, but rather on an accumulation of cues (similar to those factors that would be considered during the troubleshooting process). Because this type of expertise does not lend itself well to documentation, ALS emphasizes cross-training to ensure consistent data generation, and the retention of 'corporate knowledge'. See section 11.4.

8.4 EQUIPMENT DOCUMENTATION REQUIREMENTS

Analysts are responsible for maintaining calibration/verification and maintenance records of all instruments and equipment involved in the creation of the analytical data they generate. Considerations of maintenance, settings and trends, and their documentation, vary widely contingent upon the type of equipment, how automated it is, and the degree of sample throughput. Documentation can be accomplished by various means, electronically and via hardcopy. For example, ICP, ICP/MS and CVAA routine maintenance is entered into the instrument's PC and printed out in the raw data header, while service contract maintenance and repair are documented in hardcover logbooks. Labwide, dedicated hardcover maintenance logbooks are assigned to each piece of major ALS instrumentation, however, the manner in which equipment documentation is recorded, is at the discretion of the work group/Department Manager/Group Leader. It is not ALS's intent to unify or centralize maintenance information.

Although the manner of record keeping varies, in order to provide a clear and complete history of repairs and maintenance associated with the instrument, each entry may, but not limited to, include the following elements:

- the date of the maintenance or repair;
- the reason for the maintenance or repair (e.g., was this action taken to correct a problem or was this action routine instrument maintenance);
- a full description of the maintenance or repair conducted;
- the name of the analyst or vendor who performed the maintenance or repair;
- reference that it was verified that the equipment is operating properly before being placed back in service (SOP 317), and where this information can be found; and
- the initials of the analyst making the entry and date of entry.

Where applicable, the identity of the reference material used as an instrument check must also be recorded, and where applicable, a statement as to the calibration's expiration must also be made.

Details regarding equipment documentation are also provided in SOP 303. Note that maintenance logs are included in monthly logbook review.

Table 8.1 (Maintenance Snapshot) following provides a brief summary of laboratory equipment, an overview of associated maintenance performed, and comments regarding how associated maintenance documentation is accomplished.

8.5 CORRECTIVE ACTIONS, SPARE PARTS, CONTINGENCY PLAN

8.5.1 CORRECTIVE ACTIONS

Corrective measures for failed QC checks are given in the associated determinative SOP. General procedures for removing equipment from service and placing new or repaired equipment into service, are provided in SOP 317. Detail regarding corrective measures and repair for support equipment failures (e.g., ovens, cooling units, pipets, DI water system), are discussed in SOPs 320, 326, 321 and 319, respectively. Actions to be taken in the event of catastrophic failure are discussed in Section 8.5.3 below.

ALS maintains service contracts (preventive maintenance, repair) for most major analytical equipment. Some equipment (particularly some support equipment) does not lend itself to repair and would likely be replaced instead, per requirements given in SOP 127.

8.5.2 SPARE PARTS

An adequate inventory of spare parts is required to minimize equipment downtime. This inventory should include those parts and supplies that:

- are subject to frequent failure;
- have limited useful lifetimes, or
- cannot be obtained in a timely manner should failure occur.

Department Managers Work Group Leaders departments are responsible for maintaining an adequate inventory of necessary spare parts for all major instruments and equipment items. Examples of spare parts maintained for major instrumentation include: septa, inserts, columns, tube fittings, filaments, source parts, and traps.

8.5.3 CONTINGENCY PLAN

In the event of a catastrophic instrument failure, ALS will make every effort to analyze samples within holding times by alternate means. If the redundancy in instrumentation is insufficient to handle the affected samples, then the Department Manager Work Group Leader will notify the Project Manager immediately. In turn, the PM will notify the client to discuss options that will ensure successful completion of the project.

ALS will also take appropriate mitigating steps and notify the client should significant power, cooling unit, etc. failures occur that create circumstances which could adversely impact the client's sample results. An automated system is in place to notify computer support and operations. the IS Manager and Laboratory Director should a power outage of significant duration occur. However, any employee who notes an outage or unit failure is responsible for contacting the

Department appropriate manager. Operations Manager or Laboratory Director, who will in turn direct the necessary actions. The specific course of action taken is dependent upon the nature and extent of the failure. General procedures to be followed in the event of catastrophic failure are provided as an appendix to ALS's Emergency and Contingency Plan (ECP).

8.6 SUPPORT EQUIPMENT

ALS defines support equipment as all those devices which are not the primary determinative instrument defined by the analytical method, which support laboratory operations and would contribute to the testing uncertainty.. Support equipment includes balances, ovens, refrigerators, freezers, water baths, temperature measurement devices, and mechanical (e.g., Eppendorf™ pipets. Support equipment affecting the uncertainty of testing results is calibrated or verified, typically annually, within the applied range of use. NIST-traceable references must be used when available, and the results of the calibration/verification are documented and within the specifications required of the application for which the equipment is intended.

Per ALS's definition, support equipment also includes: desiccators; centrifuges; vortex mixers; sonicators; homogenizers (including ball mills, riffle splitters and shatter boxes); pressure filters; vacuum pumps; zero headspace (ZHE) extractors; tumbling devices; platform shakers; water baths; chillers; heating blocks, mantles, hot and stir plates; evaporators; muffle furnaces; kilns and cleanup apparatus. Because automatic dispensing devices used to deliver solvents or reagents (e.g., for sample preservation and extractions) are not used to deliver critical volumes, these devices are exempt from daily verification.

Additionally, ALS has procedures for the following support equipment:

D's deionized (DI) water systems (SOP 319)

and hHealth physics equipment (Appendix G) and are also considered to be support equipment.

GRquirements pertaining to glassware are given in SOPs 334 and 720.

Procedures for maintaining computers and other electronic devices (e.g., printers, backup devices, etc.) are developed, implemented and maintained by the IS Department (Form 159, et. al.)

Support equipment must be calibrated or verified, typically annually, within the applied range of use. NIST-traceable references must be used when available, and the results of the calibration/verification must be documented and within the specifications required of the application for which the equipment is intended.

Mechanical Pipettes, SOP 321. All support equipment must be maintained in proper working order, and records must be retained to document the equipment's performance, maintenance, and repair. *Each business day, near to the beginning of the work shift, the proper functioning and calibration of the following equipment must be verified: balances, ovens, refrigerators, freezers.* Water bath temperatures must be verified each day of use. Additional monitoring must also be performed and documented, if so prescribed by a test method.

Per **SOP 321**, the volumes dispensed from mechanical pipets are verified prior to each use, as these volumes are critical measurements. Because automatic dispensing devices used to deliver solvents or reagents (e.g., for sample preservation and extractions) are not used to deliver critical volumes, these devices are exempt from daily verification.

Where necessary, in-house verifications are performed to document the capability of any measuring device when data is of importance to the final result.

Certificates of Accuracy are acquired from the manufacturer and are retained on file within each Department department Work Group for using glass microliter syringes.

The following SOPs provide additional information about calibration and verification of support equipment:

- **SOP 305** -- balance calibration and verification
- **SOP 320** -- monitoring and recording of oven temperatures
- **SOP 326** -- monitoring refrigerator and freezer temperatures.

9. QUALITY CONTROL PROCEDURES

ALS' quality control program provides a systematic process that enables the laboratory to evaluate and control the validity of analytical results, by measuring and monitoring accuracy and precision by method and matrix; by developing control limits and using these limits to detect errors or out-of-control events; and by requiring corrective actions to prevent or minimize the recurrence of these events. ALS observes QC procedures to ensure that sample data meet laboratory and client quality objectives.

The purpose of preparing and analyzing QC samples is to demonstrate accuracy and precision of the sample data and efficacy of the method for the target analytes being investigated. Acceptance criteria may be dictated by reference methods or by project requirements. All assessments of QC data are performed after all rounding and significant figure truncations have been performed.

For all analyses performed by ALS, the QC concepts and samples described in the following sections are mandatory. Determinative SOPs contain a Table that summarizes the types and

frequency of QC samples, acceptance criteria, and corrective actions required. Observation of maximum holding time allowance is discussed in LQAP Chapter 4.

9.1 DEFINITION OF BATCH

9.1.1 PREPARATION BATCH

A preparation batch consists of as many as 20 field samples of the same or similar matrix, that are prepared together by the same analyst(s) within a limited or continuous time period, following the same method, and using the same kind of equipment and same lots of reagents. Each batch must contain the appropriate number and kind of method control samples (e.g., MB, LCS) and matrix-specific QC samples (e.g., MS/MSD, DUP). Cleanup procedures may be included as part of the preparation batch. All field and QC samples in the batch should be subjected to the same preparation and cleanup procedures.

9.1.2 ANALYSIS BATCH

The analysis batch (or sequence) consists of samples that are analyzed together within the same or continuous time period, on the same instrument, and processed using the same calibration. Each analysis sequence must contain the appropriate number and kind of standards and samples as defined by the method. If samples from a preparation batch are analyzed in multiple analysis batches, extended method control and matrix-specific QC samples need not be analyzed with every analysis batch.

Where no sample pre-treatment (such as extraction or digestion) is required prior to analysis (e.g., analysis of volatile organic compounds, anions analysis by ion chromatography, etc.), the preparation batch and analysis sequence are equivalent.

9.2 PREPARATION BATCH QC SAMPLES AND STANDARDS – DEFINITION AND USE

The results of quality control samples provide an estimate of accuracy and precision for the preparation and analysis steps of sample handling. The following sections describe the QC information provided by each of these analytical measurements.

9.2.1 METHOD BLANK

A method blank (MB) consists of an aliquot of well-characterized, controlled, or certified matrix (e.g., reagent water, Ottawa sand, solid reference material, boiling chips) that is processed through the entire sample preparation, cleanup, and analysis procedure. For radiochemical analyses, a suitable blank solid matrix has not been identified; therefore, reagent water is routinely used for the blank for

most solid matrices. The volume or weight of the blank must be approximately equal to the sample volume or weight processed for sample analyses.

The purpose of the MB is to demonstrate that interferences caused by contaminants in solvents, reagents, glassware, and other sample processing hardware, are known and minimized. A method blank should not contain target analytes at or above the reporting limit, unless otherwise permitted in the method. Other maximum blank contamination control criteria may apply, as indicated in the associated LIMS program specification.

While some methods may require background correction, sample results are typically not corrected for blank contamination.

9.2.2 LABORATORY CONTROL SAMPLE

A Laboratory Control Sample (LCS) consists of an aliquot of well-characterized, controlled, certified matrix (e.g., reagent water, sand, solid reference material, Teflon™ chips) that is spiked with analytes of interest and processed through the sample preparation, cleanup, and analysis procedure.

The purpose of the LCS is to provide an estimate of bias based on recovery of the compounds from the clean, controlled matrix, and to demonstrate that the laboratory is performing the method within accepted guidelines without potential non-matrix interferences.

Where sample pretreatment is not required, such as with ion chromatography or gamma spectroscopy analysis, or the analysis of volatile organic compounds, the ICV standard or other appropriate control standard may be employed as the LCS.

An LCS for methods with extensive lists of analytes that may interfere with one another may include a limited number of analytes, but the analytes included must be representative of as many analytes as is practical.

Other client-specific QC requirements may be prescribed in the applicable LIMS program specification. The requirements set forth in the LIMS program specification supercede those stated in the method, SOP or LQAP.

9.2.3 MATRIX SPIKE/MATRIX SPIKE DUPLICATE

A matrix spike (MS) or matrix spike duplicate (MSD) is a field sample to which known concentrations of target analytes are added before the sample is processed. The purpose of MS/MSD samples is to assess the

performance of the method for a particular matrix and to provide information about the sample's homogeneity. Results of the MS/MSD samples are evaluated in relation to the method QC samples to determine the effect of the matrix in regards to accuracy and precision. Sample results are not corrected for MS/MSD excursions.

To generate MS/MSD pairs for any analysis, there must be an adequate volume/weight of field sample available. Inadequate sample volumes preclude the possibility of generating this pair of QC samples. ALS asks clients to designate the sample to be used for MS/MSD analysis to ensure that adequate sample volumes are collected.

For some analyses, changing the composition of the sample in any way invalidates the analysis to be performed (e.g., hardness, alkalinity, pH). Therefore, an MS/MSD pair cannot be generated for these analyses. Normally, duplicate sample aliquots are analyzed in order to generate an estimate of the method's precision.

Other client-specific quality control requirements may be prescribed in the applicable LIMS program specification. The requirements set forth in the LIMS program specification supercede those stated in the method, SOP or LQAP.

9.2.4 SAMPLE DUPLICATE

A sample duplicate (DUP) is a second representative portion of sample that is carried through the preparation, cleanup and analysis process. Results for the duplicate sample are compared to the initial sample analysis results as a means of evaluating precision. For organic analyses, the MS/MSDs fulfill this function. The degree of sample homogeneity directly impacts the integrity of the sample duplicate analysis.

Precision criteria for sample duplicate analyses are those prescribed in the reference method and/or SOP, unless otherwise superceded by client-specific requirements contained in the applicable LIMS program specification.

9.2.5 SURROGATES

Surrogates are organic compounds that are similar to the target analytes, but are unlikely to be present in actual field samples. They are introduced into all field and QC samples in a batch prior to sample preparation, and provide an estimate of bias based on recovery of similar compounds, for a given extraction technique and analysis method combination. Sample results are not corrected for surrogate recoveries.

Acceptance criteria for surrogates are those prescribed in the reference method and/or SOP, unless otherwise superseded by client-specific requirements contained in the applicable LIMS program specification.

9.2.6 CHEMICAL YIELD MONITORS OR ISOTOPIC TRACERS

Chemical yield monitors are used in radiochemical analyses and provide information similar to the surrogate spikes discussed above. The primary difference between a chemical yield monitor and a surrogate is that sample results are corrected for chemical yield recoveries and not corrected for surrogate recoveries. A chemical yield monitor is a substance that has similar chemical characteristics as the parameter being measured. It is introduced into all field and QC samples in a batch during the preparation procedure. Chemical yield monitors provide information regarding the performance of a method on a sample-by-sample basis.

Chemical yield monitors are evaluated against established laboratory control limits. These ALS default control limits may be superseded by other quality control criteria specified in the applicable LIMS program specification.

9.3 CONTROL CHARTS

Control charts are a tool that can assist the laboratory in evaluating process control and trends. Control charts are used as a visual queue giving warning before a measurement system drifts into an out-of-control situation. Information such as radiochemical calibration parameters, results of daily efficiency checks, etc. can be documented in control charts. Accuracy control charts, discussed further below, that contain method LCS (and surrogate, as applicable) performance information, are managed through LIMS. Although the QAM is responsible to annually review LCS information, and determine if a significant change to a method or process has occurred. The QAM then notifies technical management if the mean and standard deviation of LCS data show significant change (>10%). QC limits can be updated after review by technical personnel as appropriate. LCS information is accessible to *all* bench personnel **for their consideration**, through LIMS.

Further discussions of control charts and control limits and other considerations such as outlier rejection and trend evaluation follow below.

9.3.1 ACCURACY CONTROL CHARTS

Accuracy (recovery) for a batch can be evaluated by plotting the individual percent recovery points for analytes on a control chart and comparing the values against the current control limits. If the spike recovery values for the current analytical batch meets the acceptance criteria for that method, then the data point (and batch) are accepted. **If not, and re-preparation/analysis is possible, the batch is generally**

reprocessed. At minimum, the failure(s) is considered a non conformance and is narrated in the laboratory data package. See Appendix A for general process and the QC Table of each determinative SOP for further details as to the appropriate corrective actions to be taken for controlled failures.

Accuracy control charts are generally maintained for each method that utilizes an LCS. For methods that cannot use LCS samples (e.g., pH, flashpoint, conductivity), other tools, **such as periodic participation in 3rd party Performance Test sample analysis**, are used to assess method control.

If fewer than 20 data points for a method, matrix, and analyte combination are acquired, then control charts yield advisory limits.scant information.

9.3.2 CONTROL LIMITS

Control limits for each controlled analyte are calculated, and can be updated, using ALS's LIMS. The recovery values from all data processed within a specified date range, are used to calculate the control limits and compile the control chart. **Standard outlier tests, based on the population number evaluated (e.g., Dixon $n \leq 20$; Grubbs $n=3-147$; etc.), per their restrictions/requirements, may be applied.**

The upper and lower control limits of the control chart are designated as the value equal to the average recovery plus or minus three times the standard deviation (i.e., 99% confidence interval).

The upper and lower warning limits for the control chart are designated as the value equal to the average recovery plus or minus two times the standard deviation (i.e., 95% confidence interval).

The average recovery, standard deviation, minimum value, maximum value, and population are displayed on each control chart.

Control limits are updated as needed (e.g., acquisition of a sufficient number of data points to establish meaningful control limits for a newly implemented method; if deemed appropriate as a result of a corrective action investigation; etc.). The frequency with which control limits are updated may vary for different methods. Generally, intra-laboratory historical control limits are not updated more than once per year.

9.3.3 OUTLIER REJECTION

For the generation of control charts, and other quality control data that monitor the laboratory's performance, it is essential to prevent spurious or erroneous data from being incorporated. It may be necessary to reject data as an outlier to prevent an adverse effect on the values being calculated. **Only established statistical approaches may be used, such as application of the Grubbs, Dixon, etc., tests, to identify and handle outliers. Any data point meeting established outlier criteria is justified to be rejected, however, the analyst has the discretion to reaccept the data point where it is technically sound to do so.** In every case, the cause of the outlier rejection must be clearly understood before any data point is ~~manually~~ rejected.

For the purposes of statistically determining whether a data point is an outlier or not, ALS may use the procedures discussed in the Dixon Rank Sum Test, the Grubbs Test, **or other established appropriate statistical treatment.** If a data point is determined to be an outlier, it **generally** will not be incorporated into the dataset when updating QC limits.

See SOP 329 for further details regarding the processing of MDL studies and evaluation of outliers.

9.3.4 TREND EVALUATION

In addition to evaluating individual batch QC results against control limits, QC results from successive batches are also evaluated for possible trends. See section 11.4.

Trend analysis techniques can be applied to control charts as a preventive tool to help indicate conditions that could cause an analysis to become out of control. In evaluating control charts, a trend is recognized if one or more of the following situations exist:

- A series of seven successive points occur on the same side of the mean;
- A series of five successive points occur going in the same direction;
- Two consecutive points occur between the warning and control limits;
- A single value occurs outside of control limits.

Actions may be employed for trends identified. Items which might be considered but not limited to include:

- Has there been a change in instrumentation or personnel?
- Has instrument maintenance been properly performed?
- What conditions have changed since the trend began?
- Have standard or spike solutions changed?

9.4 **SECOND COLUMN OR SECOND DETECTOR CONFIRMATION**

Second column or detector confirmation is performed for several GC and HPLC methods. Whenever two dissimilar chromatography columns or two detectors of a different nature are available for a given method, the laboratory performs second column or second detector confirmation analysis to confirm the identity of target analytes in field samples. When second column analysis is performed for any chromatography technique, the following policies apply:

- Every attempt will be made to calibrate the second (confirmatory) column in the same manner as the quantitative (primary) column. The same initial and continuing calibration standards will be analyzed on the confirmation column in the same manner as the quantitation column. The purpose of this dual calibration requirement is to allow the possibility of reporting quantitative results from the confirmation column if interferences on the primary column prevent accurate target analyte quantitation.
- For chromatographic techniques, the determination of target analytes in a sample depends solely on peak retention times observed in both primary and secondary column chromatograms. If target analyte peaks are present at the proper retention times in both confirmation and quantitation column chromatograms at levels above the MDL, then ALS considers this analyte to be confirmed.
- In general, ALS reports a single the higher value fromof the two columns based on client requirements. In the absence of client requirements per SW8000C guidance (e.g., 8011, 8081, 8082, 8141, 8151, 8021). It is also ALS's policy to reports the higher value of the two columns for other EPA methods (e.g., 608, 615).

If no interferences are present, and an analyte's value from either the primary or secondary column is greater than the reporting limit but between the MDL and the reporting limit on the other column, then ALS reports the higher value that is greater than the reporting limit for that analyte.

- ALS customarily reports the value from the primary column for methods SW8330 and SW8332. Co-elutions or interferences are frequently observed on the secondary column for these HPLC methods.
- Other reporting rules may apply as dictated in the applicable LIMS program specification. The rules of the LIMS program specification supercede standard ALS policy.

9.5 MANUAL RE-INTEGRATION POLICIES AND PROCEDURES

Many data collection systems allow the analyst to reprocess data, thereby allowing for the manual re-integration of analyte peaks. ALS makes every attempt to optimize peak integration parameters; however, manual reprocessing of data must be performed to correct a data system's integration error (e.g., incorrect or missed peak assignment, over- or under-integration of area). Manual re-integrations may not be performed solely to meet initial or continuing calibration criteria or any QC criteria (e.g., tuning, or surrogate or spiking compound recovery).

Whenever a manual integration is performed, the analyst performing this process must include a hardcopy of the original and re-integrated peak in the final data report. In addition, the analyst must initial and date the re-integrated page and document the reason for re-integration on the printout. The re-integration must be documented in the case narrative.

Further details regarding manual integration procedures are given in **SOP 939**.

10. DATA REDUCTION, VALIDATION AND REPORTING

Data transfer and reduction are essential functions in summarizing information to support conclusions. It is essential that these processes are performed accurately and are followed by multiple reviews before data are submitted to the client. All analytical data generated by ALS are extensively reviewed for accuracy and completeness. The data validation process consists of data generation, reduction, and multiple levels of review, as described below.

10.1 DOCUMENTATION OF RAW DATA

Where possible, raw data are captured and processed electronically using verified software programs (see **SOPs 709 and 1400** for further information regarding software verification).

To facilitate manual documentation of raw data (where suitable LIMS benchsheet interfaces do not yet exist), ALS creates custom logbooks comprised of forms or benchsheets that are tailored to contain the information required to adequately document the process being performed, and the associated data. The Quality Assurance Department controls these forms and benchsheets, and issues bound and paginated logbooks to the laboratory as needed via controlled distribution.

As applicable, hardcover, bound laboratory notebooks (most frequently used for instrument maintenance logs or Project Manager notebooks) are also issued via controlled distribution to laboratory staff as needed.

The manually recorded raw data are entered into the laboratory logbook directly, promptly, and legibly in indelible ink. All raw data entries must, at a minimum, contain the following information:

- the initials of the individual who performed the process;
- the date the process was performed;
- the methodology used; and
- the identity of all samples or standard solutions that were employed in carrying out the process.

Raw data must be maintained as part of the laboratory's records. Raw data not only includes instrument outputs, but sample preparation, standard materials documentation, and equipment maintenance information as well. Raw data may be archived electronically or as hardcopy.

10.2 CORRECTION OF ERRORS IN DOCUMENTS

During the course of processing and reviewing sample preparations and analysis results, it may be necessary to correct documentation errors. Detailed requirements for the correction of manual documentation errors are prescribed in **SOP 303**; the correction of electronic information is governed by LIMS controls and audit trails. In summary, manual entries may not be obliterated by erasure, use of correction fluid, or other means. In order to maintain the integrity of the documentation generated by the laboratory, changes to hardcopy documentation must be made in the following manner:

- A single line must be struck through the error so that the original text remains legible;
- As applicable, a corrected entry must be made adjacent to the error; and
- The person making the change must initial and date the corrective entry.

If not clearly evident, the reason for the data change must be indicated.

10.3 DATA REDUCTION

ALS analysts perform data reduction. This process consists of interpreting instrument results and verifying calculated concentrations in samples from the raw data. The complexity of the data reduction is dependent on the specific analytical method and the number of discrete operations involved in obtaining a

measurement (e.g., digestions, dilutions, cleanups, concentrations). The analyst calculates the final reportable values from raw data or enters all necessary raw data into the LIMS so that the LIMS can calculate the final reportable values.

Data are reduced according to protocols described in SOPs and method-specific review checklists. Computer software used for data reduction is validated before use and verified regularly by manual calculations. All information used in calculation is recorded in order to facilitate reconstruction of the final results (e.g., raw data, calibration files, tuning records, results of standard additions, interference check results, sample response, and blank or background-correction protocols). Information about the preparation of the samples is maintained in order to facilitate reconstruction of the final results (e.g., weight or volume, percent moisture for solids, extract volume, dilution factor).

Copies of all raw data and the calculations used to generate the final results, as recorded in hardbound laboratory notebooks, spreadsheets, electronic data files and LIMS record files, are retained in the project file to allow reconstruction of the data reduction process.

10.4 REPORTING OF SAMPLE RESULTS

Sample results are reported either on an “as-received” basis, or in units of dry-weight measure. The number of significant figures reported is consistent with the limits of uncertainty inherent to the analytical method. In most cases, results are reported to no more than two or three significant figures. Analytical problems, and/or any modifications of referenced methods are noted in the data package case narrative.

Standard units appropriate to the analytical method are used to report all sample results. Measurements for radiochemical analyses are reported in units of activity such as:

- picocuries per liter (pCi/L), aqueous; or picocuries per gram (pCi/g), solid matrix samples.
- disintegrations per minute per liter (dpm/L) or disintegrations per minute per gram (dpm/g).
- Becquerels per liter (Bq/L) or Becquerels per gram (Bq/g).

It should be noted that one (1) Curie is equal to 2.22×10^{12} dpm; and is also equal to 3.7×10^{10} Bq.

Standard units for inorganic and organic analyses are units of mass per volume (aqueous samples), or mass per weight (solid matrix samples). For example, Wet Chemistry parameters such as hardness, total organic carbon (TOC), etc., are typically reported in milligrams per liter (mg/L) or milligrams per kilogram (mg/kg). Metals results for liquid samples may be reported as mg/L or as

micrograms per liter ($\mu\text{g/L}$). Some methods have specific reporting units mandated by their analysis technique. For example, pH is reported as pH units, and specific conductance is reported as milli-Siemens (mmho/cm) or micro-Siemens ($\mu\text{mho/cm}$).

10.5 DATA REVIEW

ALS employs multiple levels of data review. All data generated and reduced follow review protocols specified in laboratory SOPs (such as **SOPs 052** and **715**), and method-specific checklists. The preparatory technician and analyst who generates the analytical data perform a **Level 1** review of the data for correctness and completeness. This data review verifies that:

- the appropriate SOPs have been followed;
- any special sample preparation or analytical requirements that were communicated to the laboratory via the LIMS program specification have been met;
- all sample preparation information is correct and complete;
- all analysis information is correct and complete;
- QC samples meet criteria for frequency, accuracy and precision;
- all calculations, conversions, and data transfers are accurate;
- all documentation is present and complete, including benchsheets and/or run logs, any applicable NCRs, and documentation and presentation of manual integrations per SOP 939, as applicable.

Procedures for handling unacceptable data are discussed subsequently (LQAP Section 10.6).

Following completion of the Level 1 Review, the analyst then forwards the data to the Department Manager/Group Leader or another qualified reviewer whose function is to provide an independent **Level 2** review of the data. In addition to the elements evaluated in the Level 1 review described above, the Level 2 reviewer verifies that:

- the calibration data are scientifically sound, appropriate to the method, and completely documented;
- qualitative identification of target analytes is correct;
- quantitative results are correct.

The Level 2 reviewer selects a sample and verifies it to the benchsheet. If no errors are found, then the review is considered complete. If any problems are discovered, then additional samples are verified to the benchsheet with the process continuing until no additional errors are found or until the data package has been reviewed in its entirety. The Level 2 review is documented by recording the date and initials of the reviewer on the checklist employed. This sign-off signifies that the data are approved for release and a final report is prepared.

Once the final report is prepared, an additional overall technical review is performed before it is routed to the Project Manager for a **Level 3** review. The intent of this review is to verify that the report is complete and that the data meet the overall objectives of the project.

Each step of the review process involves evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the analysis and/or review. This application of technical knowledge and experience to the evaluation of the data is essential in ensuring that data produced are consistently of known, documented, and appropriate quality.

10.6 PROCEDURES FOR HANDLING UNACCEPTABLE DATA

All QC information is recorded in the same format, with the same units, as that of the associated sample results. It is the analyst's responsibility to evaluate QC data against applicable prescribed limits. See Appendix A for guidance on method QC evaluation. When an analysis of a QC sample (e.g., MB, LCS, CCV, etc.), indicates that the associated samples do not meet requirements, the analyst must immediately notify the Department Manager/Group Leader. The Department Manager/Group Leader then consults with the PM (and QAM, as applicable) to determine whether or not the affected samples must be re-prepped and/or re-analyzed, and/or if specific corrective action needs to be taken before additional analysis may proceed. A Nonconformance Report (NCR) as discussed in Chapter 11 of this LQAP, is initiated per **SOP 928**, as applicable. If the non-compliant data cannot be corrected, then the affected results must be flagged as discussed below, and the discrepancy disclosed in the data package case narrative. .

10.7 DATA REPORTING

Data reports contain final sample results, the methods of analysis used and limits of detection, and QC data. The extent of supportive data included (e.g., benchsheets, run logs, calibration data, instrument raw data printouts, etc.), is contingent upon the type of report contracted by the client.

Results of subcontracted data are clearly indicated as subcontract laboratory results when incorporated into the final data package report.

10.7.1 FACSIMILE OR IMAGED REPORTS

For projects that require rapid turnaround of sample analysis results, the

laboratory may provide a facsimile or imaged e-mail attachment to the client, followed by the full data report at a later date. If the analysis results provided by facsimile or imaged e-mail attachment have undergone the same review processes followed for final data packages, then this forwarded report indicates that the sample analysis results are final. However, if the accelerated turnaround time requirements preclude a full review/validation of the sample data, then the report is marked as “PRELIMINARY” to indicate that results may change as the review process is completed.

10.7.2 HARDCOPY DATA PACKAGES

The format and content of a data report is dependent upon project specifications, and it is beyond the scope of this document to describe project-specific report requirements. In the absence of client-specified data package deliverables, the following sections describe the items that must be included in all data reports.

10.7.2.1 COVER LETTER

Items contained in the cover letter include:

- the client’s name and address;
- ALS’s name and address, name of contact and telephone number;
- a tabular presentation of field/client sample ID, ALS Sample ID, date received, matrix, and date collected. This item is typically presented as an attachment, the Sample Cross Reference Table;
- a list of each analysis performed and total number of pages for each analytical report;
- identification of all test data provided by a subcontract laboratory;
- a discussion of previously submitted or partial reports that pertain to the samples discussed in the current report; and
- the signature of ALS’s Project Manager or designee.

10.7.2.2 REPORT FORMAT

Analysis reports are presented in tabular format, and consistent significant figures and units of measurement are used. The following information is included in each report:

- laboratory name, client name, project name and/or number;
- client/field sample ID and ALS sample ID;
- date of sample receipt, date and time of sample collection, and date/time of sample preparation and/or analysis;
- sample matrix;
- reporting units and identification of whether the sample results are reported on an “as-received” or dry weight basis;
- method reference for the parameter analyzed and method reporting limits;
- identification of numerical results with values below the method reporting limit;
- case narrative that identifies test methods, describes any deviation from the method or contractual requirements, additions or exceptions to the SOP, and discloses any conditions that may affect the quality of the results;
- identification of sample results that did not meet sample acceptance criteria;
- footnotes or qualifiers referenced to specific data (as applicable) and explanations or keys to flags and abbreviations used;
- surrogate and tracer recoveries, where applicable;
- where applicable, a statement of the estimated uncertainty of the test result; and
- a signature and title, or equivalent electronic identification, of the personnel who accepts responsibility for the content of the report, and the date of issue.

If a report is reissued, the amendments must clearly state that the report is reissued. The cover letter and case narrative must describe why the report has been reissued and which sample results have been reissued.

10.7.2.3 QC REPORTS

Each final report includes QC reports that summarize results from the associated LCS, MB, and matrix QC samples. Additional QC samples may be prepared and reported to comply with project-specific requirements.

10.7.2.4 DATA QUALIFIERS – FLAGGING CODES

Whenever the data quality objectives of the LQAP are not met, the associated sample results must be flagged with the appropriate flagging codes. These codes are applied only in the event that the laboratory cannot generate (through reanalysis) fully compliant data. If sample values are reported outside the calibration range of the method or unreliable interferences exist in the sample, then descriptive codes are applied to the result.

Data qualifiers are added by the laboratory prior to reporting the analysis results. The laboratory appends data qualifiers to each environmental field sample based on an evaluation of all available QC information (e.g., MS/MSD samples, laboratory blanks, LCSs, calibration verification standards, etc.). Analytical batch comments are added to the narrative section of each data report to explain any nonconformance or other issues.

Other flagging practices may be observed if so dictated by the applicable LIMS program specification.

10.7.3 ELECTRONIC DATA DELIVERABLES (EDDS)

The electronic data deliverables generated by the laboratory are project-specific and are produced in a format specified by the client.

Information presented in corresponding fields of the hardcopy report and EDD are identical as both are generated from LIMS. Before submitting the EDD file, the Project Manager or designee verifies that the EDD is complete and meets the client's format requirements. All EDDs are submitted to the client on computer disks or are transmitted electronically.

10.8 RECORDS AND DATA STORAGE

Records provide the direct evidence and support for the necessary technical interpretations, judgments, and discussion concerning laboratory results. These records, particularly those that are anticipated to be used as evidentiary data, provide the historical evidence needed for later review and evaluation. Records must be legible, identifiable, and retrievable. They must be protected against damage, deterioration, fire, theft, vermin, and loss. Though only 5-year retention is required by TNI, ALS retains all records for a minimum of seven (7) years, or as otherwise specified per the client's contract.

Laboratory records include the following kinds of documentation:

- personnel qualifications, experience, and training;
- correspondence between ALS and clients;
- quality assurance records (e.g., retired SOPs and LQAPs, PT study results, internal and external audit reports and responses);
- contents of laboratory logbooks;
- equipment maintenance records;
- traceability of standards, solvents and reagents;
- instrument checks and calibrations;
- raw data;
- final data reports; and
- sample management records (e.g., sample login, field and internal chain-of-custody, storage, disposal).

10.8.1 ELECTRONIC RECORDS

ALS employs a multi-level system that addresses both the frequent backup of sample results (in LIMS) and the periodic backup of raw data (from both networked and non-networked instruments).

Additionally, the software that ALS uses for these backups, contains a disaster recovery module that allows for the complete recovery of the backup database, in its entirety. In short, ALS's LIMS is backed up hourly, and, along with all network servers, is additionally backed up to tape each business day. As indicated in the IS and LIMS Policy Statement (SOP 143 and SOP 1401), instrument backups are performed approximately monthly. Contingent upon the volume of analysis, the frequency of backup might vary.

Backup of the instrument computers is done centrally by the IS Manager if the instrument computer is on the network. It is the responsibility of the operator/user to coordinate a convenient time for both the IS Manager and the user for non-network instrument backup. The instruments that are not on the network are backed up using portable devices. These devices, as well as media, are checked out from the IS Manager, then are returned to the IS Manager for safe storage.

An electronic archive for maintaining final project reports was implemented in 2001. Upon completion of a workorder, all data reports are scanned to create image files that are catalogued and saved to a dedicated server that is backed up daily as described above. The

scanned images remain available on the network for review should any questions regarding the data arise.

10.8.2 TRANSFER OF RECORDS

In the event that the laboratory changes ownership, the responsibility for the retention of records in accordance with the guidelines established in this LQAP, is conferred to the new owner. Should ALS go out of business, ALS will inform our clients in writing of this business decision, and that the transfer of records to the client must be in compliance with state, regulatory and legal records retention times and may limit the client's request. will transfer records at the client's request.

10.9 CLIENT INQUIRIES/COMPLAINTS

The focal point of contact with the client is the ALS Project Manager. If a complaint or any circumstance raises doubt concerning ALS's compliance with its policies or procedures, or with the requirement of a method or quality system, it is the Project Manager who initiates investigation and follows through to resolution. The QAM, Department Managers Operations Manager, and Laboratory Director are made aware of, and involved in, the resolution process as needed. Documentation of the complaint and its resolution are maintained as part of the project records. Where resubmission of data is required and/or implementation of preventive measures is necessary, it is processed (**SOP 928**), through the QAM. ALS will respond to all complaints in a timely fashion.

10.10 CONFIDENTIALITY

All laboratory results and associated raw data are confidential and may not be released to or discussed with any party other than the client who requested the analytical services. Access to laboratory records and LIMS is limited to laboratory personnel, on a restricted basis, based on need (i.e., job function). Records are available for an accrediting authority's on-site review, and records specific to the client (as well as quality system records) are available to the client for client audits. ALS requires that auditors will honor our clients' and ALS's confidentiality requirements, and will not discuss any results, documents, or records viewed during the course of an audit.

Confidentiality is included as a component of ALS's ethics training, which is provided to each person as they join the ALS staff, and annually, as a refresher training, thereafter.

11. CORRECTIVE ACTION, PREVENTIVE ACTION AND IMPROVEMENT

Corrective action is necessary when any measurement system fails to meet the requirements of this LQAP, the appropriate SOP or project-specific instructions, or whenever an error is detected. Items that may need corrective action range from a minor problem such as an

analyst failing to initial a form, to a major problem such as a chemist preparing a sample using the wrong reference method.

Corrective actions fall into two general categories: short-term and long-term. Short-term corrective actions are those that can be applied immediately. Examples include: having an analyst initial a form where the initial was missed, or correcting an error in a logbook entry per procedures described in SOP 303. Long-term corrective actions are those that require a clarification of practice or a change in policy in order to effectively resolve the problem. Corrective actions must be completed by the date designated by the QA Department (i.e., within 21 calendar days or less, unless otherwise provided for). Associated SOPs may need to be revised and republished for long-term corrective actions, laboratory staff must be re-trained in accordance with the updated procedures.

11.1 RESPONSIBILITIES FOR CORRECTIVE ACTION INITIATION

The type of corrective action taken is coordinated by the Department Operations, Quality Assurance and applicable Project Managers. A controlled Nonconformance Report is used to document the corrective action. Any individual who notes a problem or deviation is responsible for initiating the NCR in a timely manner.

It is the responsibility all personnel who work with samples to note any discrepancies or nonconformances that occur with sample handling. It is the responsibility of the chemists who prepare samples for analysis to document any problems that are noted during sample preparation. It is the analyst's responsibility to monitor the proper functioning of the analytical system prior to, during and following sample analysis. To accomplish this, various DQIs as discussed in Chapter 3 of this LQAP are monitored and evaluated against laboratory established or project-specific QA/QC requirements. If the evaluation reveals that any of the QC acceptance criteria are not met, then the analyst must immediately correct the problem. When an acceptable resolution cannot be achieved and/or data quality is negatively impacted, the analyst must notify the Department Operations and Project Managers and must initiate an NCR (**SOP 928**) immediately. Per the guidance contained in SOP 928, the laboratory shall notify all affected clients of potential data quality issues in a timely manner, and corrective actions taken to resolve the issue shall be completed in a reasonable timeframe, with documentation submitted to the client.

11.2 **ALS NONCONFORMANCE AND CORRECTIVE LABORATORY GROUP, FORT COLLINS CORRECTIVE ACTION PROCESS**

Non-conformances are reported (documented) electronically through a LIMS interface that is available to all staff. The individual who discovered the problem or deviation is responsible for initiating the next sequential NCR in LIMS. Note that in addition to documenting laboratory sample or test issues, NCRs are also used to address client inquiries, and to investigate Performance Test (PT) sample failures.

Documented on the NCR are the initials of the initiator and descriptions of the method, workorder(s) and samples affected; the type, content and extent of the problem noted; the probable cause and the root of the problem (if known); measures taken to prevent recurrence; the specific corrective actions taken and their outcome; and the final disposition/resolution of the data.

As described in **SOP 928**, the processing of the NCR flows from the initiator, to their immediate Supervisor and/or Department Manager/Group Leader and the relevant Project Manager(s), and finally to the Quality Assurance Manager. In this manner, a consensus is achieved as to what specific corrective actions are to be taken. The Project Manager, at his or her discretion, may or may not contact the client to discuss options based on the nature of the nonconformance. Whether or not the client is contacted is noted on the NCR, if the client is contacted, the Project Manager documents who was contacted and when. The Project, Department Operations and Quality Assurance Managers electronically sign and date the NCR, documenting their final approval and verification of the disposition of the data. The LIMS provides for delegation of signature authority as needed to cover key staff outages.

The LIMS, which is subject to ALS's frequent backup protocols, maintains an archive of all NCRs generated. In this manner, NCRs are retained as part of the laboratory's electronic records. Also, contingent upon the level of data deliverable specified by the client, a copy of the associated NCR report is included in the analytical data package.

Corrective actions that require follow-up, including those initiated by internal or external audits and systematic non conformances, are catalogued in a separate database that tracks audit findings, root cause, corrective actions, follow up for effectiveness, and closure. This database is managed by the QA Department but is available to all staff on a read-only basis.

11.3 IMPROVEMENT AND PREVENTIVE ACTION

At ALS, improvement of the quality systems and preventive action is effected through an ongoing systems review by management using input from all staff.

ALS actively seeks employee and client input for improvements through surveys and questionnaires. ALS maintains a process improvement website for employees to provide suggestions for improvements. For clients, ALS provides surveys and feedback on services provided. These automated systems report directly to the laboratory director for input into the management review process.

Preventive actions include preventive instrument maintenance as listed in all ALS Testing SOPs. These actions are documented in run logbooks and maintenance logbooks.

The laboratory Non conformance system within the LIMS identifies events as non conformance or incidence. The incidence is considered a potential non conformance and is evaluated along with all events for needed potential improvements to the ALS testing processes.

Management and key personnel review strategic goals and necessary improvements through a planning process (Balanced Scorecard). This process and review of actions items is available in monthly reports for the laboratory to corporate operations. All employees are asked to participate these goal setting sessions on a regular basis. The top laboratory management team conducts an ongoing review of the operations and quality system. This review process includes daily, weekly and monthly status meetings.

11.4 IDENTIFICATION OF TRENDS IN QC DATA

Preventive Actions using QC sample trending although not required is available to help prevent non compliance QC situations from occurring.

While a trend is not necessarily an out-of-control situation in itself, it can provide an early warning of a condition that can cause the system to go out of control. Trending can be used for calibration, equipment, reagents, and various other routine processes in the laboratory. ALS analytical SOPs describe in detail the assessment of batch and sample QC data in the laboratory.

The following conditions are trends that can initiate action and/or monitoring.

- A series of seven successive points on the same side of the mean
- A series of five successive points going in the same direction
- A cyclical pattern of QC sample results
- Two successive points between warning limits and control limits

ALS relies on analytical staff to identify trends in analytical systems and processes. Quality Assurance and laboratory personnel can produce control charts as needed to help assess trends but this activity in itself is not preventive and is only used to verify trends exist. The occurrence of a trend does not invalidate data that are otherwise in control. However, trends do require attention to determine whether a cause can be assigned to the trend so that appropriate preventive action can be undertaken.

Long term trends in control limits are evaluated yearly by Quality Assurance and technical operations as per ALS LQAP Section 9.3.1.

Process for identification of trends in QC data

Control limits are guides used for data evaluation. Verifying that QC sample values are not trending ensures that the method may continue to be used for the analysis of field samples. If an undesirable trend appears in the analytical QC data, field sample data for samples analyzed with the QC samples might also be trending in the same manner.

A trend in method QC data might be indicated if one or more of the following situations exist:

- A series of seven successive points on the same side of the mean
- A series of five successive points trending in the same direction
- Two consecutive points outside of warning limits

To identify a trend in surrogate, tracer and carrier recovery data, all values for a preparation batch must be evaluated collectively as a single event, since the values were generated during the same preparation event. Trends should be evaluated between preparation batches and not on any single sample.

LIMS can provide control charts for review to verify that trends exist but is not a tool used for trend identification. It is the responsibility of the analyst to review data for trends.

Evaluation of Significance

After a trend has been identified, the significance of the trend must be evaluated. An individual trend in data might, or might not, be a cause for action, particularly in the case of a single analyte in a multi-analyte method.

Examples:

- 1) Seven points (values of 97% – 100%) on the same side of the chart mean (value of 96%), with a warning limit at 104% and a control limit at 109%.

Evaluation: Consistent data, less than one standard deviation from the chart mean. No action required.

- 2) Five successive points (values of 88% – 96%) moving in the same direction, with a chart mean of 94% and an upper control limit of 109%.

Evaluation: Data moving across the chart mean, within one standard deviation from the chart mean, data are in the middle of the performance range of the method. No action required.

- 3) Five successive points (values of 94% – 107%) moving in the same direction, with a chart mean of 94% and an upper control limit of 109%.

Evaluation: Data moving away from the chart mean, nearing the control limit. Action while not required should be implemented to keep the procedure from going out-of-control.

If data exhibit a sufficiently significant trend to require corrective action, the cause of the trend must be determined.

Questions to be considered in the evaluation of a data trend and the determination of the cause of the trend might include (but are not limited to) the following:

- Five Why Root Cause Analysis
- Is this trend representative of the entire method?
- Is this trend limited to a single analyte in a multi-analyte method?
- Is this trend exhibited in the data of several analytes in a multi-analyte method, and is the same general trend observed for each analyte?
- What is the time period of the trend (i.e., a week, several weeks, several months)?
- What changes in the analytical system have occurred during the time period to which the trend applies?
- Are new personnel involved?
- Is different instrumentation involved?
- Were new or different standard solutions introduced?
- Was there a change in the analytical protocol or method?
- Has instrument sensitivity or response changed dramatically?
- Has instrument maintenance been performed recently?
- Have there been any changes in method reagents (i.e., brand, lot)?
- Have there been any matrix effects carried over from difficult samples?

Assignment of Significance

Following the identification of a data trend (as indicated above) and the evaluation of the trend for significance, a decision must be made that the level of significance does or does not require action.

At the time of quality control sample data evaluation, the evaluator must make a decision based upon personal judgment. Criteria can determine whether a trend exists, but judgment must be used in the determination of the significance of that trend.

If the data trend is determined to not pose a threat to the quality of *immediate future analytical data*, or does not reasonably indicate that the analytical method might begin to produce data that could be anomalous, the level of significance is INSIGNIFICANT.

If the data trend is determined to not pose a threat to the quality of *immediate analytical data* such that no action is required, but does possibly indicate that the analytical method may begin to produce data that could be anomalous, the level of significance should be MONITORED by technical personnel.

If the data trend is determined to possibly or reasonably pose a threat to the quality of *future analytical data*, and reasonably indicates that the analytical method may begin to produce data that could be anomalous, the level of significance is SIGNIFICANT, and actions must be initiated to prevent out of control events.

Resolution Procedure

Following identification of a trend and an assignment of a level of significance, future action regarding the trend must be determined.

If a data trend is evaluated as significant, laboratory personnel responsible for data trend evaluation must promptly inform all analysts involved in work related to the significant trend that the trend exists and that action must be initiated to prevent its reoccurrence and correct it.

All activities related to a significant trend will be documented in normal analysis records.

Laboratory personnel are required to initiate action to correct a significant data trend related to their work.

The trending rules used by ALS are in the following table. In most instances experience chemists identify trends and take action upon reviewing analytical data.

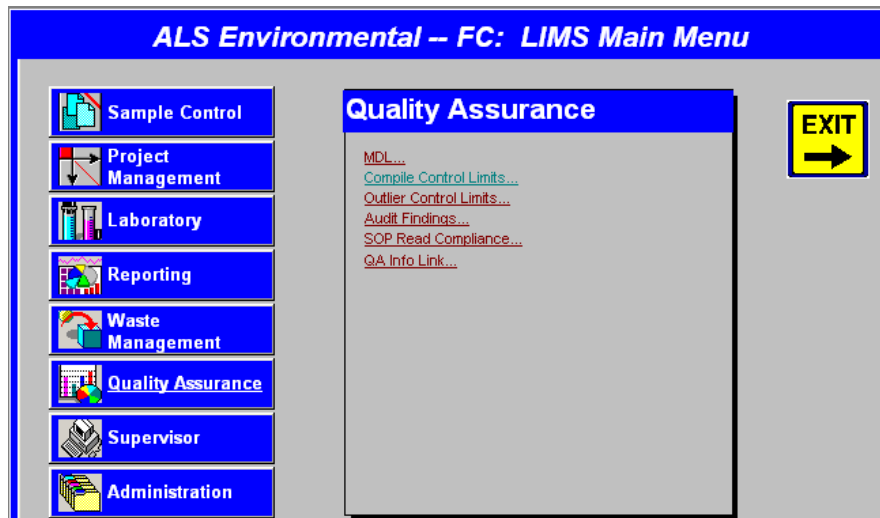
RULE	DESCRIPTION	POSSIBLE PREVENTIVE ACTIONS
Above Warning Limits	Two of three data points above warning limits	Check Calibration and Spiking Solutions Instrument Maintenance
Below Warning Limits	Two of three data points below warning limits.	Check Calibration and Spiking Solutions Instrument Maintenance
Above Mean	Seven consecutive data points above the mean	Check Calibration and Spiking Solutions Instrument Maintenance
Below Mean	Seven consecutive data points below the mean	Check Calibration and Spiking Solutions Instrument Maintenance
Ascending Data	Seven consecutive data points in ascending direction	Check Calibration and Spiking Solutions Instrument Maintenance
Descending Data	Seven consecutive data points in descending direction	Check Calibration and Spiking Solutions Instrument Maintenance

Procedure for producing Control Charts to verify trends are present

LIMS Main Menu

From Quality Assurance Menu

Select Compile Control Limits



Compile Control Utility Menu

In the Compile/Review Parameters Box

Select Analysis Method, Extraction Method, Matrix, Analyte and Date Range (Use no more than the last 12 months)

In the Command Option Box (In Sequence)

Compile Data

Calculate Statistics

Control Charts

ALS Laboratory Group -- FC: Control Chart Utility

Auto Compile These Methods

Click "Enable" to select the list of methods to compile.

(QA Use Only)

Begin Pull Date: 7/1/2012
End Pull Date: 9/30/2012

☒ Enable

Settings

Pull: 12 Months
of Data Points

1st Quarter: 01/01--03/31
2nd Quarter: 04/01--06/30
3rd Quarter: 07/01--09/30
4th Quarter: 10/01--12/31

Compile/Review Parameters

Analysis Method:
Extraction Method:
Matrix:
Analyte:

Date Range: From: To:

☐ Blank Activity Only

LIMS Control Limits Menu

Command Options

Compile Data
Compile Data
Review Compiled Data

Statistics Evaluation

Delete Minimum Data points ☐

Outlier Test: Delete

%Rec< 0 and %Rec> 200

Calculate Statistics
Review Statistics

Preview Reports

Control Charts
Statistics
Rejected Recoveries

Data Set Maintenance

Save Compiled Data Set/Stats

Retrieve Data Set/Stats Delete

NOTE: Data Sets and statistics may only be saved for 30 days. After this period they will be automatically deleted from the system.

Compile/Review Parameters

Analysis Method: SW8081
Extraction Method: SW3520
Matrix: LIQUID
Analyte: 4,4'-DDE

Date Range: From: 01/01/2012 To: 07/25/2012

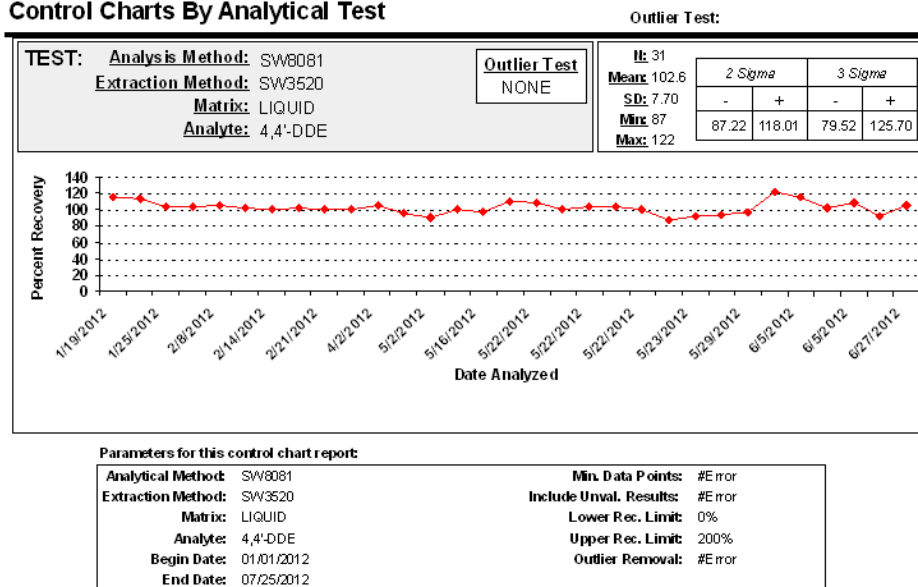
Command Options

Compile Data
[Compile Data](#)
[Review Compiled Data](#)

Statistics/Evaluation
[Delete Minimum Data points](#) ☐
 Outlier Test:
 %Rec< and %Rec>
[Calculate Statistics](#)
[Review Statistics](#)

Preview Reports
[Control Charts](#)
[Statistics](#)
[Rejected Recoveries](#)

Control Charts By Analytical Test



12. AUDITS

12.1 INTERNAL AUDITS

Periodic evaluations conducted by the Quality Assurance Department and the analysis of Proficiency Test (PT) samples are two types of internal audits used to assess and document the performance of laboratory staff and processes. Audit documentation constitutes a permanent record of the conformance of ALS's measurement systems to quality system requirements.

Internal audits include both technical and systems audits, and are performed periodically per an annual schedule developed and maintained by the Quality Assurance Department. Considerations taken into account in developing the internal audit schedule include, but are not limited to, requests made by the

Laboratory Director; the scheduled occurrence of external audits; as needed to support a specific project's requirements; to verify the continued effectiveness of corrective actions previously taken; or in response to an identified need to evaluate compliance in any area of laboratory operations. The intention of the internal audit schedule is to provide for the evaluation of each laboratory area or system at least once annually, thereby providing an overview of laboratory operations. Form 168 or other audit questionnaire may be used as a guide to conduct and document internal audits. Each year, the internal audits conducted are compiled into the annual Quality Systems Audit (QSA), which is discussed subsequently (LQAP Section 12.1.3).

All internal audits are conducted by QA staff or designees who, by experience, are deemed to be knowledgeable in the area assessed. The assigned auditor identifies the scope, time frame and expected duration of the audit, and communicates this information to the applicable Department Manager Work Group Leader. The auditor reviews relevant information such as regulations, contract requirements, published procedures, SOPs, etc., prior to the audit. The criteria set forth in these applicable guidances establish the basis of the audit. These reference materials may also be used as auditor's aids.

The audit is conducted in an efficient and professional manner. Findings, Observations and comments are communicated to the Operations Department Manager.

Short-term corrective actions may be taken at the time an item is noted, or an appropriate long-term corrective action plan may be developed. An audit is considered to be closed-out when deficiencies have been satisfactorily corrected.

An audit report summarizing the Determinations made and the corrective actions taken or planned is compiled; the original auditor's notes are customarily included as an attachment of the audit report. The outcome of the audit is communicated to the Laboratory Director. Internal audit corrective actions requiring follow up are tracked in a LIMS Table that is available for viewing to all laboratory personnel. The QAM oversees satisfactory completion of corrective measures taken. Internal audit records are maintained by the Quality Assurance Department.

See **SOP 937** for additional information pertaining to internal audit procedures.

12.1.1 INTERNAL TECHNICAL AUDITS

Departmental Operational functions that may be reviewed during a technical audit may include, but are not limited to:

- Adherence to SOPs and compliance with promulgated method requirements during sample preparation and analysis;
- Maintenance of internal chain-of-custody;

- Proper preparation, storage, use and documentation of standards;
- Performance and documentation of instrument maintenance;
- Performance and documentation of data review;
- Evaluation of documentation practices pertaining to benchsheet and logbook entries, Nonconformance Report (NCR) generation and analyst demonstration of capability.

12.1.2 INTERNAL SYSTEM AUDITS

Examples of elements that may be reviewed as a system audit may include, but are not limited to:

- An assessment of the SOP process, including procedures for submitting and approving revisions, update and distribution of SOPs, tracking of employee SOP assignments and sign-offs, SOP electronic file management, and archiving of older SOP iterations and records.
- LIMS data capture and reporting processes.
- Sample handling, storage and disposal practices, including maintenance of sample storage areas, sample tracking and internal chain-of-custody documentation, duration of retention, and disposal designation and documentation.
- Use of ALS's Standards and Reagents database.
- Performance and documentation of laboratory logbook review.

12.1.3 ANNUAL QUALITY SYSTEMS AUDIT

A lab-wide review of conformance to ALS's quality system is conducted annually by the QA Manager or designee(s) as required by the TNI Standard. The annual Quality Systems Audit (QSA) shall be managed, conducted and reported according to the audit procedures described above. Inputs to the QSA may include, but are not limited to, summaries of the following: Nonconformance Reports (NCRs), Proficiency Testing (PT) study results, deficiencies noted during data review, internal audit Determinations, and Determinations made via external audits.

12.1.4 PROFICIENCY TESTING STUDIES

ALS participates in agency studies and/or contracts approved vendors to provide PT samples in accordance with a schedule developed and maintained by the Quality Assurance Department. Participation in PT studies enables ALS to demonstrate capability for continued accreditation, competency in a newly developed method, or the effectiveness of corrective actions taken.

ALS participates in the following inter-laboratory proficiency testing studies:

- Water Supply (WS) -- twice annually
- Water Pollution (WP) -- twice annually
- Soil/Hazardous Waste and UST -- twice annually
- Radiochemistry -- twice annually
- US Department of Energy (USDOE) Mixed Analyte Performance Evaluation Program (MAPEP) -- twice annually

These PT studies support various regulatory programs (SDWA, CWA, RCRA) and require that the laboratory perform analyses per various methodologies (e.g., EPA 600 series, MCAWW, ASTM, SW-846), matrices and analytes. Analyte lists include: volatile organics, semivolatile organics, organochlorine pesticides, polychlorinated biphenyls, organophosphorous pesticides, phenoxyacid herbicides, high explosives, petroleum hydrocarbons, metals, minerals, nutrients and radionuclides. The analyses of PT samples are conducted in-house, in the manner prescribed by the provider, and within the turnaround time stipulated. The PT samples are distributed to the laboratory and are processed by qualified analysts who routinely perform the analytical method.

PT study results are evaluated by the Quality Assurance Department and the applicable Department/Department Operations Manager as they become available. The NCR and corrective action process as described in Chapter 11 of this LQAP, is used to address any deficiencies that are noted. An archive of PT study reports, maintained by the QA Department, is posted to the network for lab-wide access.

12.1.5 ANNUAL MANAGERIAL REVIEW

A lab-wide Managerial Review is performed annually. The Managerial Review assesses operational effectiveness in terms of meeting ALS's business goals. It is a tool used to document and facilitate the

consideration and introduction of needed operational changes and improvements.

The Managerial Review is performed by a designee under the direction of the Laboratory Director. The general techniques of scoping, assessment interview, reporting and follow-up as described in the internal audit procedures discussed above and outlined in SOP 937, are used to conduct the annual Managerial Review. The contents of the annual Managerial Review are considered to be confidential. A confidential footer must, therefore, appear as a component of the annual Managerial Review report.

Inputs to the Managerial Review may include, but are not limited to the following: a snapshot summary of product generated (i.e., number of samples analyzed and the types of analyses performed), various business assessment reports (e.g., TAT, on- time delivery), output from the annual QSA (i.e., problem areas identified), interview of laboratory staff, and presentation of items discussed during strategic planning sessions and/or Manager's meetings.

12.2 EXTERNAL AUDITS

External audits may be performed by a state or Federal agency or a client as part of an ongoing certification process. Items evaluated by external assessors may include, but are not limited to, reviews of the following: analytical capabilities and procedures; COC procedures; document control; quality systems; and QC procedures. Blind PT samples may be submitted to the laboratory as a form of external audit.

ALS certifications are maintained on the internal network folders and are available by request. Should ALS drop or lose an accreditation, the PMs must notify all clients that may be affected in a timely manner.

13. PERSONNEL TRAINING

The selection of well-qualified personnel is a factor that contributes to ALS's success. Therefore, qualifications of personnel are based upon education and experience. In order to maintain qualified staff, provide personnel advancement within the laboratory, and to provide for personnel's ongoing awareness of potential hazards and protective measures, ALS follows a formal documented program of orientation and training. Records of Health & Safety and waste training are maintained by the Health & Safety Manager/RSO and Facilities/Waste Compliance Manager. Technical training records are forwarded to the Quality Assurance Department for retention.

13.1 ORIENTATION

Before working in the laboratory, new employees receive a four-part orientation as described below:

- Human resources -- involves matters of immediate personal concern, such as benefits and company policies
- Quality assurance -- addresses topics related to ethical conduct, good laboratory practices and ongoing documentation of employee capability demonstrations. Required readings (SOPs, LQAP) are assigned at this time. See ALS SOP 143.
- Health & safety -- provides for a review of ALS's various safety program documents (Chemical Hygiene Plan, CHP; Radiation Protection Plan, RPP; Emergency and Contingency Plan, ECP; Respiratory Protection Plan, ResPP; Waste Management Plan, WMP); as well as other safety and security training.
- Department functional orientation -- focuses on the new employee's basic understanding of their role within the Department and the overall role of Operations within the structure of ALS. The Departmental Work Group department training expands upon the employee's scientific background and work experience to provide the employee with a level of competence that enables the individual to successfully function within the defined responsibilities of his/her position.

Temporary employees receive the same orientation as regular staff, with the exception of the human resources orientation.

SOP 143 details information regarding quality assurance orientation and training for new employees.

13.2 TECHNICAL TRAINING

Chemists (analysts) and technicians are qualified to perform specific analytical procedures and methods. The qualification process, at a minimum, consists of background/theory training, on-the-job training, and demonstration of proficiency. Additional training may include further individualized instruction, programmed learning, conferences and seminars, and specialized training by instrument manufacturers.

Department ManagersThe Operations Manager or designee is are responsible for providing documentation of analytical training and proficiency for each employee in their group(s) to the Quality Assurance Department for retention. See ALS SOP 150

13.2.1 INITIAL DEMONSTRATION OF CAPABILITY (IDOC)

New analysts and technicians are trained by Department ManagersWork Group Leaders according to the following guidelines:

- * The new employee reads the SOP(s) pertinent to the analytical method being learned, and receives background/theory instruction, as applicable.
- * The new employee observes the procedure in which the analytical method and required process documentation is demonstrated by trained personnel. Job requirements are outlined and quality control measurements are defined. For most methods, the trainee performs an Initial Demonstration of Capability (IDOC) by preparing and/or analyzing four (4) blank spike samples under the supervision of the Technical or Department Manager/Group Leader, or an analyst proficient in that method.
- * The results of the new employee's preparation and/or analysis are evaluated and problems and corrective actions are discussed. If the blank spike recovery and precision data meet quality control criteria for that method, the employee is deemed to have demonstrated proficiency and is allowed to work on client samples. If the values generated are outside acceptance limits, then training continues until the trainee can consistently meet the acceptance criteria for the method.
- * After the certification process has been successfully completed, the Department Operations Manager forwards the documentation to the Quality Assurance Department for retention.

13.2.2 CONTINUING DEMONSTRATION OF CAPABILITY (CDOC)

ALS's personnel are required to demonstrate their proficiency upon hire and with each batch of samples. Results from the laboratory control sample (LCS) spike performed by the chemist (analyst) or technician is evaluated ongoing and significant problems are dealt with immediately through the peer review process, non conformance system, and training. This LCS data is available to review upon request. Alternately, RVS samples and PT sample analysis may also be used to demonstrate an employee's capability.

13.3 TRAINING RECORDS

Technical and quality assurance training records are maintained on network servers by the Quality Assurance Department. Health & Safety training records are also maintained on network servers. Waste management training records are managed and maintained by the Facilities/Waste Compliance Manager. Training records are designated for storage using the ALS SOP 150.

14.1 GLOSSARY, ACRONYMS AND SYMBOLS GLOSSARY

<u>TERM</u>	<u>DEFINITION</u>
Acceptance Criteria:	Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQ)
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. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one. (TNI)
Accrediting Authority, Primary:	The agency or department designated at the Territory, State, or Federal level as the recognized authority with responsibility and accountability for granting TNI accreditation for a specified field of testing. (TNI)
Accuracy:	The degree of agreement between a observed value and the accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations. (QAMS)
Aliquot:	A discrete, measured, representative portion of a sample taken for analysis. (EPA QAD)
Ambient:	Usual or natural surrounding conditions, e.g. ambient temperature – the natural, uninfluenced temperature of the surroundings. (NIRP Glossary)
Analyte:	The specific chemicals or components for which a sample is analyzed; may be a group of chemicals that belong to the same chemical family and that are analyzed together. (DoD QSM)
Audit:	A systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity. (EPA-QAD)
Background:	Ambient signal response recorded by measuring instruments that is independent of radioactivity contributed by the radionuclides being measured in the sample. (DOE QSM)
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 to twenty environmental samples of the same TNI-defined 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 24 hours. An analytical batch is composed of prepared environmental samples

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(extracts, digestates, or concentrates) which are analyzed together as a group. An **analytical batch** can include prepared samples originating from various environmental matrices and can exceed 20 samples. (TNI Quality Systems Committee)

Bias: The deviation of a single measured value of a random variable from a corresponding expected value, or a fixed mean deviation from the expected value that remains constant over replicated measurements within the statistical precision of the measurement (Synonyms: deterministic error, fixed error, systematic error). (DOE QSM)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, or analysis. The blank is subjected to the same analytical and measurement process as the associated samples. Blanks include:

Equipment blank: a sample of analyte free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (TNI)

Field blank: a blank prepared in the field by filling a clean container with pure deionized water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)

Trip blank: Contaminant free water, or appropriate matrix, which accompanies bottles and samples during shipment to assess the potential for sample contamination during shipment. Trip blanks are not opened in the field, and are required for Volatile Organic Analysis only. (NIRP)

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

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 the steps of the analytical procedures. (TNI)

Reagent blank: a sample consisting of reagent(s), without the target analyte(s) or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (QAMS)

Blind Sample: A sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample, but not

<u>TERM</u>	<u>DEFINITION</u>
	the composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process. (TNI)
Calibration:	To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. See Initial Calibration. (TNI)
Calibration, Continuing:	The process of analyzing standards periodically to verify the maintenance of calibration of the analytical system.
Calibration Curve:	The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (TNI)
Calibration, Initial:	The process of analyzing standards, prepared at specified concentrations, to define the quantitative response, linearity and dynamic range of the instrument to the analytes of interest. Initial calibration is performed whenever the results of a continuing calibration do not conform to the requirements of the method in use or at a frequency specified in the method. See Calibration.
Calibration, Initial Check/Verification (ICV):	Verification of the ratio of instrument response to analyte amount, a calibration check is done by analyzing for analyte standards in an appropriate solvent. Calibration check solutions are made from a stock solution which is different from the stock used to prepare calibration standards. (NIRP Glossary)
Carrier:	Carriers are typically non-radioactive (e.g. natural strontium, barium, yttrium) elements. They follow similar chemical reactions as the analyte during processing and are added to samples to determine the overall chemical yield for the analytical preparation steps. The yield of the carrier is typically determined gravimetrically or by ICP and is used to correct radiochemical results for acceptable losses occurring during the preparation process. (DOE QSM)
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, preservation, and requested samples. (TNI)
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

<u>TERM</u>	<u>DEFINITION</u>
	to safeguarding identified CBI and to maintain information identified as such in full confidentiality. (TNI)
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 calibration, 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)
Control Chart:	A graphical plot of test results with respect to time or sequence of measurement, together with limits within which they are expected to lie when the system is in a state of statistical control.
Control Limit:	A range within which specified measurement results must fall to signify compliance. Control limits may be mandatory, requiring corrective action if exceeded, or advisory, requiring that nonconforming data be investigated and flagged.
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)
Counting Efficiency:	The ratio of the net count rate of a radionuclide standard source to its corresponding known activity. (DOE QSM)
Counting Uncertainty (Poissonian):	A statistical estimate of uncertainty in a radiochemical measurement due to the random nature of decay. Every radiochemical result is reported with an associated counting uncertainty, usually at the 95% confidence interval.
Data Quality Indicators:	The qualitative or quantitative statements that specify the quality of data required to support decision for any process requiring chemical or physical analysis.
Data Reduction:	The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form. (EPA-QAD)
Daughter:	A nuclide formed by radioactive decay of a parent radionuclide.

<u>TERM</u>	<u>DEFINITION</u>
Deficiency:	An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)
Demonstration of Capability (DOC):	A procedure to establish the ability of the analyst to generate acceptable accuracy. (TNI)
Detection Limit, Analyte:	The lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value. See Method Detection Limit. (TNI)
Detection Limit, Instrument (IDL):	The concentration of an analyte that produces an output signal twice the root mean square of the background noise, or the parameter determined by multiplying by three the standard deviation obtained of three to five times the desired IDL on three nonconsecutive days with seven consecutive measurements per day. IDL is only required for the metals and analysis. (DOE QSM)
Detection Limit, Method (MDL):	The Method Detection Limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. It may be determined using replicate spike samples prepared by the lab and taken through all steps of the method. The detection limit is calculated using the ALS SOP 329
Digestion:	A process in which a sample is treated (usually in conjunction with heat) to convert the sample into a more easily measured form. (DoD QSM)
Dilution Factor:	The factor by which the dilution level of the sample differs from that of a predefined method blank. The method blank is prepared within the prescribed parameters of the method, and has a dilution factor of one. The dilution factor does not include a dryness factor. (DOE QSM)
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 is performed. (ASQC)
Dry Weight:	The weight of a sample based on percent solids. The weight after drying in an oven at 105±5°C.
Duplicate, Replicate Analysis:	The analyses or measurements of the variable of interest performed identically on two sub samples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement

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precision but not the precision of sampling, preservation, or storage internal to the laboratory. (EPA-QAD)

The measurements of the variable of interest performed identically on two or more sub-samples of the same samples within a short time interval. (TNI)

Duplicate (Replicate) Error Ratio (DER/RER): A measure of precision used to assess agreement between radiochemical duplicates (replicates) that compares the discrepancy between two measurements to the associated uncertainties.

Duplicate, Replicate Sample: A second aliquot of the same sample that is treated the same as the original sample in order to determine the precision of the method.
A second, separate sample collected at the same time, from the same place, for the same analysis, as the original sample in order to determine overall precision.

Eluent: A solvent used to carry the components of a mixture through a stationary phase. (DoD QSM)

Elution: A process in which solutes are washed through a stationary phase by the movement of a mobile phase. (DoD QSM)

Energy Calibration: The correlation of the multi-channel analyzer (MCA) channel number to decay energy, obtained from the location of peaks from known radioactive standards. (DOE QSM)

False Negative: An analyte incorrectly reported as absent from the sample, resulting in potential risks from their presence. (DoD QSM)

False Positive: An item incorrectly identified as present in the sample, resulting in a high reporting value for the analyte of concern. (DoD QSM)

Finding: An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding is normally a deficiency and is normally accompanied by specific examples of the observed condition. (TNI)

Half Life ($T_{1/2}$): The time required for 50% of a radioactive isotope to decay. (DOE QSM)

Holding Time (Maximum Allowable): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised. (40 CFR Part 136)

Homogeneity: The degree to which a property or substance is evenly distributed

<u>TERM</u>	<u>DEFINITION</u>
	throughout a material.
Interference, Spectral:	Occurs when particulate matter from the atomization scatters the incident radiation from the source or when the absorption or emission of an interfering species either overlaps or is so close to the analyte wavelength that resolution becomes impossible. (DoD QSM)
Interference, Chemical:	Results from the various chemical processes that occur during atomization and later the absorption characteristics of the analyte. (DoD QSM)
Internal Standards:	A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method. (TNI)
Isomer:	Generally, any two chemicals with the same chemical formula but with a different structure. (DoD QSM)
Isotope:	A variation of an element that has the same atomic number of protons but a different weight because of the number of neutrons. Various isotopes of the same elements may have different radioactive behaviors, some are highly unstable. (NIRP Glossary)
Lot:	A quantity of bulk material of similar composition processed or manufactured at the same time.
Matrix:	The substrate of a test sample. Field of Accreditation Matrix: these matrix definitions shall be used when accrediting a laboratory: <u>Drinking Water:</u> any aqueous sample that has been designated a potable or potential potable water source. <u>Non-Potable Water:</u> any aqueous sample excluded from the definition of Drinking Water matrix. Includes surface water, groundwater, effluents, water treatment chemicals, and TCLP or other extracts. <u>Solid and Chemical Materials:</u> includes soils, sediments, sludges, products, and by-products of an industrial process that results in a matrix not previously defined. <u>Biological Tissue:</u> any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin. <u>Air and Emissions:</u> 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

<u>TERM</u>	<u>DEFINITION</u>
	with a sorbent tube, impinger solution, filter, or other device. (TNI)
	<u>Non-aqueous Liquid</u> : any organic liquid with <15% settleable solids.
Minimum Detectable Activity (MDA, Lower Limit of Detection):	The minimum detectable activity is the smallest amount (activity or mass) of an analyte in a sample that will be detected with a probability beta of nondetection (Type II error) while accepting the probability alpha of erroneously deciding that a positive (non-zero) quantity of analyte is present in an appropriate blank sample (Type I error). For the purposes of this standard, the alpha and beta probabilities are both set at 0.05 unless otherwise specified. (ANSI N 13.30 and ANSI N42.23)
Minimum Detectable Concentration (MDC):	The Minimum Detectable Activity expressed in concentration units.
National Voluntary Laboratory Accreditation Program (NVLAP):	A program administered by NIST that is used by providers of proficiency testing to gain accreditation for all compounds/matrices for which NVLAP accreditation is available, and for which the provider intends to provide NELAP PT samples. (TNI)
Negative Control:	Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results. (TNI)
Nonconformance:	An indication or judgment that a product or service has not met the requirements of the relevant specifications, contract or regulation, also the state of failing to meet the requirements. (DoD QSM)
Performance Based Measurement System (PBMS):	A set of processes wherein the data quality needs, mandates, or limitations of a program or project are specified and serve as criteria for selecting measurement processes which will meet those needs in a cost effective manner. (TNI)
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. (TNI)
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)
Proficiency Test	A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical

<u>TERM</u>	<u>DEFINITION</u>
Sample:	results within specified acceptance criteria. (QAMS)
Qualitative:	Analysis without regard to quantity or specific numeric values. (NIRP Glossary)
Quality Assurance:	An integrated system of activities involving planning, quality control, quality assessment, reporting, and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. (QAMS)
Quality Control (QC):	The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of the users. (QAMS)
Quality Control Sample:	An uncontaminated matrix spiked with known amounts of analytes. 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. (EPA-QAD)
	<u>Laboratory Control Sample (LCS)</u> : (However named, also Laboratory Fortified Blank, Blank Spike, 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. 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. (TNI)
	<u>Laboratory Duplicate (DUP)</u> : Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently. (TNI)
	<u>Matrix Spike (spiked sample or fortified sample)</u> : A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate 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. (QAMS)
Quantitation Limits, Practical (PQL):	Levels, concentrations, or quantities of a target variable (e.g. target analyte) that can be reported at a specified degree of confidence. (TNI) The value at which an instrument can accurately measure an analyte at a specific concentration (i.e. a specific numeric concentration can be quantified). These points are established by the upper and lower limits of the calibration range. (DoD clarification)

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The lowest concentration where the 95% confidence interval is within 20% of the true concentration of the sample. The percent uncertainty at the 95% confidence level shall not exceed 20% of the results for concentrations greater than the practical quantitation limit. (DOE QSM)

Quantitative:	Analysis with regard to quantities or specific numeric values. (NIRP Glossary)
Radioactive Decay:	The process by which a spontaneous change in nuclear state takes place. This process is accompanied by the emission of energy and subatomic particles. (DOE QSM)
Radiation Yield:	The amount of radiation of the type being measured that is produced per each disintegration, which occurs. For gamma spectrometry, this is commonly called gamma abundance. (DOE QSM)
Raw Data:	Any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm, or microfiche copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (e.g. tapes which have been transcribed verbatim, data and verified accurate by signature), the exact copy or exact transcript may be submitted. (EPA-QAD)
Reagent Water:	Shall be water (defined by national or international standard) in which no target analytes or interferences are detected as required by the analytical method. (TNI)
Region of Interest (ROI):	In radiochemical analysis, the Multi-channel Analyzer region defining the isotope of interest displayed in terms of energy or channels. (DOE QSM)
Relative Percent Difference (RPD):	A measure of precision between two duplicate (replicate) results expressed as the percent difference between the results relative to the average of the results.
Reliability Check (Daily):	A periodic check of the Continuing Calibration of an instrument used for radiochemical measurements.
Reporting Limit:	The level at which method, permit, regulatory and client specific objectives are met. The reporting limit may never be lower than the statistically determined MDL, but may be higher based on any of the above considerations. Reporting limits are corrected for sample

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amounts, including the dry weight of solids, unless otherwise specified.

Retention Time: The time between sample injection and the appearance of a solute peak at the detector. (DoD QSM)

Rounding Rules: If the figure following those to be retained is less than 5, the figure is dropped, and the retained figures are kept unchanged. As an example, 11.443 is rounded to 11.44. If the figure following those to be retained is greater than 5, the figure is dropped, and the last retained figure is raised by 1. As an example, 11.446 is rounded to 11.45. If the figure following those to be retained is 5, and if there are no figures other than zeros beyond the five, the figure 5 is dropped, and the last-place figure retained is increased by one if it is an odd number or it is kept unchanged if an even number. As an example, 11.435 is rounded to 11.44, while 11.425 is rounded to 11.42. If a series of multiple operations is to be performed (add, subtract, divide, multiply), all figures are carried through the calculations. Then the final answer is rounded to the proper number of significant figures.

Sample: A single container or series of containers identified by a unique number comprised of material drawn from a single location or a composite of locations during a fixed period representative of that location (s) and time period(s) for the purpose of analytical testing or physical evaluation. (DOE QSM)

Selectivity: (Analytical chemistry) The capability of a test method or instrument to respond to a target substance in the presence of non-target substances. (EPA-QAD)

Sensitivity: Capability of method or instrument to discriminate between measurement responses representing different levels (e.g. concentrations) of a variable of interest. (TNI)

Signal-to-Noise Ratio: The signal carries information about the analyte, while noise is made up of extraneous information that is unwanted because it degrades the accuracy and precision of an analysis and also places a lower limit on the amount of analyte that can be detected. In most measurements, the average strength of the noise is constant and independent of the magnitude of the signal. Thus, the effect of noise on the relative error of a measurement becomes greater and greater as the quantity being measured (producing the signal) decreases in amplitude. (DoD QSM)

Split Sample: A portion or subsample of a total sample obtained in such a manner that is not believed to differ significantly from other portions of the

<u>TERM</u>	<u>DEFINITION</u>
	same sample.
Standard Operating Procedure (SOP):	A written document which details the method of an operation, analysis, or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing routine and repetitive tasks. (QAMS)
Reference Material:	<p>A certified reference material produced by the U.S. National Institute of Standards and Technology or other equivalent organization and characterized for absolute content, independent of analytical method. (EPA-QAD)</p> <p>A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30 – 2.2)</p>
Standard (Spike) Addition:	In radiochemistry, the addition of a known quantity of a radiotracer to a sample and to a split or splits of a sample. Both the sample and split(s) are then processed through the method and the difference in response between the samples used to correct for overall bias resulting measurement bias and from losses during preparation. This method of internal calibration is used in radiochemical determinations where isotopic differentiation between target analyte and tracer is not possible.
Statistical Minimum Significant Difference (SMSD):	The minimum difference between the control and a test concentration that is statistically significant, a measure of test sensitivity or power. The power of a test depends in part on the number of replicates per concentration, the significance level selected, and the type of statistical analysis. If the viability remains constant, the sensitivity of the test increases as the number of replicates is increased. (TNI)
Surrogate:	A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes. (QAMS)
Target Analytes:	Identified on a list of project-specific analytes for which laboratory analysis is required.
Tolerance Chart:	A chart in which the plotted quality control data is assessed via a tolerance level (e.g. +/-10% of a mean) based on the precision level judged to be acceptable to meet overall quality/data use requirements instead of a statistical acceptance criteria (e.g. +/- 3 sigma) (applies to radio bioassay laboratories). (ANSI)
Total Propagated	An estimate or approximation of the total error associated with a

<u>TERM</u>	<u>DEFINITION</u>
Uncertainty (TPU):	measured value by propagation of individual (preparation, determination) uncertainties.
Traceability:	The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM-6.12)
Tracer:	A traceable internal standard, usually a unique isotope of the element being determined, added to each sample in known amount which enables quantitation of analytes of interest independent of external means of calibration.
Tracer Chemical Recovery:	The percent yield of the recovered radioisotope after the sample/tracer aliquot has undergone preparation and instrument analysis. (DOE QSM)
Tune:	An injected standard required by the method as a check on instrument performance for mass spectrometry. (DoD QSM)
Validation:	Confirmation by examination and provision of evidence that specified requirements have been met. (EPA-QAD)
Verification:	<p>Confirmation by examination and provision of evidence that specified requirements have been met. (TNI)</p> <p>NOTE: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.</p> <p>The result of verification leads to a decision either to restore in service, to perform adjustment, to repair or downgrade, or declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.</p>
Warning Limits:	The limits (typically 2 standard deviations either side of the mean) shown on a control chart within which most results are expected to lie (within a 95% probability) while the system remains in a state of statistical control.

14.2 ACRONYMS

<u>TERM</u>	<u>DEFINITION</u>
AA	Atomic Absorption
AFCEE	Air Force Center for Environmental Excellence
ANSI/ASQ	American National Standards Institute/American Society for Quality
APHIS	USDA Animal and Plant Health Inspection Service
API	American Petroleum Institute
ARAR	Applicable or Relevant and Appropriate Requirement
ASCII	American Standard Code Information Interchange
ASTM	American Society for Testing and Materials
BFB	Bromofluorobenzene
BNA	Base-Neutral and Acid Extractable Organic Compounds
BS	Blank Spike
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
°C	Degrees Celsius
CAS	Chemical Abstract Service
CCC	Calibration Check Compound
CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification
CDPHE	Colorado State Department of Public Health and the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Calibration Factor
CFR	Code of Federal Regulation
CLLE, CLE	Continuous Liquid-Liquid Extractor
CLP	Contract Laboratory Program
COC	Chain of Custody
CVAA	Cold Vapor Atomic Absorption Spectroscopy.

<u>TERM</u>	<u>DEFINITION</u>
CWA	Clean Water Act
D	Drift or Difference
DBCP	1,2-Dibromo-3-chloropropane
DCM	Dichloromethane
DENIX	Defense Environmental Management Information Exchange
DER	Duplicate Error Ratio
DFTPP	Decafluorotriphenylphosphine
DI	Deionized
DOC	Demonstration of Capability
DoD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DPM	Disintegrations per Minute
DQI	Data Quality Indicator
DRO	Diesel Range Organics
ECD	Electron Capture Detector
EDB	Ethylene Dibromide
EDD	Electronic Data Deliverable
EERF	Eastern Environmental Radiation Facility
EMSL	Environmental Monitoring Systems Laboratory
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
FPD	Flame Photometric Detector
GALP	Good Automated Lab Practice
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry

<u>TERM</u>	<u>DEFINITION</u>
GFAA	Graphite Furnace Atomic Absorption
GFPC	Gas Flow Proportional Counting
GPC	Gel Permeation Chromatography
GRO	Gasoline range organics
HECD	(Hall) Electrolytic Conductivity Detector
HEM	Hexane Extractable Material
HDPE	High-Density Polyethylene
HPGe	High Purity Germanium Gamma Spectrometer
HPLC	High-Performance Liquid Chromatography
IC	Ion Chromatography
ICAP-AES	Inductively Coupled Argon Plasma -Atomic Emission Spectroscopy
ICB	Initial Calibration Blank
ICP	Inductively Coupled Plasma
ICP-MS	Inductively Coupled Plasma - Mass Spectrometry
ICS	Interference Check Standard
ICV	Initial Calibration Verification
IDL	Instrument Detection Limit
IPC	Instrument Performance Check
IPN	Incoming Project Notice
IRPIMS	Installation Restoration Program Information Management System
IS	Internal Standard
ISO/IEC	International Standards Organization/International Electrotechnical Commission
KD	Kuderna Danish
LCS	Laboratory Control Sample
LD	Laboratory Duplicate

<u>TERM</u>	<u>DEFINITION</u>
LFB	Laboratory Fortified Blank
LFM	Laboratory Fortified Matrix
LIMS	Laboratory Information Management System
LLRW	Low Level Radioactive Waste
LQAP	Laboratory Quality Assurance Plan
LRB	Laboratory Reagent Blank
LSC	Liquid Scintillation Counting
LUFT	Leaking Underground Fuel Tank
LUST	Leaking Underground Storage Tank
MAPEP	Mixed Analyte Performance Evaluation Program
MCAWW	Methods for Chemical Analysis of Waters and Wastes
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
MDL	Method Detection Limit
MEK	Methyl Ethyl Ketone (2-Butanone)
MIBK	Methyl Isobutyl Ketone
MSA	Method of Standard Additions
MSD	Matrix Spike Duplicate
MSDS	Material Safety Data Sheet
MTBE	Methyl tert-butyl ether
N/A	Not applicable
NIST	National Institute of Standards
NCR	Nonconformance Report
ND	Non Detect
NEIC	National Enforcement and Investigations Center
NELAC	National Environmental Laboratory Accreditation Conference

<u>TERM</u>	<u>DEFINITION</u>
NELAP	National Environmental Laboratory Accreditation Program
NEPA	National Environmental Policy Act
NFESC	Naval Facilities Engineering Service Center
NIRP	Navy Installation Restoration Program
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
NVLAP	National Voluntary Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PARCC	Precision, Accuracy, Representativeness, Completeness, Comparability
PBMS	Performance Based Measurement System
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
PEG	Polyethylene Glycol
PEL	Permissible Exposure Limit
PETN	Pentaerthrite tetranitrate
PID	Photoionization Detector
PM	Project Manager
PNA	Polynuclear Aromatic Hydrocarbon
PQL	Practical Quantitation Limit
psi	pounds per square inch
PT	Proficiency Testing
PTFE	Polytetrafluoroethylene
QA	Quality Assurance
QAPjP	Quality assurance project plan

<u>TERM</u>	<u>DEFINITION</u>
QASS	Quality Assurance Summary Sheet
QC	Quality Control
QIP	Quench Indicating Parameter
r^2	Correlation Coefficient
RCRA	Resource Conservation and Recovery Act
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RFP	Request for Proposal
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	Reporting Limit
ROI	Region of Interest
RPD	Relative Percent Difference
RPM	Revolutions Per Minute
RRT	Relative Retention Time
RSD	Relative Standard Deviation
RSO	Radiation Safety Officer
RT	Retention Time
RTW	Retention Time Window
TNI	The NELAC Institute
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SMSD	Statistical Minimum Significant Difference
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCC	System Performance Check Compound
SPLP, SLP	Synthetic Precipitation Leaching Procedure

<u>TERM</u>	<u>DEFINITION</u>
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TCMX	Tetrachlorometaxylene
TCL	Target Compound List
TDS	Total Dissolved Solids
TIC	Tentatively Identified Compound
TLV	Threshold Limit Value
TNI	The NELAC Institute
TOC	Total Organic Carbon
TPH	Total petroleum hydrocarbon
TPU	Total Propagated Uncertainty
TRPH	Total Recoverable Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility
TSS	Total Suspended Solids
TVPH	Total Volatile Petroleum Hydrocarbons
USACE	United States Army Corp of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WET	Waste Extraction Test
ZHE	Zero Headspace Extraction

14.3 SYMBOLS

LENGTH

um

DEFINITION

micrometer

SYNONYM

10^{-6} meter

mm

millimeter

10^{-3} meter

cm

centimeter

0.01 meter

dm

decimeter

0.1 meter

m

meter

SYNONYM

WEIGHT

pg

DEFINITION

picogram

10^{-12} gram

ng

nanogram

10^{-9} gram

ug

microgram

10^{-6} gram

mg

milligram

10^{-3} gram

g

gram

kg

kilogram

10^3 gram

VOLUME

uL

DEFINITION

microliter

SYNONYM

10^{-6} Liter

mL

milliliter

10^{-3} Liter

dL

deciliter

0.1 Liter

L

Liter

CONCENTRATION

ng/uL

DEFINITION

nanograms per microliter

ug/L

micrograms per liter

ug/kg

microgram per kilogram

ug/g

microgram per gram

ug/mL

microgram per milliliter

mg/kg

milligram per kilogram

mg/L

milligram per liter

ug/m³

microgram per cubic meter

ppb

part per billion

ppm

part per million

TIME

s or sec
m or min
h

DEFINITION

second
minute
hour

SYNONYM

1/60 minute
60 seconds, 1/60 h
60 minutes

14.

TEMPERATURE

°C

°F

° K

DEFINITION

Degrees Celsius
Degrees Fahrenheit
Degrees Kelvin

ACTIVITY

Bq
Ci
dpm

DEFINITION

Bequerels
Curie
Disintegrations per minute

SYNONYM

Disintegration/s
 3.7×10^{10} Bq

ELECTRICAL

V

A

EV

F

Ω

S or mho

W

DEFINITION

Volt
Ampere
Electron Volt
Farad
Ohm
Siemens
Watt

PREFIXES

tera
giga
mega
kilo
hecto
deca
deci
centi
milli
micro
nano
pico
femto

NUMERIC AMOUNT

10^{12}
 10^9
 10^6
 10^3
 10^2
10
0.1
 10^{-2}
 10^{-3}
 10^{-6}
 10^{-9}
 10^{-12}
 10^{-15}

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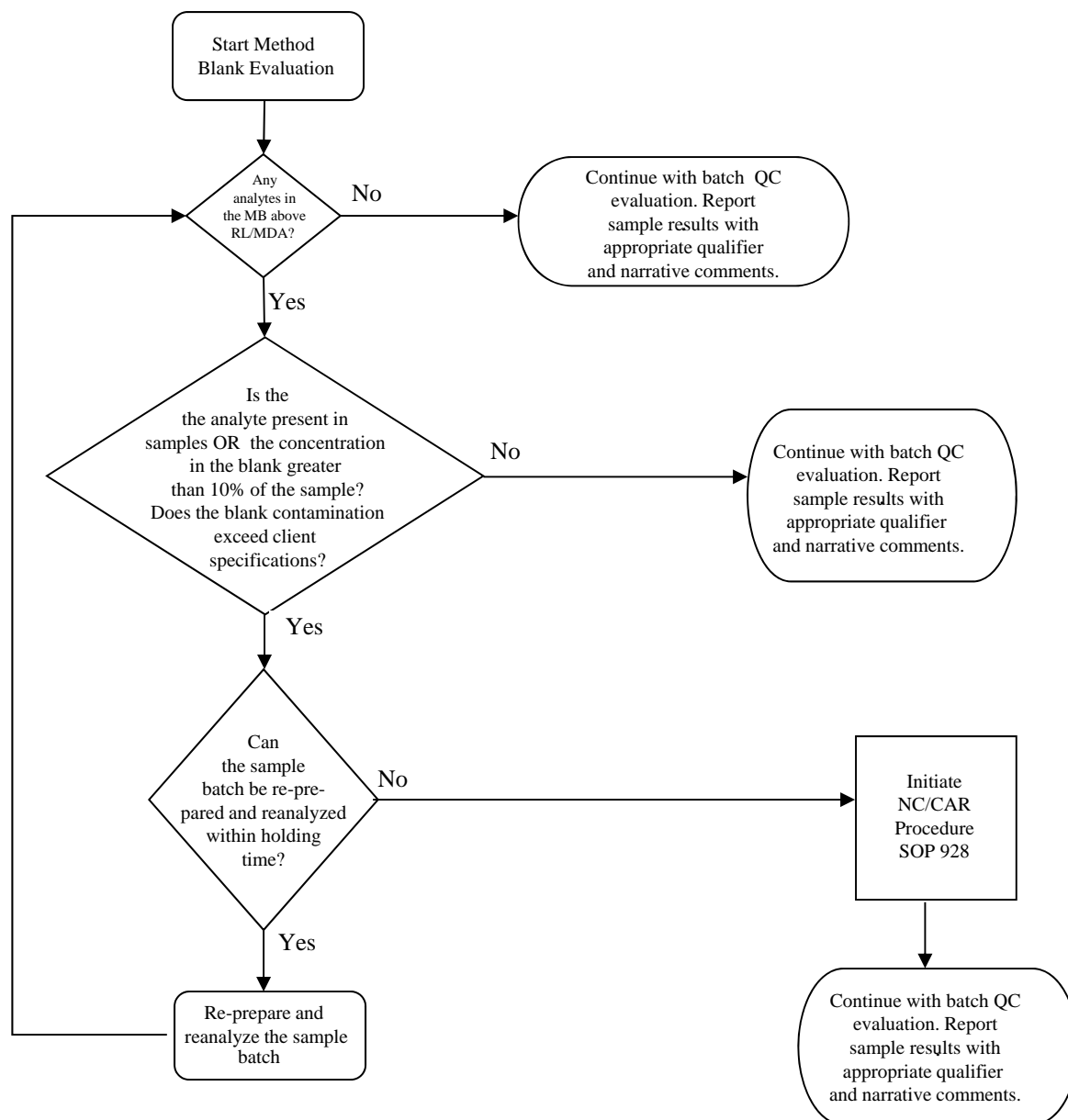
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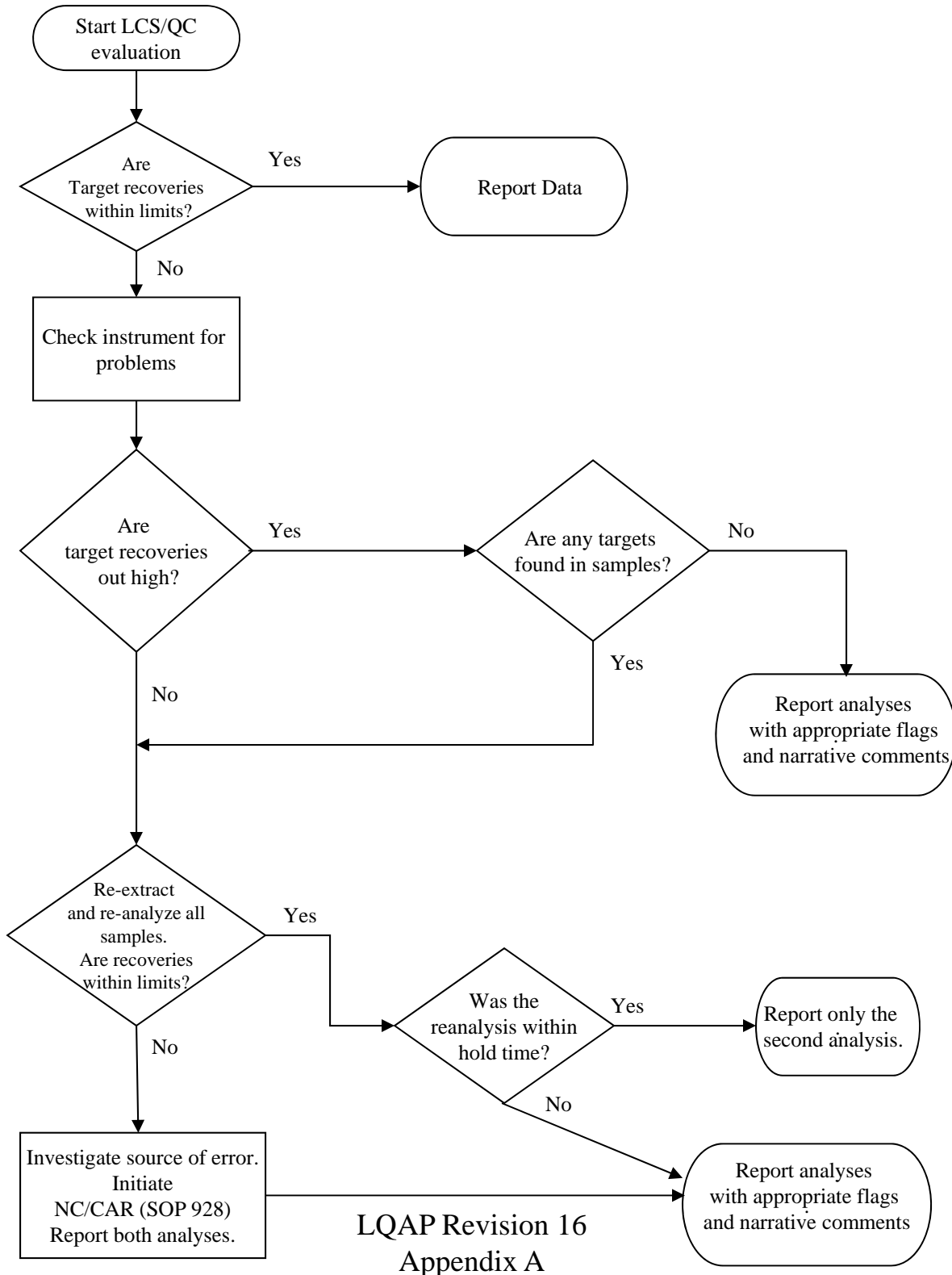
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Method Blank Acceptability

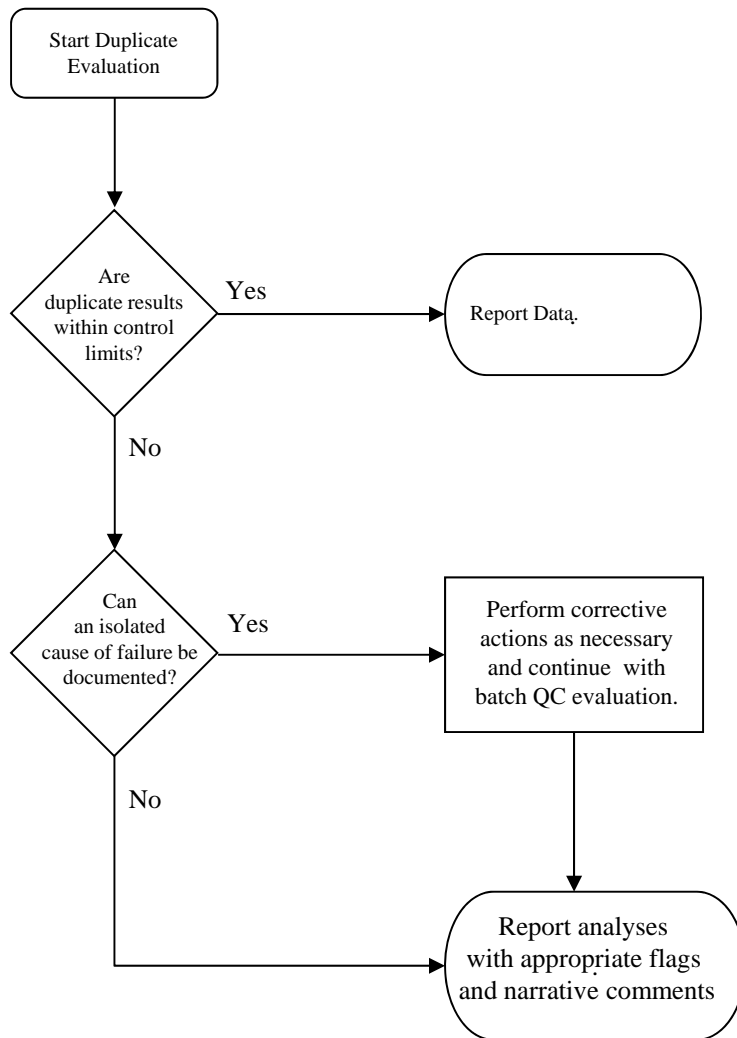


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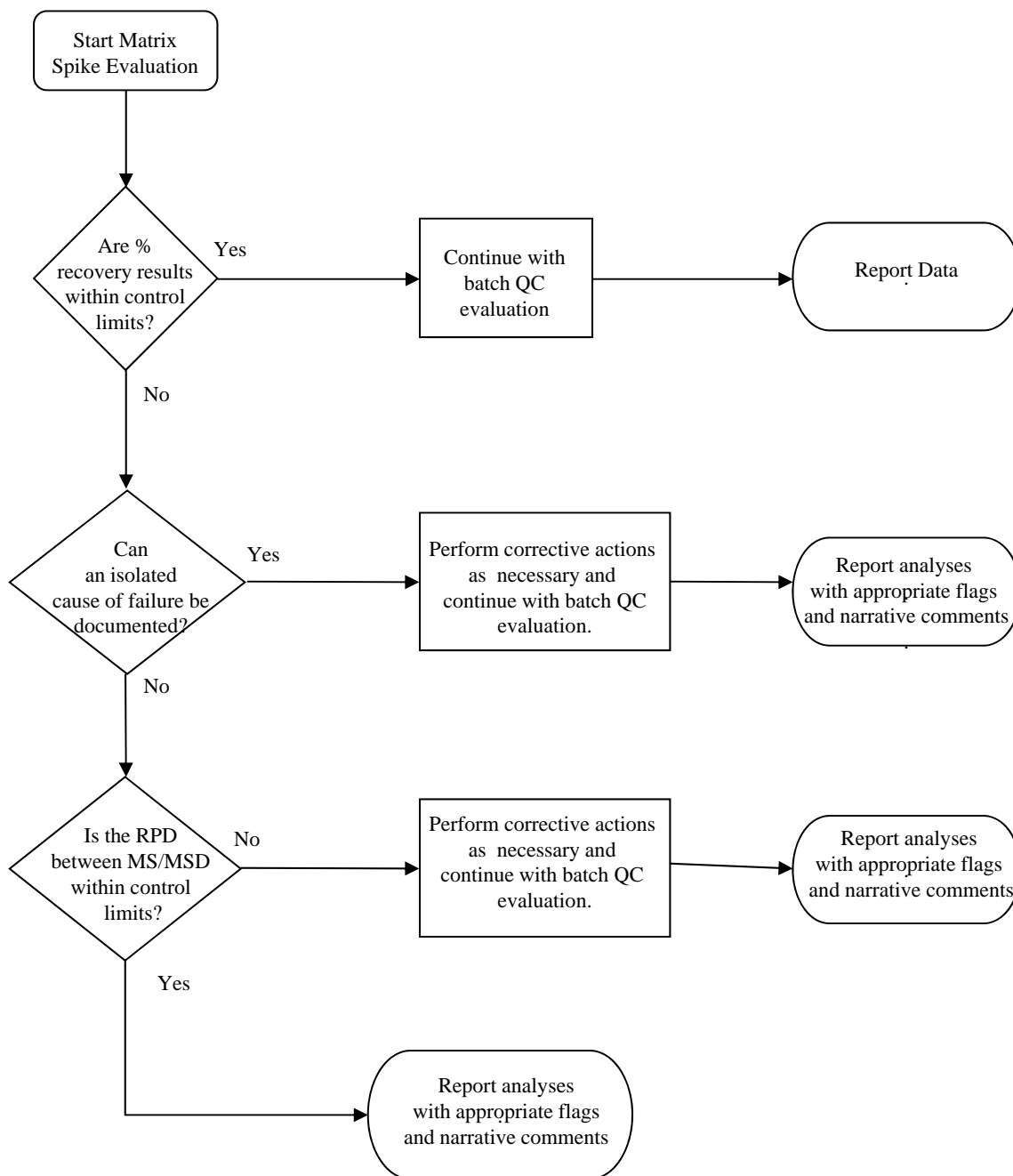


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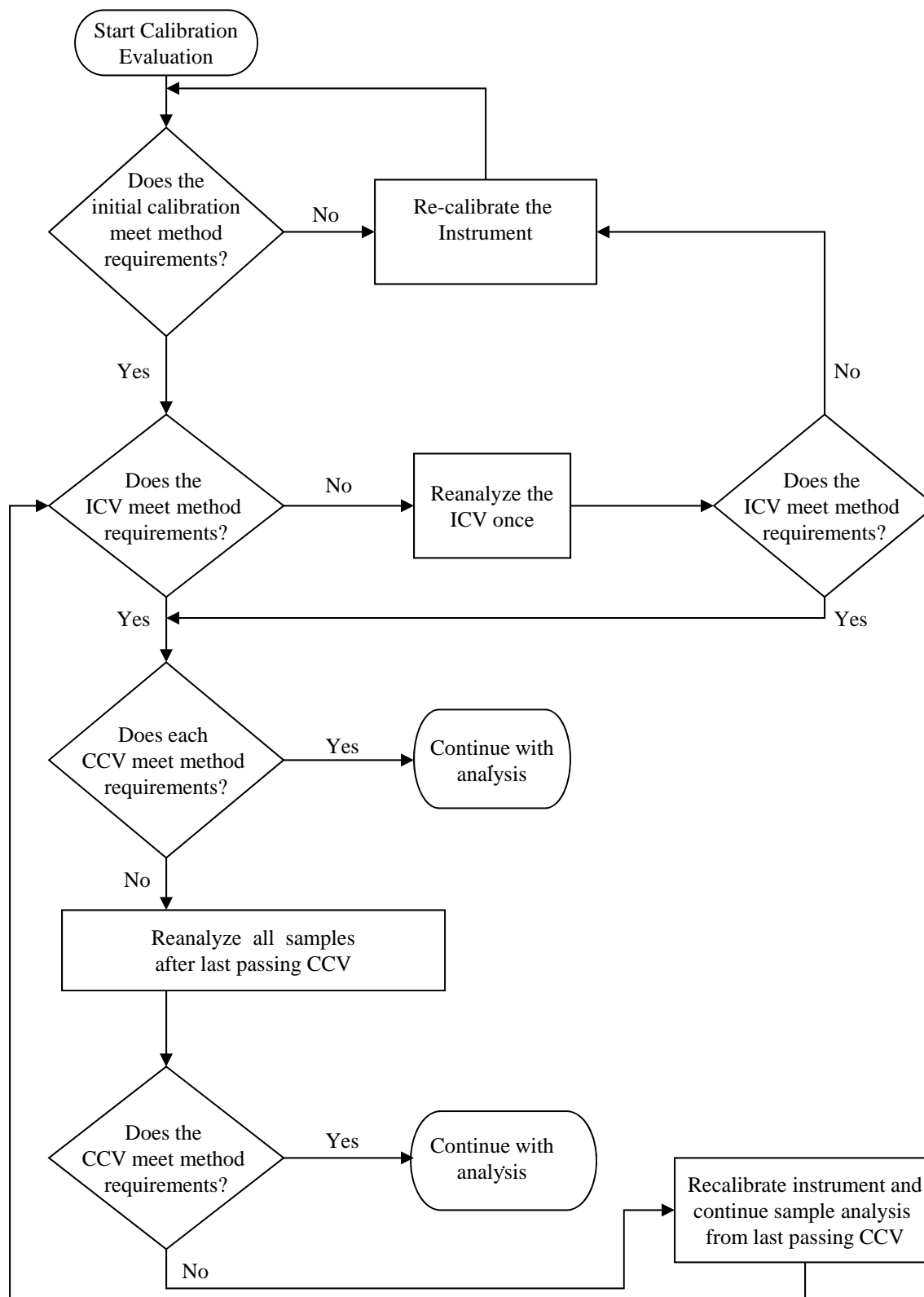
Matrix Duplicate Acceptability



Matrix Spike/Matrix Spike Duplicate Acceptability

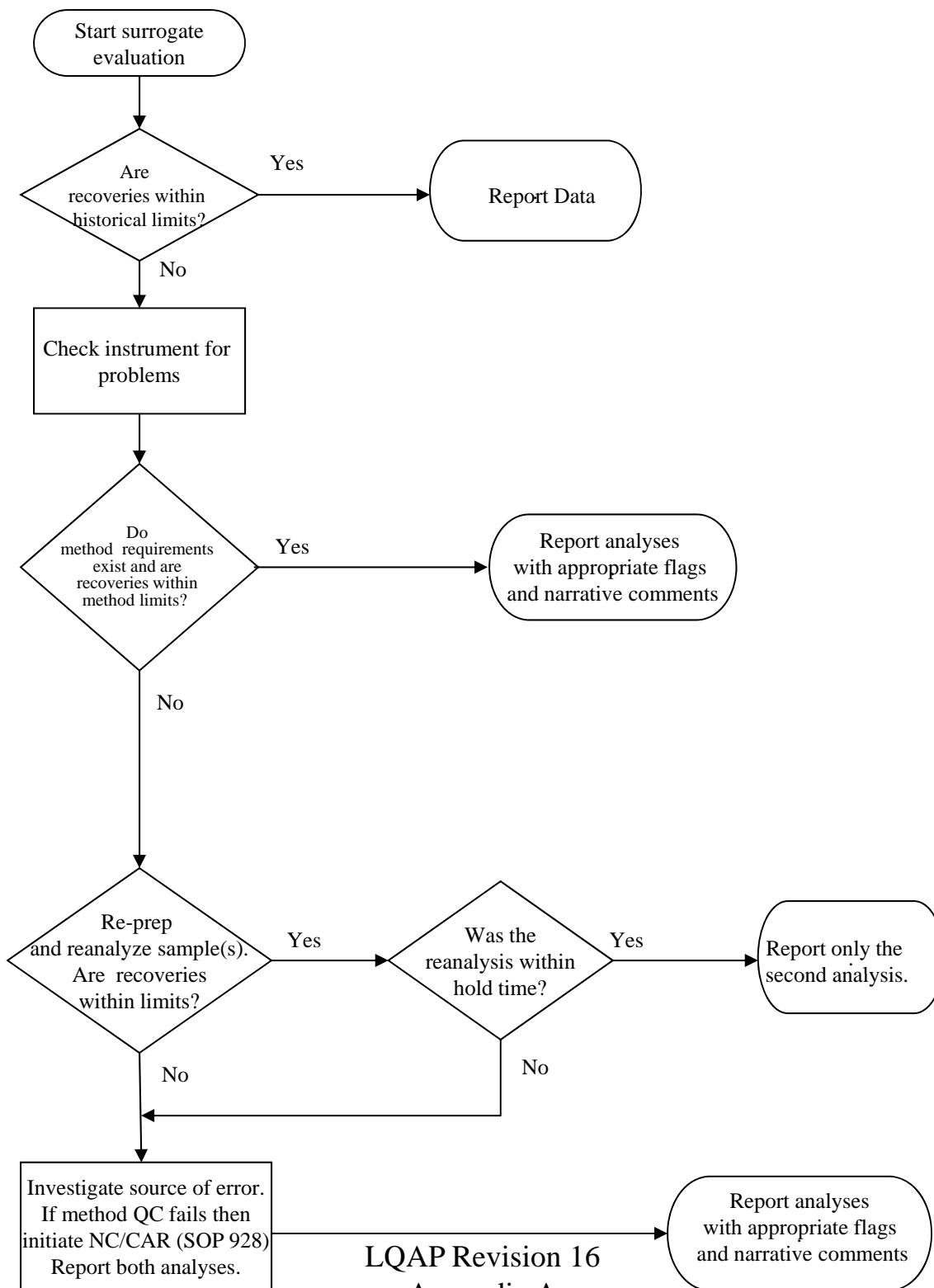


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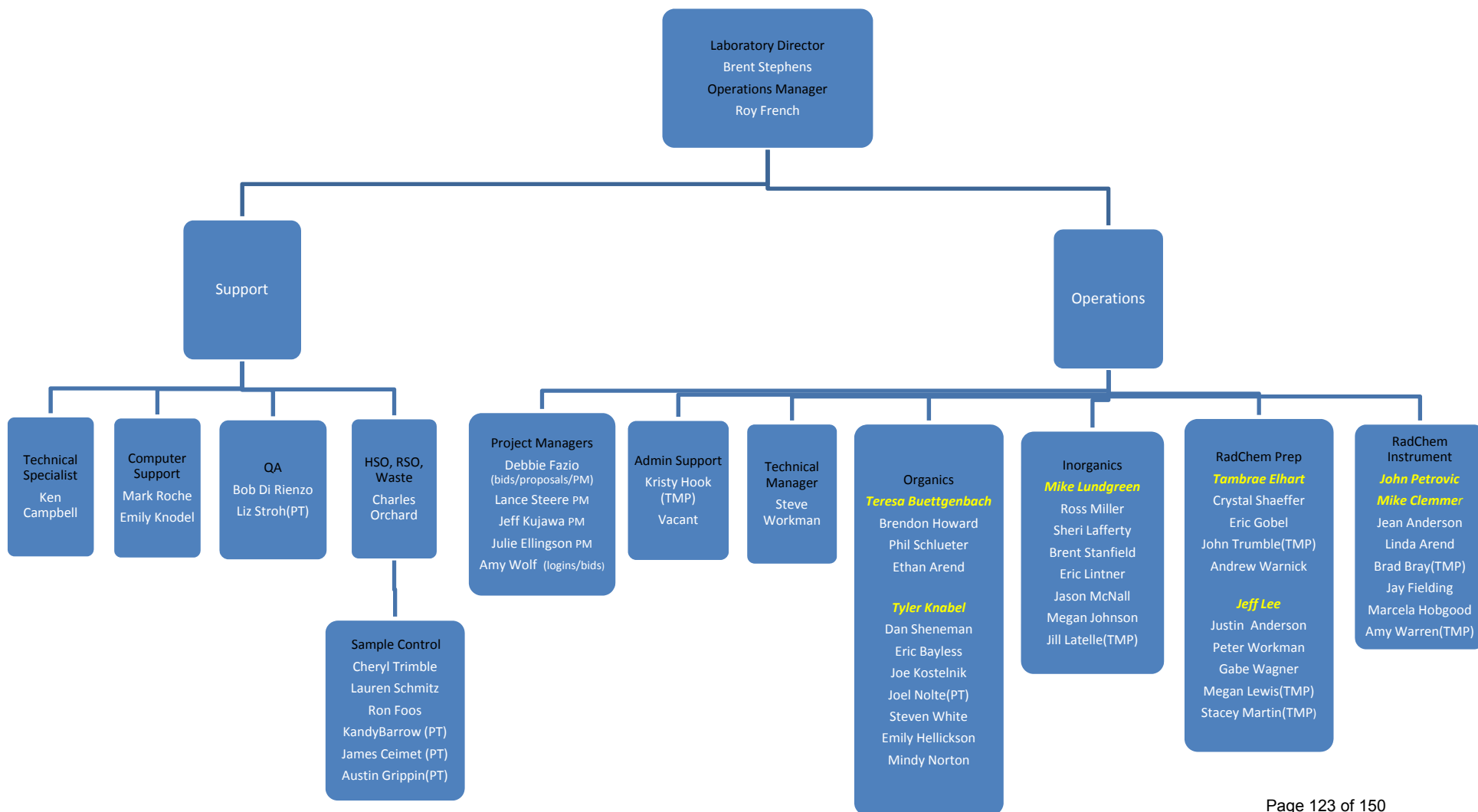


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Appendix A

Surrogate – Chemical Yield - Tracer Acceptability



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Appendix A





Sample Handling Guidelines

Fort Collins, CO

General Inorganic Parameters							
		Water			Soil/Sludge		
Parameters	Method	Preservative	Container	Holding Time	Preservative	Container	Holding Time
Acidity	E305.1	4°C	250 mL / P	14 Days	Matrix Not Applicable		
Alkalinity (Total, Carbonate, Bicarbonate, Hydroxide)	E310.1, SM2320B	4°C	250 mL / P	14 Days	Matrix Not Applicable		
Ammonia	E350.1, SM4500	4°C, H ₂ SO ₄ to pH <2	125 mL / P	28 Days	4°C	4oz WMG	28 Days
Anions: Br, Cl, F, SO ₄ / NO ₂ , NO ₃ , o-PO ₄	E300.0, SW9056	4°C	125 mL / P	28 Days / 48 Hours	4°C	4oz WMG	28 D / 48 H from Prep
Chloride	E325.3	4°C	125 mL / P	28 Days	4°C	4oz WMG	28 Days from Prep
Fluoride	E340.2, SM4500, SW9214	4°C	125 mL / P	28 Days	4°C	4oz WMG	28 Days from Prep
Nitrite	E354.1	4°C	125 mL / P	48 Hours	4°C	4oz WMG	48 Hours from Prep
Chromium VI (Hexavalent Cr)	SW7196A(aq, so), SW7196A/3060A (so)	4°C	125 mL / P	24 Hours	4°C	4oz WMG	24 Hours from Prep
Cyanide (Total)	E335.2, SW9010B, SW9013B, SW9014	4°C, NaOH to pH >12	125 mL / P	14 Days	4°C	4oz WMG	14 Days
Cyanide (Amenable to Chlorination)	E335.2, SW9010B, SW9013B, SW9014	4°C, NaOH to pH >12	125 mL / P	14 Days	Matrix Not Applicable		
Cyanide (Weak and Dissociable)	SM4500	4°C, NaOH to pH >12	125 mL / P	14 Days	4°C	4oz WMG	14 Days
Nitrate + Nitrite as N	E353.2	4°C, H ₂ SO ₄ to pH <2	125 mL / P	28 Days	4°C	4oz WMG	28 Days
Oxyanions (bromate, chlorate, chlorite, iodate)	SW8321	4°C, 1 µL 5% EDA/1 mL sample	40 mL / TLC-Amb G	14 Days	Matrix Not Applicable		
Perchlorate	E314.0, SW9058, SW6850, E331.0, DoD Handbook	4°C, 1/3 headspace	250 mL / P	28 Days	4°C	4oz WMG	28 Days
Phosphorous, Total	E365.2, SM4500	4°C, H ₂ SO ₄ to pH <2	125 mL / P	28 Days	4°C	4oz WMG	28 Days
Phosphate, Ortho	E365.2, SM4500	4°C	125 mL / P	48 Hours	4°C	4oz WMG	48 Hours from Prep
pH	E150.1, SW9040, SW9045	4°C	125 mL / P	4 Days from Receipt	4°C	4oz WMG	4 Days from Receipt
Solids, Dissolved (TDS)	E160.1	4°C	250 mL / P	7 Days	Matrix Not Applicable		
Solids, Suspended (TSS)	E160.2	4°C	250 mL / P	7 Days	Matrix Not Applicable		
Solids, Total (TS)	E160.3	4°C	250 mL / P	7 Days	Matrix Not Applicable		
Solids, Volatile (TVS)	E160.4	4°C	250 mL / P	7 Days	Matrix Not Applicable		
Specific Conductance	E120.1, SW9050, SM2510B	4°C	125 mL / P	4 Days from Receipt	Matrix Not Applicable		
Sulfide	E376.1 (aq)	4°C, ZnAc, NaOH to pH >9	250 mL / P	7 Days	Matrix Not Applicable		
Total Organic Carbon (TOC)	E415.1 (aq), 9060 (aq), Walkley Black (so)	4°C, H ₂ SO ₄ to pH<2	125 mL / Amb G	28 Days	4°C	4oz WMG	28 Days
Turbidity	E180.1	4°C	125 mL / P	48 Hours	Matrix Not Applicable		
Metals Parameters							
		Water			Soil/Sludge		
Parameters	Method	Preservative	Container	Holding Time	Preservative	Container	Holding Time
Metals	E200.7, SW6010B, E200.8, SW6020A	4°C, HNO ₃ to pH<2	250 mL / P	6 Months	4°C	4oz WMG	6 Months
Mercury	E245.1, SW7470 (aq), SW7471 (so)	4°C, HNO ₃ to pH<2	250 mL / P	28 Days	4°C	4oz WMG	28 Days
Hardness	Calculation from Ca & Mg Results	4°C, HNO ₃ to pH<2	250 mL / P	6 Months	Matrix Not Applicable		
Sodium Adsorption Ratio (SAR)	Calculation from Ca, Mg, & Na Results	4°C, HNO ₃ to pH<2	250 mL / P	6 Months	Matrix Not Applicable		
Organic Parameters							
		Water			Soil/Sludge		
Parameters	Method	Preservative	Container	Holding Time*	Preservative	Container	Holding Time*
Chlorinated Herbicides	SW8151A	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
EDB and/or DBCP	8260	4°C, HCl to pH<2, ZH	3 x 40 mL / V-TLS	14 Days	Matrix Not Applicable		
Explosives	SW8330A, SW8330B, SW8332, SW8321	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
Glycols (ethylene and propylene)	SW8015D	4°C	3 x 40 mL / V-TLS	7 / 14 Days	4°C	4oz WMG / TLC	14 Days
Lipids	SOP 672	Matrix Not Applicable			Frozen	8oz WMG / TLC	28 Days
Methane, Ethane, Ethene	RSK175	4°C, HCl to pH<2, ZH	3 x 40 mL / V-TLS	14 Days	Matrix Not Applicable		
Moisture	ASTM 2216	Matrix Not Applicable			4°C	4oz WMG / TLC	14 Days
Organochlorine Pesticides	E608, SW8081A	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
Organophosphorous Pesticides	SW8141	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
PCBs	E608, SW8082	4°C	1000 mL / TLC-Amb G	None	4°C	4oz WMG / TLC	None
Polynuclear Aromatic Hydrocarbons	SW8270D, SW8270D-SIM	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
Semivolatile Organics (Base/Neutrals/Acids)	E625, SW8270D , SW8270D-SIM	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
Total Petroleum Hydrocarbons							
TRPH (C8-C40)	FL-PRO	4°C, H ₂ SO ₄ /HCl to pH<2	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG	14 / 40 Days
DRO and/or MO	SW8015M, CAL-LUFT	4°C, H ₂ SO ₄ /HCl to pH<2	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
GRO	SW8015, CAL-LUFT	4°C, H ₂ SO ₄ /HCl to pH<2, ZH	3 x 40 mL / V-TLS	14 Days	4°C	4oz WMG / TLC	14 Days
Oil and Grease	E1664 (aq), SW9071 (so)	4°C, H ₂ SO ₄ /HCl to pH<2	1000 mL / TLC-Amb G	28 Days	4°C	4oz WMG	28 Days
Volatile Organics	E524.2, E624, SW8260B	4°C, HCl to pH <2, ZH	3 x 40 mL / V-TLS	14 Days	4°C	4oz WMG / TLC	14 Days
BTEx and/or MTBE	E524.2, E624, SE8260B	4°C, HCl to pH <2, ZH	3 x 40 mL / V-TLS	14 Days	4°C	4oz WMG / TLC	14 Days
Volatile Organics	5035A/SW8260B	Matrix Not Applicable			4°C	3 ENCORE Sampler	14 Days or Freezing
Volatile Organics	5035A/SW8260B	Matrix Not Applicable			4°C / sodium bisulfate	1 Tetra Core Sampler	14 Days

*Where two holding times are provided, the first value indicates holding time to extraction, the second value indicates holding time between extraction and analysis.



Sample Handling Guidelines

Fort Collins, CO

RCRA Characterization							
		Water			Soil/Sludge		
Parameters	Method	Preservative	Container	Holding Time*	Preservative	Container	Holding Time*
Corrosivity (pH)	SW9040B, SW9045C	4°C	125 mL / P, G	4 Days from Receipt	4°C	4oz WMG	4 Days from Receipt
Ignitability	E1010, ASTM 93-80	4°C	1000 mL / TLC-Amb G	7 Days	4°C	4oz WMG / TLC	14 Days
Paint Filter Liquids	SW9095A	N/A	1000 mL / P, G	N/A	N/A	8oz WMG, P	N/A
Reactivity - Cyanide & Sulfide	SW846 7.3	4°C	125 mL / P, G	14 Days	4°C	4oz WMG	14 Days
TCLP / SPLP Parameters	Method	Preservative	Container	Holding Time Collection to Leaching / Leaching to Prep / Prep to Analysis	Preservative	Container	Holding Time Collection to Leaching / Leaching to Prep / Prep to Analysis
Metals	SW1311 / SW1312 / SW6010B	4°C	1000 mL / P	180D / NA / 180D	4°C	4oz WMG	180D / NA / 180D
Mercury	SW1311 / SW1312 / SW7470	4°C	1000 mL / P	28D / NA / 28D	4°C	4oz WMG	28D / NA / 28D
Chlorinated Herbicides	SW1311 / SW1312 / SW8151A	4°C	1000 mL / TLC-Amb G	14D / 7D / 40D	4°C	8oz WMG	14D / 7D / 40D
Organochlorine Pesticides	SW1311 / SW1312 / SW8081A	4°C	1000 mL / TLC-Amb G	14D / 7D / 40D	4°C	8oz WMG	14D / 7D / 40D
Organophosphorous Pesticides	SW1311 / SW1312 / SW8141A	4°C	1000 mL / TLC-Amb G	14D / 7D / 40D	4°C	8oz WMG	14D / 7D / 40D
Semivolatiles	SW1311 / SW1312 / SW8270D	4°C	1000 mL / TLC-Amb G	14D / 7D / 40D	4°C	8oz WMG	14D / 7D / 40D
Volatiles	SW1311 / SW1312 / SW8260B	4°C	1000 mL / TLC-Amb G	14D / NA / 14D	4°C	4oz WMG	14D / NA / 14D

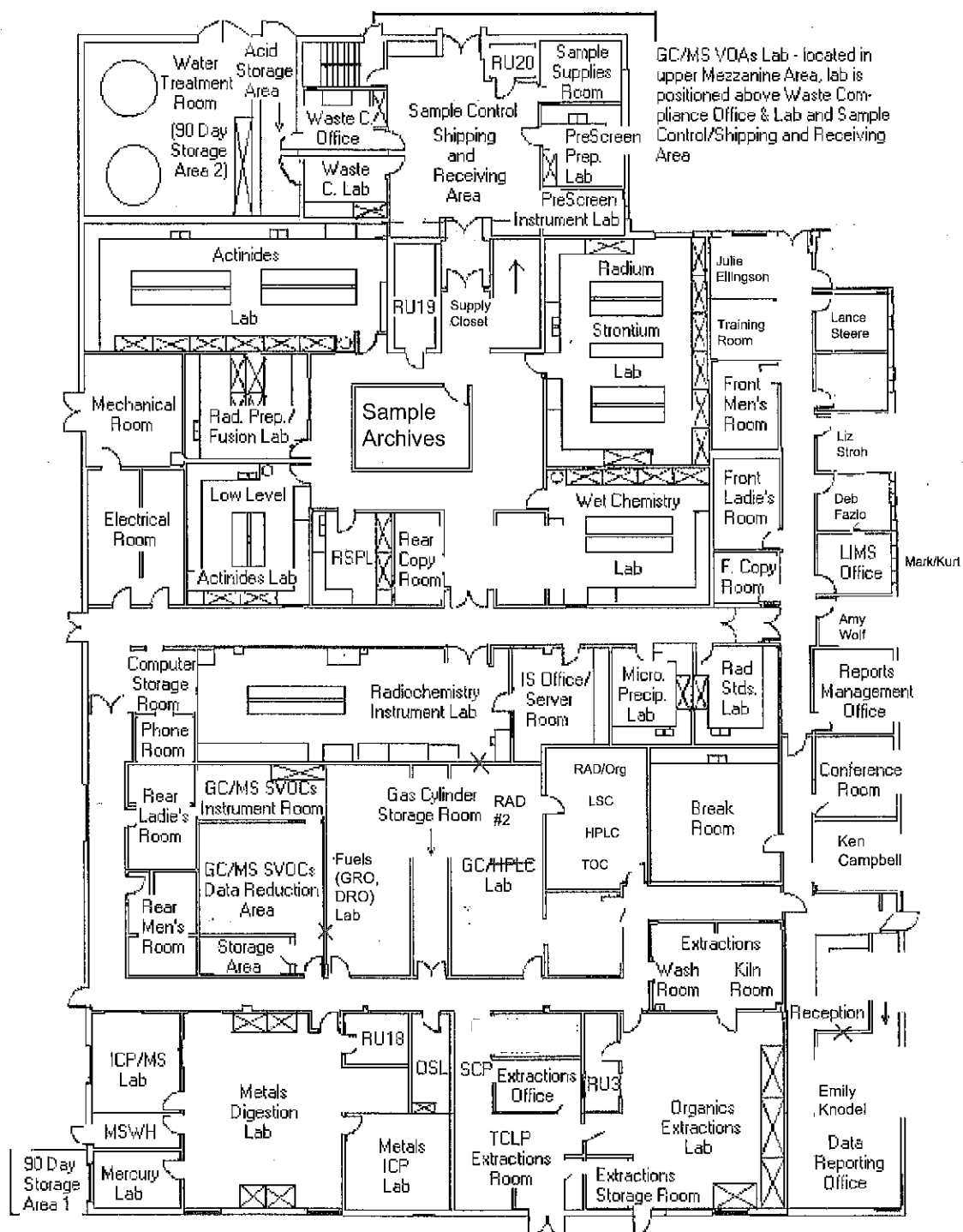
*Where two holding times are provided, the first value indicates holding time to extraction, the second value indicates holding time between extraction and analysis.

Radiochemistry							
		Water			Soil/Sludge		
Parameters	Method	Preservative	Container	Holding Time	Preservative	Container	Holding Time
Americium-241	ASTM D3972	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Carbon-14	EERF C-01M	N/A	250 mL / Amb G	N/A	N/A	4oz WMG, WMP	N/A
Chlorine-36	ALS SOP 753	N/A	2000 mL / Amb G	N/A	N/A	4oz WMG, WMP	N/A
Curium-244	ASTM D3972	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Gamma Emitters (Stock FANP Library*)	E901.1	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	16oz WMG, WMP	N/A
Gross Alpha/Beta	E900.0, SW9310	HNO ₃ to pH <2	500 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Iodine-129	E902.0	N/A	2000 mL / Amb G	N/A	N/A	4oz WMG, WMP	N/A
Iron-55	RESL Fe-01M	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Lead-210	ALS SOP 704	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Neptunium-237	ASTM D3972	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Nickel-59	ASTM D3972	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Nickel-63	RESL Ni-01M	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Plutonium-238, 239	ASTM D3972	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Plutonium-241	ASTM D3972	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Plutonium-242	ASTM D3972	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Polonium-210	ASTM D3972	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Promethium-147	ALS SOP 758	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Radium, Total Alpha Emitting	E903.0, SW9315	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Radium-226	E903.0	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Radium-226	E903.1, Alpha Spec ALS SOP 701	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Radium-228	E904.0, SW9320	HNO ₃ to pH <2	2000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Radon-222 (Water)	SM 7500-Rn B	N/A, ZH	3 x 40 mL / V-TLS	4 Days	Matrix Not Applicable		
Radon-222 (Air)	E903.1M	N/A	500 mL Tedlar Bag	4 Days	Matrix Not Applicable		
Strontium-89	ASTM D5811	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Strontium-90 (Total Radiostromium)	ASTM D5811	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Technetium-99	EICHRM	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Thorium-228, 230, 232	ASTM D3972	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A
Tritium (H-3)	E906.0	4°C	250 mL / Amb G	6 Months	4°C	8oz WMG	N/A
Uranium-234, 235, 238	ASTM D3972	HNO ₃ to pH <2	1000 mL / P	N/A	N/A	4oz WMG, WMP	N/A

*Fission Activation and Natural Products Library

Acronym Definitions		Preservative	
G - Glass	H - Hours	ALS Laboratory Group 225 Commerce Drive Fort Collins, CO 80524 PH: 970.490.1522 FX: 970.490.1522 www.alsenviro.com	H ₂ SO ₄ - Sulfuric acid
P - Polyethylene	D - Days		HNO ₃ - Nitric acid
Amb - Amber	M - Months		HCl - Hydrochloric acid
WMG; WMP - Wide Mouth Glass or Poly Jar	E - EPA		NaOH - Sodium hydroxide
V-TLC - Glass Vial Teflon-lined Cap	SW - EPA SW846		ZnAc - Zinc acetate
V-TLS - Glass Vial Teflon-lined Septum	SM - Standard Methods		NaHSO ₄ - Sodium bisulfate
ZH - Zero Headspace	ASTM - ASTM International		EDA - Ethylene diamine
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06/12/2012



SCP = Stable Chem. Printing Area

OSL = Organics Standards Laboratory

RSPL = Rad. Sample Prep. Lab

WSS = Warm Sample Storage

MSWH = Metals Satellite Waste Hall

Names_Map4.bmp (6/2/04)

ALS Laboratory Group -- FC

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001 R8	6/7/2011	6/6/2013	Treatment of Quarantined Soils, Aqueous Extracts, and Solid Residues and Cleaning Containers Used To Store Quarantined Sample Materials		CRO
002 R8	12/9/2010	11/30/2014	Laboratory Fume Hood Velocity Monitoring	Reviewed by Charles on 11/30/11	CRO
003 R6	7/9/2010	7/9/2014	Management of Nonradioactive Hazardous Waste		CRO
008 R10	5/21/2012	5/21/2013	Initial Receipt of Radioactive Samples and External Radiation Exposure Rate and Removeable Radioactive Material Contamination Survey of Incoming Radioactive Material Packages	Revised by C. Orchard 5/24/12	CRO
009 R8	4/11/2011	4/10/2013	Incoming Radioactive Material Packages That Exceed Removable Radioactive Material Contamination Limits		CRO
010 R5	5/21/2012	5/21/2013	Survey of Laboratory Areas for Radioactive Contamination	Revised by C. Orchard 5/24/12	CRO
012 R6	7/20/2008	10/4/2012	Contamination Surveys using Portable Survey Meters (Electra, Micro Roentgen)	Reviewed by Orchard 10/4/2010	CRO
015 R6	11/9/2007	10/4/2012	Disposal of Radioactive Waste	Reviewed 10/4/2010 by Orchard - No Revisions Necessary	CRO
016 R7	12/8/2010	10/22/2013	Electron Capture Detector Leak Tests		RTF
017 R6	4/11/2011	4/10/2013	Effluent Monitoring and Release	Reviewed by Orchard 4/10/2011	CRO
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029 R3	5/22/2012	5/22/2013	Calibration and Use of the Berthold LB 1043 AS Hand and Foot Monitors	Reviewed by C. Orchard 5/22/12	CRO
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150 R1	6/9/2011	6/8/2014	Employee Training Records		RPD
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205 R10	12/15/2011	12/14/2014	Preparation of Bottle Orders, Shipping Sample Kits, and Maintaining Inventory of Bottles, Preservatives, and Labels		CRO
210 R7	3/9/2011	12/14/2014	Use and Calibration Verification of Infrared Temperature Guns	Reviewed by Bob D on 12-15-11	CRO
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303 R12	1/13/2012	1/12/2015	Control, Format and Review of Laboratory Logbooks		RPD
305 R11	5/6/2010	4/9/2014	Balance Calibration, Verification and Utilization	Reviewed by Bob and Liz 4-9-12	RPD
306 R5	4/11/2011	4/10/2014	The Use of Significant Figures and Rules For Rounding Numbers	Reviewed by Bob Di Rienzo 3/7/11	RPD
317 R11	4/11/2011	4/10/2014	Removing and Returning Equipment From Service	Reviewed by Bob Di Rienzo 3/7/11	RPD
318 R7	12/8/2010	11/19/2012	Chain-of-Custody		RPD
319 R9	3/8/2011	3/7/2013	Generation and Monitoring of Deionized (DI) Water		RPD
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326 R10	1/10/2012	1/9/2014	Monitoring and Recording Refrigerator and Freezer Temperatures		RPD
329 R10	11/11/2010	11/11/2012	Method Demonstration Procedures: Instrument Detection Limit (IDL), Method Detection Limit (MDL), Detection Limit (DL), and Method and Analyst Demonstration of Capability (DOC)		RPD
334 R7	1/24/2010	1/24/2013	Glassware Cleaning Procedures and Maintenance of Glassware Used in The Organics and Inorganics Departments		RTF
336 R0	12/26/2007	6/11/2014	Representative Laboratory Subsampling - Stable Chemistry	Reviewed on 5-15-12 by Bob - No Changes	RPD
337 R1	9/10/2010	9/10/2012	Organics Calibration Procedures -- Method 8000C		RPD
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406 R16	11/7/2011	11/6/2012	Extractable Petroleum Hydrocarbons Analysis by Gas Chromatography (TEPH, DRO)		RTF
407 R10	8/15/2011	8/14/2012	Organophosphorus Compounds by Gas Chromatography - Methods SW8141A and EPA 614		RTF

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425 R16	4/5/2012	4/5/2013	Analysis of Total Volatile Petroleum Hydrocarbon (TVPH) Gasoline Range Organics (GRO) by Gas Chromatography -- Methods SW8015B, D and CAL-LUFT		RTF
434 R10	8/15/2011	8/14/2012	Analysis of Chlorinated Herbicides by Gas Chromatography - Methods SW 8151A, EPA 615 and EPA 515.1		RTF
438 R12	8/15/2011	8/14/2012	Microextraction and Analysis of EDB and DBCP in Water by Gas Chromatography - Methods EPA 504.1 and SW8011		RTF
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449 R2	3/19/2012	3/19/2013	Determination of Dissolved Gases in Water Samples Using Gas Chromatography with Flame Ionization Detection		RTF
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506 R19	3/18/2011	2/7/2013	Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry, Capillary Column Technique - Methods SW8270D and EPA 625	Reviewed by Bob during internal audit 2-7-12	RTF
511 R9	11/7/2011	11/6/2012	Volatiles Reagent Water Preparation and Blank Analysis		RTF
512 R11	11/7/2011	11/6/2012	Refrigerator Blank Preparation and Analysis		RTF
525 R15	5/4/2012	5/4/2013	Determination of Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry -- Methods SW8260 C and EPA 624	Reviewed by T. Knaebel 4/2012	RTF
526 R8	2/17/2012	2/16/2013	Determination of Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) -- Method 524.2		RTF
600-699 EXTRACTIONS					
603 R12	4/5/2012	4/5/2013	Extraction of Hydrocarbons From Soil and Water Samples		RTF
604 R9	11/7/2011	11/6/2012	Silica Gel Cleanup -- Method SW3630C		RTF
607 R10	11/9/2011	11/8/2012	Extract Concentration Using Kuderna-Danish Apparatus	Reviewed 11/8/11; no revision needed	RTF
608 R13	11/9/2011	11/8/2012	Method for Toxicity Characteristic Leaching Procedure (TCLP) Extraction of Wastes for the Analysis of Volatile Organic Compounds by Zero Headspace Extraction (ZHE) - Method SW1311	Reviewed 11/8/11; no revision needed	RTF
609 R14	1/20/2012	1/19/2013	Method for Toxicity Characteristic Leaching Procedure (TCLP) of Wastes and Soils For The Analysis of Metals and Semivolatile Organics - Method SW1311		RTF
617 R14	4/5/2012	4/5/2013	Continuous Liquid/Liquid Extraction (CLE) -- Method SW3520C		RTF
622 R7	11/7/2011	11/6/2012	Waste Dilution Extraction -- Method SW3580A		RTF
625 R12	4/5/2012	4/5/2013	Soxhlet Extraction -- Method SW3540C		RTF
626 R10	4/5/2012	4/5/2013	Separatory Funnel Liquid-Liquid Extraction -- Method SW3510C		RTF
629 R11	11/7/2011	11/6/2012	Determination of Ignitability by The Pensky-Martens Closed-Cup Tester -- Method SW1010A		RTF
634 R7	4/9/2012	4/9/2013	Sulfur Cleanup -- Method SW3660B	Reviewed by Roy French 4/9/12	RTF
637 R10	11/9/2011	11/8/2012	Concentration and Solvent Exchange by The Nitrogen Blowdown Technique	Reviewed 11/8/11; no revision needed	RTF

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640 R9	12/15/2011	12/14/2012	Extraction and Gravimetric Determination of Hexane Extractable Material in Solids -- Method SW9071B		RTF
641 R9	6/9/2011	6/8/2012	Gel Permeation Chromatography (GPC) Cleanup -- Method SW3640A		RTF
642 R9	6/15/2010	6/17/2012	Gravimetric Determination of Percent Moisture For Solid Matrices	Released without revision 6/17/11	RTF
648 R8	11/7/2011	11/6/2012	Florisil Cleanup -- Method SW3620B		RTF
651 R10	4/5/2012	4/5/2013	Sulfuric Acid Cleanup -- Method SW3665A		RTF
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663 R8	4/5/2012	4/5/2013	Monitoring TCLP Tumbler Revolutions and Room Temperature		RTF
664 R9	4/5/2012	4/5/2013	Extraction and Derivatization of Samples For Herbicide Analysis by Gas Chromatography -- Methods SW8151A, EPA 615 and EPA 515.1		RTF
666 R8	6/15/2012	6/15/2013	Waste Extraction Test (Cal-WET) For The Analysis of Metals and Semivolatile Organic Compounds		RTF
668 R5	11/9/2011	11/8/2012	Synthetic Precipitation Leaching Procedure (SPLP) For The Analysis of Metals and Semivolatile Organics -- Method SW1312	Reviewed 11/8/11; no revision needed	RTF
669 R5	11/9/2011	11/8/2012	Method for Synthetic Precipitation Leaching Procedure (SPLP) Extraction of Samples For The Analysis of Volatile Organic Compounds by Zero Headspace Extraction (ZHE) -- Method SW1312	Reviewed 11/8/11; no revision needed	RTF
670 R14	7/8/2010	7/27/2012	Analysis of Total Organic Carbon By Methods EPA 415.1, SW9060A, and SM5310 C	Review by Roy 7/27/11	RTF
671 R10	12/15/2011	12/14/2012	Determination of n-Hexane Extractable Material (HEM) and Silica Gel Treated Hexane Extractable Material (SGT-HEM) by Extraction and Gravimetry For Aqueous Samples -- Methods EPA 1664A and SW9070A	Reviewed 8/14/2010	RTF
672 R5	12/15/2011	12/14/2012	Extraction and Gravimetric Determination of Lipids in Tissues	Reviewed 11/8/11 - no revision needed	RTF
673 R3	8/26/2011	8/25/2012	Extraction of Polychlorinated Biphenyl Wipes Using Ultrasonic Bath Agitation		RTF
674 R1	4/11/2011	4/9/2013	Gravimetric Determination of Magnesium Oxide Reactivity	Review by Operations	RTF
700-799 RADIOCHEMISTRY					
700 R12	5/8/2011	8/31/2012	Preparation of Environmental And Drinking Water Samples For Tritium Analysis -- Method EPA 906.0		RXG
701 R1	8/4/2010	3/12/2013	Determination of Ra-226 in Aqueous Matrix by Alpha Spectrometry	This SOP is not online for offering this analysis to clients as on 3-12-12	RXG
702 R20	12/28/2011	7/31/2012	Preparation of Gross Alpha and Gross Beta in Environmental Matrices -- EPA Method 900.0 and SW-846 Method 9310		RXG
703 R9	12/27/2011	7/31/2012	Sample Prescreening		RXG
704 R10	12/28/2011	12/27/2012	Analysis of Tritium and Other Beta-Emitting Nuclides by Liquid Scintillation Counting -- Method EPA 906.0		RXG
707 R11	12/30/2011	12/29/2012	Radiostromium in Water, Soil, Filters, Vegetation and Hazardous Waste Samples		RXG
708 R9	12/8/2010	4/11/2013	Calculation of Radioanalytical Results	Reviewed on 4-11-11 by Renee Gallegos and Liz Stroh	RXG
709 R7	4/22/2011	10/30/2012	Verification and Validation of Radioanalytical Software		RXG
710 R0	6/29/2011	8/31/2012	Reagent and Standard Preparation for RadioChemistry		RXG

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711 R8	12/30/2011	8/31/2012	Preparation of Water and Solid Samples for the Analysis of Polonium-210 -- EML Procedure Po-01		RXG
712 R15	12/30/2011	12/29/2012	Determination of Total Alpha-Emitting Radium Isotopes in Drinking Water -- EPA Method 903.0 and SW9315		RXG
713 R12	6/17/2011	6/16/2012	Analysis of Gamma Emitting Radionuclides by Gamma Spectrometry -- Method EPA 901.1		RXG
714 R12	3/19/2010	7/31/2012	Analysis of Alpha Emitting Radionuclides by Alpha Spectrometry	Review by Renee on 4/22/11	RXG
715 R16	3/28/2012	9/30/2012	Review of Radioanalytical Data		RXG
724 R11	12/30/2011	9/30/2012	Analysis of Alpha and Beta Emitting Radionuclides by Gas Flow Proportional Counter -- EPA Method 900.0		RXG
726 R7	1/19/2012	1/18/2013	Determination of Lead -210 in Soils, Sediments, and Waters		RXG
733 R8	6/17/2011	9/30/2012	Checking the pH of Aqueous Samples in the Radiochemistry Department	Re-released with minor revisions - no rev # change	RXG
736 R0	6/10/2011	10/30/2012	Representative Laboratory Subsampling - Radiochemistry	Reviewed 6/10/2011 - no revision necessary	RPD
739 R10	7/9/2010	11/30/2012	Preparation of Samples for Analysis by Gamma Spectroscopy	Reviewed by Renee 7/26/11	RXG
746 R10	2/9/2012	4/30/2013	Determination of Radium-228 According to EPA Method 904.0 or SW846 Method 9320, With Modifications		RXG
748 R6	1/13/2012	1/12/2013	Preparation of Liquid and Solid Samples For The Analysis of Fe-55		RXG
749 R1	5/1/2012	5/1/2013	DETERMINATION OF RADIUM-228 VIA CHEMICAL SEPARATION OF RADIUM AND ACTINIUM.		RXG
751 R4	1/30/2012	1/29/2013	Actinides -- Americium/Curium Separation -- Purification by TRU and TEVA Spec Column		RXG
753 R4	6/24/2011	6/23/2012	Determination of Radioactive Iodine in Environmental Samples -- EPA Method 902.0		RXG
754 R7	4/9/2012	6/30/2012	Preparation of Solid Samples For Tritium Analysis by Microwave Oven		RXG
755 R10	1/26/2012	1/25/2013	Determination of Technetium-99 in Solid and Water/Aqueous Samples		RXG
758 R4	4/22/2011	8/31/2012	Determination of Promethium-147 in Water		RXG
760 R8	1/30/2012	1/29/2013	Preparation of Solid Samples by Potassium Pyrosulfate Fusion		RXG
765 R6	1/30/2012	1/29/2013	Separation and Analysis of Neptunium-237 in Environmental Matrices		RXG
766 R8	4/11/2011	4/10/2013	Witnessing the Addition of Carriers, Tracers and Standards in Radiochemistry Samples		RXG
767 R8	1/26/2012	1/25/2013	Sample Preparation: Filter Leaching		RXG
772 R6	5/9/2011	7/31/2012	Preparation of Water and Soil Samples for the Analysis of Carbon-14 Using Potassium Permanganate -- EPA EERF Method C-01		RXG
773 R12	1/30/2012	1/29/2013	Total Dissolution of Solids for the Radiochemical Determination of Actinides and Other Non-Volatile Radionuclides		RXG
774 R3	4/9/2012	3/31/2013	Nickel 59, 63 in Water and Soil Samples Using Eichrom Nickel Resin		RXG
776 R13	1/30/2012	3/31/2013	Preparation of Water Samples for Actinides		RXG
777 R11	4/9/2012	5/30/2013	Actinides - Thorium, Americium and Plutonium Sequential Separation by Anion Exchange		RXG
778 R14	1/19/2012	1/18/2013	Actinides - Uranium, Plutonium, and Americium/Curium (Partial) Sequential Separation by Ion Exchange		RXG
780 R10	1/30/2012	4/30/2013	Actinides - Americium/Curium Separation -- Purification by Methanolic Anion Exchange and TEVA Spec Column		RXG

SOP	Active Date	Schedule Date	Title	Notes	Author
783 R9	12/9/2010	6/30/2012	Radium-226 in Aqueous and Soil Matrices -- Radon Emanation Technique--Method EPA 903.1		RXG
785 R5	3/28/2012	3/28/2013	Total Activity in Environmental Matrices		RXG
786 R6	3/30/2012	3/30/2013	Gross Alpha in Water by Coprecipitation Method -- SM7110C		RXG
791 R6	4/9/2012	4/9/2013	Preparation of Silica Gel Samples For Tritium Analysis	Reviewed 4-9-12	RXG
799 R4	6/17/2011	9/30/2012	Determination of Radon-222 in Water Samples by Liquid Scintillation Counting - SM 7500-Rn B and ASTM D5072-92		RXG
800-899 METALS					
806 R15	5/4/2012	5/4/2013	Digestion of Waters, Soils and Wastes for Metals Analysis -- Methods SW3005A, SW3010A, SW3050B, EPA 200.2 and CLP SOW ILMO3.0 and ILMO4.0		RTF
807 R13	8/15/2011	8/14/2012	Determination of Metals by Inductively Coupled Plasma Emission Spectroscopy - Method EPA 200.7 (Trace ICAP)		RTF
812 R15	8/26/2011	8/25/2012	Preparation and Determination of Mercury by Cold Vapor Atomic Absorption Spectroscopy -- Methods SW7470A, SW7471A, EPA 245.1, ILMO3.0, ILMO4.0		RTF
827 R9	2/6/2012	2/5/2013	Determination of Elements by Inductively Coupled Plasma Mass Spectrometry -- Methods EPA 200.8 AND SW6020A		RTF
834 R8	8/26/2011	8/25/2012	Determination of Metals by Inductively Coupled Plasma Emission Spectroscopy -- Method SW6010B (Trace ICAP)		RTF
900-999 QUALITY ASSURANCE					
901 R10	3/13/2012	3/13/2015	Verification of Laboratory Weights		RPD
923 R11	1/10/2011	1/10/2013	Verification of Thermometers		RPD
926 R12	10/12/2010	10/12/2012	Controlled Document Management		RPD
927 R1	9/10/2010	9/10/2012	Preparation and Review of Standard Operating Procedures		RPD
928 R9	6/11/2010	6/11/2014	Non-Conformance and Corrective Action Procedures	Reviewed by Bob on 5-15-12 - No Changes	RPD
937 R11	12/30/2011	12/29/2014	Internal Audits	See CE-QA001	RPD
939 R4	1/24/2010	12/13/2013	Manual Re-Integration Policy and Procedures	Reviewed by Bob 12/13/11	RPD
997 R0	6/10/2011	6/9/2014	Client Communication		RPD
998 R0	6/9/2011	6/8/2014	Estimation of Uncertainty of Analytical Measurements for Stable Chemistry		RPD
999 R0	6/7/2011	6/6/2014	Minimum Validation Protocol and Documentation Requirements for New and Modified Methods and Documentation Requirements for Project Specific Modified Testing Activities		RPD
1100-1199 WET CHEMISTRY					
1100 R11	7/9/2010	7/27/2012	Determination of Total Suspended Solids (TSS or Total Non-Filterable Residue) -- Methods EPA 160.2 and SM2540D	Review by Roy 7/27/11	EAL
1101 R11	7/9/2010	7/27/2012	Total Solids, Total Dissolved Solids (TDS or Total Filterable Residue), and Total Fixed and Volatile Solids -- Methods EPA 160.3, EPA 160.1, and EPA 160.4 and Methods SM2540B, SM2540C and SM2540E	Reviewed by Roy 7/27/11	EAL

<u>SOP</u>	<u>Active Date</u>	<u>Schedule Date</u>	<u>Title</u>	<u>Notes</u>	<u>Author</u>
1104 R7	11/7/2011	11/6/2012	Potentiometric Determination of (Simple) Fluoride in Water and Soil Using an Ion Selective Electrode -- Methods EPA 340.2, SW9214 and SM4500-F~C		EAL
1106 R10	6/28/2011	6/27/2012	Bicarbonate, Carbonate, Hydroxide, and Total Alkalinity by Titration -- Methods EPA 310.1 and SM2320B		EAL
1110 R15	6/29/2011	6/28/2012	Determination of Total and Amenable Cyanide (Distillation) - - Methods SW9010C, SW9013A, SW9014, EPA 335.1, EPA 335.2 and CLP Inorganic SOW (ILMO4.0); Determination of Weak and Dissociable Cyanide -- Method SM4500-CN I		EAL
1112 R7	1/6/2012	1/5/2013	Determination of Reactive Cyanide and Sulfide -- EPA Method SW-846, Chapter 7	Released without revision 1/6/12	EAL
1113 R12	6/15/2011	6/14/2012	Determination of Inorganic Anions by Ion Chromatography -- Methods EPA 300.0 and SW9056		EAL
1117 R5	3/8/2012	3/8/2013	Total Organic Carbon in Soil by Rapid Dichromate Oxidation -- MSA Walkley-Black Method		EAL
1119 R7	11/7/2011	11/6/2012	Determination of Total Phosphorus and Ortho-Phosphate in Water -- Methods EPA 365.2 and SM4500-P B(5) and E		EAL
1120 R7	6/30/2011	6/29/2012	Determination of Total Sulfides in Water -- Methods EPA 376.1 and SM4500-S2F		EAL
1121 R8	8/26/2011	8/25/2012	Determination of Hexavalent Chromium in Solid Matrices Using Alkaline Digestion (Method SW3060A) and Analysis by Method SW7196A		EAL
1122 R7	1/6/2012	1/5/2013	Determination of Hexavalent Chromium by Methods SW7196A and SM3500-Cr-B	Released without revision 1/5/2012	EAL
1125 R5	1/6/2012	1/5/2013	Determination of Perchlorate in Water Using Ion Chromatography -- Methods EPA 314.0 and SW9058		EAL
1126 R18	6/15/2011	6/14/2012	Determination of pH by Electrometric Measurement -- Methods EPA 150.1, SW9040C, SW9045D and SM4500-H+ B		EAL
1127 R8	1/6/2012	1/5/2013	Determination of Nitrogen as Nitrate Plus Nitrite, Nitrite, and Nitrate in Environmental Water and Soil Samples Using a Colorimetric, Automated, Cadmium Reduction Procedure -- Methods EPA 353.2, SM4500-NO3-I, and Quikchem Method 10-107-04-1-C	released without revision 1/6/2012	EAL
1128 R10	7/8/2010	7/27/2012	Determination of Specific Conductance -- EPA Methods 120.1, SW9050A, and SM2510B	Reviewed by Roy 7/27/11	EAL
1129 R7	1/6/2012	1/5/2013	Determination of Ammonia Using An Automated Phenolate Procedure -- Methods EPA 350.1, SM4500 NH3-NH, and Quikchem Method 10-107-06-1-C	released without revision 1/6/2012	EAL
1130 R6	1/6/2012	1/5/2013	Determination of Nitrogen, Nitrite (as NO2-N) in Water And Soil by Colorimetric Spectrophotometric Determination -- EPA Method 354.1 and SM4500-NO2 -B	released without revision 1/6/2012	EAL
1132 R4	1/6/2012	1/5/2013	Sediment Load	released without revision 1/6/2012	EAL
1133 R5	6/30/2011	6/29/2012	Acidity by Titration - Methods EPA 305.1 and SM2310B		EAL

1400-1499 INFORMATION SYSTEMS MANAGEMENT

1400 R7	3/18/2010	3/29/2014	Process Software Validation	Reviewed with Marl/Kurt on 3-29-12	MSR
1401 R6	4/12/2011	4/11/2014	Computer and LIMS Backup and Restoration Protocols		MSR
1402 R7	3/18/2010	3/29/2014	Laboratory Information Management System (LIMS) Version Control	Reviewed with Mark/Kurt during internal audit 3-29-12	MSR
1403 R0	4/12/2011	3/29/2014	Change Control	Reviewed with Mark/Kurt during Internal Audit 3-29-12	MSR

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MISC- ANNUAL DOCUMENTS/REFRESHERS					
2001 R0	5/10/2011	5/9/2013	ALS Safety Module 1 - Introduction		CRO
2002 R0	5/10/2011	5/9/2013	ALS Safety Module 2 - General Health and Safety		CRO
2003 R0	5/10/2011	5/9/2013	ALS Safety Module 3 - Incident Management		CRO
2004 R0	5/10/2011	5/9/2013	ALS Safety Module 4 - Emergency Response		CRO
2005 R0	5/10/2011	5/9/2013	ALS Safety Module 5E - Exposure Control		CRO
2006 R0	5/10/2011	5/9/2013	ALS Safety Module 6 - Manual Handling		CRO
2007 R0	5/10/2011	5/9/2013	ALS Safety Module 7 - Vehicle Safety		CRO
2010 R0	5/10/2011	5/9/2013	ALS Safety Module 10 - Violence in the Workplace		CRO
2013 R0	5/10/2011	5/9/2013	ALS Safety Module 13 - Environmental Management		CRO
2014 R0	5/10/2011	5/9/2013	ALS Safety Module 14 - Hazardous Samples		CRO
CEGEN00	7/27/2011	7/26/2014	Laboratory Ethics and Data Integrity	Corporate SOP - Idelis Williams	RPD
CEQA001	12/30/2011	12/29/2014	Internal Audits	Corporate Internal Audit Guidance	RPD
CHP R13	5/7/2009	4/9/2013	Chemical Hygiene Plan (CHP)	Reviewed by Charles 4-22-11 - No Changes 4-9-12	CRO
ECP R9	1/10/2011	2/6/2013	Emergency and Contingency Plan (ECP)	Review by Charles 2/6/2012	CRO
EX1 R0	12/29/2011	1/1/2015	ISO 17025:2005 General requirements for the competence of testing and calibration laboratories		RPD
EX2 R3	12/29/2011	12/28/2012	DOE QSAS Revision 2.6		RPD
EX3 R4	12/29/2011	12/28/2012	DoD QSM Version 4.2		RPD
EX4 R0	12/29/2011	12/28/2012	TNI Volume 1 Modules 1, 2, 4, 6		RPD
EX5 R0	12/29/2011	12/28/2012	Work Order Review Folders	QA Info Folder contains Reference Methods documents, Management Systems documents, and Safety & Health documents.	RPD
IQA R0	6/21/2011	5/15/2014	Initial Quality Assurance Orientation & Ethics and Data Integrity Training	SOP 143 Training No Changes 5-15-12	RPD
LQAP R15	10/3/2011	10/2/2012	Laboratory Quality Assurance Plan (LQAP)		RPD
RESPP R	5/5/2009	4/22/2013	Respiratory Protection Plan (RESPP)	Reviewed by Charles 4-22-11	CRO
RPP R6	5/5/2009	4/9/2013	Radiation Protection Plan (RPP)	Reviewed by Charles 4-22-11 - No Changes Charles 4-9-12	CRO
Vid1 R0	6/8/2011	6/7/2025	Video Safety Training - Planning For Safety in Laboratory Operations	Blue	CRO
Vid10 R0	6/8/2011	6/7/2025	Video Safety Training - Getting Organized - Laboratory Housekeeping	Blue	CRO

<u>SOP</u>	<u>Active Date</u>	<u>Schedule Date</u>	<u>Title</u>	<u>Notes</u>	<u>Author</u>
Vid11 R0	6/8/2011	6/7/2025	Video Safety Training - Fundamentals of Radiation Safety	Brown	CRO
Vid12 R0	6/8/2011	6/7/2025	Video Safety Training - Radiation Safety and Common Sense	Green	CRO
Vid13 R0	6/8/2011	6/7/2025	Video Safety Training - Using MSDS	Gray	CRO
Vid14 R0	6/8/2011	6/7/2025	Video Safety Training - Radiation Safety: I. Key to Contamination Control	White	CRO
Vid2 R0	6/8/2011	6/7/2025	Video Safety Training - Protecting the Air You Breathe: Hoods and Glove Boxes	Blue	CRO
Vid3 R0	6/8/2011	6/7/2025	Video Safety Training - Handle with care: Glassware in the Laboratory	Blue	CRO
Vid4 R0	6/8/2011	6/7/2025	Video Safety Training - Keep Your Eyes on Safety: Eye Protection in the Laboratory	Blue	CRO
Vid5 R0	6/8/2011	6/7/2025	Video Safety Training - A Place for Everything: Chemical Storage in the Laboratory	Blue	CRO
Vid6 R0	6/8/2011	6/7/2025	Video Safety Training - Safety: It's Your Responsibility - Basic Chemical Hygiene Practices	Blue	CRO
Vid7 R0	6/8/2011	6/7/2025	Video Safety Training - How Do You Feel? - Symptoms of Chemical Exposure	Blue	CRO
Vid8 R0	6/8/2011	6/7/2025	Video Safety Training - When Accidents Happen: Spills in the Laboratory	Blue	CRO
Vid9 R0	6/8/2011	6/7/2025	Video Safety Training - Think Twice! Hazardous Waste Disposal	Blue	CRO
WMP R8	5/5/2009	4/9/2013	Waste Management Plan (WMP)	Reviewed by Charles 4/22/11 No Changes Charles 4-9-12	CRO

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<i>Purchased Location</i>	<i>Instrument Description Condition when purchased</i>	<i>Manufacturer Service Contracts</i>	<i>Model Software</i>	<i>Serial Number Version</i>
<i>Alpha Spec</i>				
1996	Alpha Spectrometer (octete)	Ortec	Ultra 600mm2	per detector
RAD - Room 151	Used	Service Contract	Alpha Vision	5.32.02
1996	Alpha Spectrometer (octete)	Ortec	Ultra 600mm2	per detector
RAD - Room 151	Used	Service Contract	Alpha Vision	5.32.02
1996	Alpha Spectrometer (octete)	Ortec	Ultra 600mm2	per detector
RAD - Room 151	Used	Service Contract	Alpha Vision	5.32.02
1996	Alpha Spectrometer (octete)	Ortec	Ultra 600mm2	per detector
RAD - Room 151	Used	Service Contract	Alpha Vision	5.32.02
1996	Alpha Spectrometer (tower)	Ortec	Tower	N/A
RAD - Room 151	Used	Service Contract	Alpha Vision	5.32.02
1996	Alpha Spectrometer (octete)	Ortec	Ultra 600mm2	per detector
RAD - Room 151	Used	Service Contract	Alpha Vision	5.32.02

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<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>
1996	Alpha Spectrometer (octete)	Ortec	Ultra 600mm2	per detector
RAD - Room 151	Used	Service Contract	Alpha Vision	5.32.02
1996	Alpha Spectrometer (octete)	Ortec	Ultra 600mm2	per detector
RAD - Room 151	Used	Service Contract	Alpha Vision	5.32.02
1996	Alpha Spectrometer (octete)	Ortec	Ultra 600mm2	per detector
RAD - Room 151	Used	Service Contract	Alpha Vision	5.32.02
1996	Alpha Spectrometer (tower)	Ortec	Tower	N/A
RAD - Room 151	Used	Service Contract	Alpha Vision	5.32.02

Cleanup

2009	GPC (Gel Permeation Cleanup) Apparatus	J2 Scientific	Accuvap	GPC-1017-1-DI
EXT - Room 134	New	Service Contract	PrepLink	0.99.66.59

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<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>
<i>CVAA</i>				
2010	Mercury Analyzer (Cold Vapor Atomic Absorption) w autosampler	CETAC	M7500	031001QTA
Metals	New		Quicktrace	version 1.6.5
2002	Mercury Analyzer (Cold Vapor Atomic Absorption) w autosampler	CETAC Technologies	M-6000A	079730AST
Metals - Room 139	Reconditioned	Outside Vendor	Cetac Hg Analyzer	Version 1.5.2

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<i>Gamma Spec</i>				
2004 RAD - Room 151	Gamma Spectrometer-13 New	Gamma Vision Service Contract	6.09 Seeker	32-TP10869A version 2.2.2.3
2004 RAD - Room 151	Gamma Spectrometer-14 New	Gamma Vision Service Contract	6.09 Seeker	05034922 version 2.2.2.3
2004 RAD - Room 151	Gamma Spectrometer-15 New	Gamma Vision Service Contract	6.09 Seeker	51-TP32763A version 2.2.2.3
2004 RAD - Room 173	Gamma Spectrometer-16 New	Gamma Vision Service Contract	6.09 Seeker	51-TP12858A version 2.2.2.3
2004 RAD - Room 151	Gamma Spectrometer-12 New	Gamma Vision Service Contract	6.09 Seeker	32-TP40384A version 2.2.2.3
1996 RAD - Room 151	Gamma Spectrometer-9 Used	EG&G Ortec Service Contract	LS - 1116 Seeker	32-TP10850A version 2.2.2.3

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<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>
1996	Gamma Spectrometer-2	EG&G Ortec	LS - 1116	34-TP40551A
RAD - Room 151	Used	Service Contract	Seeker	version 2.2.2.3
1996	Gamma Spectrometer-3	EG&G Ortec	LS - 1116	32-TP20757A
RAD - Room 151	Used	Service Contract	Seeker	version 2.2.2.3
1996	Gamma Spectrometer-4	EG&G Ortec	LS - 1116	32-TP20722B
RAD - Room 151	Used	Service Contract	Seeker	version 2.2.2.3
1996	Gamma Spectrometer-10	EG&G Ortec	LS - 1116	32-TP20736A
RAD - Room 151	Used	Service Contract	Seeker	version 2.2.2.3
1996	Gamma Spectrometer-6	EG&G Ortec	LS - 1116	26-P-396A
RAD - Room 151	Used	Service Contract	Seeker	version 2.2.2.3
1996	Gamma Spectrometer-7	EG&G Ortec	LS - 1116	32-TN10858B
RAD - Room 151	Used	Service Contract	Seeker	version 2.2.2.3
1996	Gamma Spectrometer-8	EG&G Ortec	LS - 1116	32-TN10861B
RAD - Room 151	Used	Service Contract	Seeker	version 2.2.2.3

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<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>
1996	Gamma Spectrometer-1	EG&G Ortec	LS - 1116	26-PJ96A
RAD - Room 151	Used	Service Contract	Seeker	version 2.2.2.3
1996	Gamma Spectrometer-5	EG&G Ortec	LS - 1116	34-TP40551A
RAD - Room 151	Used	Service Contract	Seeker	version 2.2.2.3
1996	Gamma Spectrometer-11	EG&G Ortec	LS - 1116	32-TP20875A
RAD - Room 173	Used	Service Contract	Seeker	version 2.2.2.3

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<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>
<i>GC</i>				
2011	Gas Chromatograph (Dual ECD)	Agilent	7890A(G3440A)	11171045
GC Room 132			EZ Chrom Elite	version 3.2.1
2011	Gas Chromatograph (Dual ECD)	Agilent	7890A (G3440A)	11171043
GC-Room 132	New		EZ Chrom Elite	version 3.3.2
1996	Gas Chromatograph (FID)	Hewlett Packard	5890A	2750A19027
GC - Room 132	Used	Service Contract	EZ Chrom Elite	version 3.2.1
1996	Gas Chromatograph (FID)	Hewlett Packard	5890A	3121A35609
Fuels - Room 135	Used	Service Contract	Enviroquant G1045	Version A.00.00
1996	Gas Chromatograph (FID)	Hewlett Packard	5890	2750A18840
Fuels - Room 135	Used	Service Contract	ChemStation	B.02.04
1996	Gas Chromatograph (Dual ECD)	Hewlett Packard	5890 Series II	3310A49739
GC - Room 132	Used	Service Contract	EZ Chrom Elite	version 3.3.2

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<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>
1996	Gas Chromatograph (Dual ECD)	Hewlett Packard	5890 Series II	3310A47805
GC - Room 132	Used	Service Contract	EZ Chrom Elite	version 3.3.2
1996	Gas Chromatograph (PID/FID)	Hewlett Packard	5890	2443A03716
Fuels - Room 135	Reconditioned	Service Contract	EZ Chrom Elite	version 3.3.2

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<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>
<i>GC/MS</i>				
2012	Gas Chromatograph (MS)	Agilent	7890A/5975C	CN11541177 and US11423931
Semi Volatiles Laboratory	New		Chemstation	E02.02.1431
2003, 1996	OI Purge and Trap - Agilent GC/MS	OI/Agilent	Archon, 5971	13833, 3188A03493
VOAs - Room 201	Used	Service Contract	EnviroQuant ChemStation	B01.00
2003	Teckmar P&T and Gas Chromatograph (MS)	Hewlett Packard	6890/5973	US10226006
VOAs - Room 201	Reconditioned	Service Contract	MSD Chem Station	Version D.03.00.611
2002	Total Organic Carbon (TOC) Analyzer & Autosampler	Tekmar - Dohrmann	14 - 7045 - 000	01011007
TOC - Room 131	Reconditioned	Outside Vendor	NA	
2001	Gas Chromatograph (MS)	Hewlett Packard	6890	US00040094
SVOCs - Room 144	New	Service Contract	HPChemStation	B.01.00
1996	Gas Chromatograph (MS)	Hewlett Packard	6890	US00031554
SVOCs - Room 144	Used	Service Contract	HPChemStation	B.02.05

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<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>
1996	Detector, Gas Chromatograph (MS)	Hewlett Packard	5973	US91911895
SVOCs - Room 144	Used	Service Contract	EnviroQuant Chem Station	B.01.00
1996	Teckmar P&T and Gas Chromatograph (MS)	Hewlett Packard	5890 Series II	3019A28661
VOAs - Room 201	Reconditioned	Service Contract	MSD Chem Station	Version D.03.00.611

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<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>

GPC

2008	Gas Flow Proportional Counter	Canberra	LB - 4110	2268
RAD - Room 151	New	Service Contract	Oxford	1.01,1.10,1.11
1998	Gas Flow Proportional Counter	Tennelec	LB - 5100	13923 (B)
RAD - Room 173	Reconditioned	Service Contract	Eclipse	S550
1996	Gas Flow Proportional Counter	Canberra	LB - 4110	43727
RAD - Room 151	Reconditioned	Service Contract	Oxford	1.01,1.10,1.11
1996	Gas Flow Proportional Counter	Canberra	LB - 4110	CR (13923)
RAD - Room 151	Reconditioned	Service Contract	Oxford	1.01,1.10,1.11
1996	Gas Flow Proportional Counter	Tennelec	LB - 5100	13923 (A)
RAD - Room 173	Used	Service Contract	Oxford	1.01,1.10,1.11

HPLC

2004	High Performance Liquid Chromatograph UV	HP	1050	33172802213
HPLC - Room 135	Used			

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ALS Environmental Analytical Instruments List

Technology

<i>Purchased</i>	<i>Instrument Description</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Serial Number</i>
<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>

IC

2000	Ion Chromatograph (IC) - Perchlorate Analysis	Dionex	DX - 120	98070245
Wet Chem	Reconditioned	Service Contract	Dionex Peaknet	version 5.1

1999	Ion Chromatograph (IC) - Anions Analysis	Dionex	DX - 120	99060762
Wet Chem	Reconditioned	Service Contract	Dionex Peaknet	version 5.1

ICP

2006	Inductively Coupled Plasma (ICP) - axial (trace)	Thermo Jarrell Ash	1342900	338590
Metals - Room 138	Used	Service Contract	ICP Manager	Version 2.0.0.800

1996	Inductively Coupled Plasma (ICP) - axial (trace)	Thermo Jarrell Ash	1342900	336490
Metals - Room 138	Used	Service Contract	ICP Manager	Version 2.0.0.800

ALS Environmental Analytical Instruments List

Technology

<i>Purchased</i>	<i>Instrument Description</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Serial Number</i>
<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>

ICPMS

2010	Inductively Coupled Plasma (ICP)/MS	Agilent	7700 Series	JP09400112
Metals-Room 138	New	Warranty-1year	Masshunter	B.01.01
2004	Inductively Coupled Plasma (ICP)/MS	Micromass	Platform ICP	WA057
Metals - Room 141	Reconditioned	Service Contract	Mass Lynx	Version 3.4

LC/MS/MS

2007	High Performance Liquid Chromatograph, MS/MS	Applied Biosystems	MDS Sciex	20683070611
LCMS - Room 130	New	Service Contract	Analyst	1.4.2

ALS Environmental Analytical Instruments List

Technology

<i>Purchased</i>	<i>Instrument Description</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Serial Number</i>
<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>

LSC

2004	Liquid Scintillation Counter	Packard	2700TR	406415
RAD - Room 132	Used	Service Contract	TriCarb 2700 TR	
2003	Liquid Scintillation Counter	Wallac	1220	2200205
RAD - Room 151	Reconditioned	Service Contract	WinQ	version 1.2
1997	Liquid Scintillation Counter	Beckman	LS 6500	7068426
RAD - Room 131	Reconditioned	Service Contract	LS6000 Data Ca	version 2.11
1996	Liquid Scintillation Counter	Beckman	LS 6000TA	598860
RAD - Room 131	Used	Service Contract	LS6000 Data Capture	version 2.11

UV/VIS

2000	Flow Injection Analyzer (Automated NO2/NO3, NH3)	Lachat	QuickChem 8000	A83000 - 642
Wet Chem	Reconditioned	Outside Vendor	Omnion FIA	version 1.3
1997	UV Spectrophotometer	Sequoia - Turner	Model 340	905970923742
Wet Chem	Reconditioned	Outside Vendor	NA	

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ALS Environmental Analytical Instruments List

Technology

<i>Purchased</i>	<i>Instrument Description</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Serial Number</i>
<i>Location</i>	<i>Condition when purchased</i>	<i>Service Contracts</i>	<i>Software</i>	<i>Version</i>
<i>Wet Chem</i>				
1997	Meter, Conductivity	VWR Scientific	23226 - 523	A22036
Wet Chem	Used	In House	NA	
1996	Meter, pH	Coming	320	C5961
Wet Chem	Used	In House	NA	
1996	Ignitability Apparatus	Pensky - Martin	89571	
EXT - Room 134	Used	In House	NA	
1996	Meter, pH	Fischer Scientific	50	C0000643
Wet Chem	Used	In House	NA	
1996	Refractometer, Differential	Waters	M410	410 - 004776
HPLC - Room 142	Used	Service Contract	NA	

ALS

STANDARD OPERATING PROCEDURE 739 REVISION ~~10~~11

**TITLE: PREPARATION OF SAMPLES FOR ANALYSIS BY
GAMMA SPECTROSCOPY**

FORMS:

APPROVED BY:

TECHNICAL MANAGER _____ DATE _____

QUALITY ASSURANCE MANAGER _____ DATE _____

LABORATORY MANAGER _____ DATE _____

1. SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the steps used to prepare soil, water and sludge samples for gamma spectroscopy analysis. Vegetation, air filter and bioassay samples are not addressed in this SOP, and must be handled on a case-by-case basis.

2. SUMMARY

Soils and sludges are prepared (i.e., dried and sieved) per SOP 736, prior to beginning the procedure outlined in this SOP. Some soils and sludges may omit such preparations if approval is given by the Project Manager. Waters are either filtered or left unfiltered prior to preparation as per work order or Radiochemistry Manager instructions. Waters are measured volumetrically into an appropriately sized Marinelli beaker. Soils are measured gravimetrically into a Lermar jar or a steel can, as appropriate for the sample size and the analyte. The gamma spec containers are sealed with their lids, and wiped with a damp paper towel to remove potential contamination.

3. RESPONSIBILITIES

- 3.1 It is the responsibility of the analyst to perform these procedures according to this SOP and to complete all documentation required for review.
- 3.2 These procedures are to be performed only by personnel who have demonstrated the ability to generate acceptable results utilizing this method. This demonstration may come in the form of Supervisory/training review, results of precision and accuracy tests, or the successful completion of an unknown proficiency test sample.
- 3.3 It is the responsibility of the analyst to be familiar with the acceptance criteria for the QC samples and other quality indicating parameters, as specified in SOP 715 as well as the LIMS program specification related to the client, project, and test method being performed.
- 3.4 It is the responsibility of all personnel who work with samples involving this method to note any anomalies or out-of-control events. Any discrepancies must

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be noted and corrective action taken and documented.

4. INTERFERENCES

- 4.1 Gamma spec samples must be produced only in the specific geometry for which the Instrumentation Group has calibrated their spectrometers.
- 4.2 New containers ordered for gamma spec must be equivalent to those currently in use. The ~~Radiochemistry~~ Manager or designee must approve the use of alternate containers or supplies in advance.
- 4.3 Gamma spec containers are not reusable due to the possibility of carry-over in the next analysis. Once the analysis is complete, the container is returned to the sample storage area.
- 4.4 The prep and instrumentation analyst maintain the internal Chain of Custody (COC). When the original client sample container is taken by a prep analyst from the sample storage area, he/she logs the sample out as normal. Because gamma spec is a non-destructive test, samples that are designated for other (non-volatile) tests may be used. Check with Group Leaders if there are questions concerning sample availability or if samples are turn-around-time sensitive.
- 4.5 The prep analyst is responsible for creating a gamma fraction for chain of custody. The prep analyst logs out the gamma container on behalf of the counting room analyst and relinquishes the sample along with the benchsheet. After counting, the gamma spec analyst will return the samples to the sample storage area and check them in. If the aliquot taken for gamma spec is needed for other analyses, log in/log out activities are managed by barcode scanning (COC SOP 318).
- 4.6 The standard filter geometry is a 47mm diameter filter mounted in a 2" stainless steel planchet. For Ra-226 analysis of a solid/soil sample, the packing must be done in a can as a geometry (GEO) 1726. ~~Usually the can packing will be done on an "As Received" basis, and the % moisture data will be provided to report on a dry weight basis. If the sample volume is limited, regular Gamma can be packed as a GEO 11 and the "Ra-can" could be packed with the available sample.~~ If the can is not filled to the top, the analyst should mark a line on the outside of the container indicating the height of the actual sample and inform the Project Manager of the limited sample. If told to proceed, the limited volume will be noted in the comments section on the bench sheet or in a QASS. write a Quality Assurance Summary Sheet (QASS), Form 302. This documentation will be included in the final report.
- 4.7 Filter samples can be digested using SOP 773 or SOP 767, then the digestate is diluted to 1000mL with DI water and packed for Gamma as GEO 1. Samples like vegetation, debris, gloves, wipes, iron bar, lead blocks, ashes, fruits, fish, cloth,

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wood chips etc., will be treated with different methods based on the nature of the samples and conditions. The samples may be leached using different acids or digested and packed with different GEO. However, all geometry preparations will be documented on a QASS and a copy will be attached to the benchsheet.

5. APPARATUS AND MATERIALS

- 5.1 Balance, top loading, 0.01g sensitivity
- 5.2 Scoops, spatulas, tongue depressors
- 5.3 Graduated cylinders, type TD (to deliver), 1L
- 5.4 Marinelli beakers with lids, Ga-ma # 138G, or equivalent *, 2L
- 5.5 Lerner Jars with 89mm screw lid, plastic, or equivalent *, 16oz
- 5.6 Large funnel, glass/plastic
- 5.7 Vinyl tape
- 5.8 Parafilm™
- 5.9 Qualitative filter paper, fluted, VWR brand #313 or equivalent
- 5.10 Cans for Geo 17, House of Cans #3104 or equivalent *

* *Equivalent containers require approval by the ~~Radiochemistry~~ Manager or designee.*

6. REAGENTS

Deionized (DI) water, obtained from the laboratory's DI water system

7. SAMPLE COLLECTION, PRESERVATION AND HANDLING

- 7.1 Samples may be collected in any type of glass or plastic container.
- 7.2 Aqueous samples should be preserved to pH<2 with nitric acid.
- 7.3 If samples are to be stored for an extended period of time, refrigeration is recommended to prevent biological growth in the sample.
- 7.4 At the current time, there is no regulatory holding time established for gamma analysis. Many sampling and analysis plans, however, apply a default holding time of 180 days from date of collection. If samples are analyzed more than 180 days after collection, this fact should be noted in the laboratory data package case narrative.

8. PROCEDURE

8.1 PROCEDURE FOR WATER SAMPLES

- 8.1.1 Samples must be properly preserved before aliquotting. Verify that the pH is less than 2, per SOP 733. If the sample contains visible sediment

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or other conditions exist that make preservation impractical, notify the Project Manager (PM) of the lab's intent to proceed with analysis of the unpreserved sample and document the situation on a Quality Assurance Summary Sheet (Form 302), or in the comments section on the bench sheet.

- 8.1.2 Do not prepare water samples in the same workspace where soil samples are being prepared. This avoids cross-contamination by dust.
- 8.1.3 If the sample contains sediment or suspended solids, check the work order and program specifications for specific instructions as to whether or not the sample should be filtered. If it is not specified, filter per SOP 736. If the project instructions specify "Dissolved" or "Filtered", filter the sample through a fluted filter into a clean 1L graduated cylinder. ~~Pre-filtering may be required for especially turbid samples. If the project instructions specify "Total" or "As Received," shake the sample container to mix thoroughly and aliquot as received.~~
- 8.1.4 Liquid samples are prepared in 2L Marinelli beakers. Measure the appropriate volume of water sample in a clean 1L type TD graduated cylinder to the nearest 0.01L (i.e., 10mL). Empty the sample into a clean, labeled Marinelli beaker.
- 8.1.5 ~~The gravimetric method is adapted for liquid samples other than water. Place an empty Marinelli beaker on the top loading balance and tare the balance to zero. Add the sample slowly into the Marinelli beaker until the final weight is 1000 ± 0.01g.~~

NOTE: If the sample volume provided falls short of the desired geometry, dilute to the appropriate geometry with DI water (e.g., dilute 600mL to 1L). *Make sure to record the original volume on the container and on the benchsheet.*

- 8.1.6 A method blank is made by adding a representative volume of DI water to an empty, labeled Marinelli beaker. Refer to SOP 715 to determine the aliquot size for the blank. The collection date for the blank is the date the samples are packed.
- 8.1.7 A Laboratory Control Sample (LCS) needs to be created on the benchsheet for every batch of twenty samples. The prep analyst does not physically prepare the LCS, instead, the gamma spec analyst uses a pre-made, independent second source LCS obtained from an outside vendor. The information to be filled in on the benchsheet for the LCS varies depending on the GEO size. For waters, indicate the following:

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<u>GEO NUMBER</u>	<u>LCS ALIQ.SIZE</u>
1	1000 mL

- 8.1.8 Attach the lid of the Marinelli beaker and seal the lid using vinyl tape. Wipe the exterior of the container with a damp paper towel to remove potential contamination. Make sure the container is labeled with the sample ID, aliquot size, date of prep and initials.
- 8.1.9 Submit the prepared samples to the counting room. The counting room will analyze the samples in the manner described in SOP 713. Upon completion of gamma counting, the sample fraction will be returned to the sample storage area and the gamma spec analyst will check the sample back in to the storage area per COC SOP 318 procedures.

8.2 PROCEDURE FOR SOIL AND SLUDGE SAMPLES

- 8.2.1 Unless approval to the contrary is given, all soil samples must be dried and sieved through a number 4 sieve prior to preparation for gamma spec analysis. Consult SOP 736 for drying and sieving procedures.

Containers for gamma spec soils are usually prepared when the soil is being prepared for other analyses under SOP 736. The bench sheet will be created at this time. ~~The gamma spec prep worksheet for soils should be filled out manually by the prep analyst at the time of packing gamma, and the electronic benchsheet will be created later on. The prep worksheet will be attached to the benchsheet when the sample is relinquished to the counting room.~~

The bench sheet provides information about the prep date, analyst, balance number, report basis, etc., as well as all the information about how the sample was packed. Any unusual situation will be documented on a QASS (Form 302), or in the benchsheet comments section.

- 8.2.2 When using Lerner jars, fill the container to the appropriate level according to the desired geometry. If enough sample is provided, use Geometry 13 (500g). If not, reduce the sample volume to Geometry 11 (100g).

- 8.2.2.1 Sample volumes should be maintained to within ½ cm of the correct geometry height in the container.

~~8.2.2.2 Zero out the container weight on the balance prior to weighing out a sample.~~

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~~8.2.2.3~~8.2.2.2 Soil samples should be well settled into their containers by gentle shaking with the lid on. Do not pack or compress soils into the containers.

~~8.2.2.4~~8.2.2.3 Consult the ~~Radiochemistry~~ Project Manager or Group Leader if the sample volume provided is less than a Geometry 11. ~~The analysis will usually still be conducted, but the Project Manager will need to be informed because of the effects on the efficiency calibration and detection limits.~~

8.2.3 For Ra-226 analysis by gamma spec, the samples will be packed as a GEO ~~17~~26. Unless otherwise directed by the LIMS program specifications or work order notes. Generally, the samples will be packed on a “Dry” basis, however, due to rush turn around times, the sample can be packed “As Received”. To accomplish this, transfer the sample to a steel can (appropriate for GEO 17), until it is filled to the top. Tap the can to remove air pockets and to settle the sample. Do not press or “pack” the sample into the can. Add more sample to fill the can to the top. To ensure a tight seal, place a piece of Parafilm over the top of the can then cap the can with the metal lid and seal with the can sealer. Remove any excess Parafilm™ from the outside of the can.

8.2.4 A Laboratory Control Sample (LCS) needs to be created on the benchsheet for every batch of twenty samples. The prep analyst does not physically prepare the LCS, instead, the gamma spec analyst uses a pre-made LCS obtained from an outside vendor. The information to be filled in on the benchsheet for the LCS varies depending on the GEO size as follows:

<u>GEO NUMBER</u>	<u>LCS ALIQ.SIZE</u>
11	100g
13	500g
17	215g
26	215g
7	1s
8	1s
9	1s
<u>14</u>	<u>2082g</u>

8.2.5 After the ~~preparation worksheet and the~~ bench sheet ~~are~~is completed, fill out the LIMS tracking sheet, review the packet, and complete the tracking sheet.

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- 8.2.6 Submit the samples prepared as above to the counting room. The counting room will analyze the samples in the manner described in SOP 713. Upon completion of gamma counting, the sample fraction will be returned to the sample storage area and the instrument analyst will check the sample back in to the storage area and fill out the internal COC.

8.3 CALCULATIONS

TPU FACTORS. As defined in SOP 708, the following preparation uncertainty factors should be applied during the final reporting stage of the analysis as a component of the Total Propagated Uncertainty (TPU):

- 8.3.1 Water samples require a preparation uncertainty factor of 0.0504 at the one-sigma level. This is based on one gross aliquoting (sample homogeneity) and one volumetric measurement. See the following equation:

$$0.0504 = \sqrt{0.05^2 + 0.006^2}$$

- 8.3.2 Solid samples require a preparation uncertainty factor of 0.0501 at the one-sigma level. This is based on one gross aliquoting (sample homogeneity) and one mass measurement. See the following equation:

$$0.0501 = \sqrt{0.05^2 + 0.003^2}$$

- 8.3.3 In practice, these two TPU factors are substantially equivalent. To simplify the data reporting procedure, the greater of the two (0.0504) may be used for both matrices.

9. QUALITY CONTROL

Acceptance criteria for QC samples may vary per client specifications (typically controlled via test code nicknames), consult applicable LIMS program specification.

- 9.1 Method blanks will be run at a frequency of five-percent (i.e., one per 20 field samples) with a minimum of one per batch. Method blanks for water consist of deionized (DI) water. Method blanks for solid samples consist of an empty container, appropriate for the geometry (i.e., 13, 11, 17).
- 9.2 Laboratory Control Samples (LCS) will be run at a frequency of five-percent with a minimum of one per batch. The LCS consists of a pre-made source from an outside vendor.
- 9.3 Duplicate samples will be run at a frequency of ~~ten~~5-percent with a minimum of one per batch, or according to client specifications. If insufficient volume is available for a duplicate, a count duplicate may be used.

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10. METHOD DEVIATIONS

SOP 739 is an ALS procedure and there are therefore no deviations from a reference method.

11. SAFETY, HAZARDS AND WASTE DISPOSAL

11.1 SAFETY AND HAZARDS

All Safety and Hazards are managed in accordance with the current facility plans:

- Chemical Hygiene Plan (CHP)
- Radiation Protection Plan (RPP).
- Emergency and Contingency Plan (ECP)
- Respiratory Protection Plan (RESPP)

11.2 WASTE DISPOSAL

All wastes are disposed of according to the Waste Management Plan (WMP)

12. REFERENCES

SOP 708, "Calculations for Radioanalytical Results."

ALS ~~Laboratory Group (ALS)~~

STANDARD OPERATING PROCEDURE 713 REVISION ~~11~~12

TITLE: ANALYSIS OF GAMMA EMITTING RADIONUCLIDES BY GAMMA SPECTROSCOPY -- METHOD EPA 901.1

FORMS: ~~754~~APPENDIX E

APPROVED BY:

TECHNICAL MANAGER _____ DATE _____

—
QUALITY ASSURANCE MANAGER _____ DATE : _____

LABORATORY MANAGER _____ DATE _____

1 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the steps necessary to perform gamma emissions analysis of samples of various media using high purity germanium (HPGe) high-resolution intrinsic gamma spectrometry. This procedure is applicable to all gamma spectrometry analyses performed at ALS ~~Laboratory Group~~. The procedures outlined in this SOP are based on EPA Method 901.1 and DOE/EML Procedure 4.5.2.3.

2 SUMMARY

Gamma emissions from radionuclides are detected by a semiconductor germanium crystal, which provides a small electronic pulse for each gamma interaction where the pulse height is proportional to the gamma incident energy. This electronic data is converted to digital data by an analog to digital converter (ADC) and stored in a multichannel buffer (MCB). The data collected by the MCB is subsequently interpreted by a complex software program, generating results in units of radioactivity per unit sample volume. The gamma spectroscopy analysis software program used is Seeker[®], Version 2.2, a product of Vertechs Software Solution, Inc.

3 RESPONSIBILITIES

3.1 It is the responsibility of the analyst to perform these procedures according to this SOP and to complete all documentation required for review. Analysis and interpretation of the results are performed by personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this method. This demonstration may come in the form of Supervisory/training review, results of precision and accuracy tests performed, or the successful completion of a proficiency test sample.

~~3.2 It is the responsibility of all personnel who work with samples or data involving this method to consult the applicable LIMS Program Specification for client-specific requirements prior to initiating handling of samples or data.~~

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~~3.3~~3.2 Upon receipt of a new or repaired detector, it is the responsibility of the technician to follow the steps outlined in Appendix D, 'General Gamma Detector Operations', prior to data acquisition.

~~3.4~~3.3 It is the responsibility of all personnel who work with samples or data involving this method to consult the applicable LIMS Program Specification for client-specific requirements prior to initiating handling of samples or data.

~~3.5~~3.4 Final review and sign-off of the data are performed by the Department Manager or designee. Initialing and dating the processed data indicates that this review for precision, accuracy, completeness and reasonableness is complete and satisfactory. Any errors that are found require corrective action, which includes notification to the analyst who performed the work and documentation of measures taken to remediate the data.

~~3.6~~3.5 It is the responsibility of all personnel who work with samples involving these procedures to note any anomalies or out-of-control events. Any discrepancies must be noted and corrective action taken and documented.

4 INTERFERENCES

The physical shape of the source and its proximity to the detector is critical to the efficiency calibration. These factors define the "counting geometry". The calibration geometry and the sample geometry must match within $\pm 0.5\text{cm}$ of the line on the sample container.

5 APPARATUS AND MATERIALS

This procedure is conducted with the use of installed gamma detection and analysis equipment consisting of multiple intrinsic germanium gamma spectrometers mounted in lead shields for the reduction of ambient background radiation, a personal computer analysis system with multichannel analyzer interfaces, three NIM-bin based multichannel buffers, gamma analysis software, and associated nuclear electronics and cabling.

6 REAGENTS

No reagents are used by this procedure. The operator should be aware, however, that water samples are preserved to $\text{pH} < 2$ with Nitric Acid (HNO_3).

7 PROCEDURE

7.1 OPERATING CONDITIONS

The gamma spectrometry systems shall be operated with detector bias as specified by the detector manufacturer and amplifier and MCB settings as required to obtain a nominal 0.5keV/channel energy calibration across a range of approximately 40 to 2000keV . The operating conditions shall be verified daily by performance of the daily quality control checks (described in Section 8 below).

7.2 SPECTRUM ACQUISITION

7.2.1 The detector must be calibrated for the geometry of the sample to be analyzed. Efficiency calibration procedures are defined in Section 8

below. A list of current geometries, calibration date and the dates the calibrations expire, as well as standards used for calibration is posted in the instrument lab. This list is maintained by instrument lab personnel and is exempt from 'Operator Aid' policies, as it is an integral part of gamma operations and is updated on an on-going basis.

Samples shall be placed directly on the detector, inside the lead shield, and in a manner that is level and centered over the detector, unless noted otherwise on a Quality Assurance Summary Sheet (QASS) or other supporting documentation.

- 7.2.2 After samples have been loaded on the detectors, select the desired detector in the Spectral Display Control menu. Next, select the 'TOOLS' icon, which will then prompt for the ID and the desired live time or count time.

Enter the sample ID as it appears on the sample benchsheet, followed by a space, and then the batch ID (e.g., 0011222-3 GSyymmdd-n). After the ID has been entered, select the 'ID SET' icon to save the sample ID.

Enter the desired count time in seconds in the box labeled 'LIVE TIME' and then select the 'PRE SET' icon to save the count time. Sample count times depend on the sample volume, geometry, and the client's required minimum detectable concentration (MDC). An outline of the geometries and their respective matrix and/or volume can be found in Appendix C of this SOP. LCS samples are typically counted for 1800 seconds (30 minutes) and blank samples will be counted for as long as the longest sample count time.

- 7.2.3 After the sample ID and count time have been entered and saved, clear the previous spectrum by selecting the 'ERASE' icon.

- 7.2.4 Begin spectrum acquisition by selecting the 'GO' icon and exit the 'TOOLS' window by selecting 'DONE'.

- 7.2.5 Enter all samples that are analyzed in the gamma spectroscopy logbook (~~Form 754~~). Use the current page with the date that the sample is counted. *Ensure that the detectors being used have passed the Daily QC checks (see Section 8 below).* Necessary information recorded in the gamma spectroscopy logbook includes:

- ALS sample ID
- detector number
- geometry, including sample orientation and the use of a positioning (puck), if appropriate
- duration of the count

- count start time
- operator's initials
- spectrum file name
- position verification check

7.3 SPECTRUM ANALYSIS

Upon completion of the sample count, the data must be transferred to the workspace and analyzed, using the procedures described below:

- 7.3.1 Select the appropriate detector, then select the appropriate analysis/application type, based on the sample geometry, from the Application Select menu. Next select 'Read MCA' on the menu bar. By "reading the MCA", the data acquired during the analysis count is transferred to the workspace and default settings and files from the application are applied (i.e., efficiency, library, units, etc.).

When 'Read MCA' is selected, the analysis parameters screen is displayed. At this time the file name is automatically generated. Record this file name in the gamma spectroscopy run log ~~(Form 754)~~.

The analyst will need to verify, enter, or edit the following sample parameters:

Sample ID: This should be automatically transferred in the format described above, but corrections can be made here.

Spec. Code: This field is left blank.

Sample Size: Enter the volume, weight, or number of filters as appropriate.

Units: This will be transferred automatically as a default, but can be changed as needed.

Sampling Start and Stop: This is normally the same date and time for both the start and stop. Enter the collection date of the sample in both boxes. The time of day is generally 12:00:00 for all samples.

Efficiency File: This line should be generated automatically by the computer and is in the form:

$(D_{xx})(S_{GG}).EFF$

where:

xx is the detector number

GG is the geometry of the sample.

If changing the efficiency file, make sure the detector of the efficiency file is for the detector the sample was counted on and that the efficiency file has not expired.

After all the parameters and values are satisfactory, select 'OK' to exit the 'Read MCA' window. By selecting 'OK', all of the parameters and values are saved under the file ID and can be retrieved later to further analyze. By selecting 'CANCEL', all of the parameters are lost and the file ID is not saved.

- 7.3.2 Next, the spectrum must be analyzed to identify peaks at the various energies. To do this, select 'PEAK SEARCH' on the menu bar and the software will apply the resolution calibration to the acquired spectrum to define peaks and peak height. This will prompt the next window, which allows the analyst to see all of the peaks identified, and the counts acquired for each peak.

The analyst shall review the peak search results to identify peak shifts, multiplets, etc. After the peak search results are considered to be satisfactory, select 'DONE' to exit the peak search results window.

- 7.3.3 To calculate activity concentrations, select the 'CALCULATE' icon under 'ACTIVITY' on the menu tool bar. This will prompt an activity report parameters window. Then perform the following:

Select the desired library to be used in the column labeled 'LIBRARY FILE'. Next select the background file to be used according to the detector and the count date. Background files are named so that the first two numbers correlate to the detector, the next two correlate to the month the background was counted, and the next two correlate to the day of the month. *Background files can be used for one week after counting (i.e. sample counts must be started before the day and time that the background calibrations were completed on the previous week.)*

The LSF File should remain as 'NONE'.

The 'RESULTS FILE' and the 'PRINTOUT FILE' should be the same as the .SPC file, except ending in .RES and .TXT,

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respectively.

Select 'OK' after the correct library and background have been selected and the Library Search Results window will be shown. This allows the analyst to review peaks that have been matched to specific peaks in the library.

To **finish the calculations**, select 'OK' to prompt the raw data printout. This window allows the analyst to review all of the parameters used in the analysis.

To **save the data**, select the 'SAVE' icon, which calls up the "SAVE" window. For general analyses the fields are automatically populated. The default values (yynnnnD##.RES) are accepted, except where multiple analyses of a spectrum are performed, as described below.

Select "SAVE" again to store the results in the defined .RES file.

Print the raw data by selecting the 'PRINTER' icon.

In some cases, reanalysis of the same spectrum may be required to apply different geometry calibrations or analytical libraries. To perform multiple analyses on the same spectrum, select "SPECTRUM" on the menu bar, then select "EDIT" and return to step 7.3.1, beginning with the "Efficiency File" specification, with the following exception:

Multiple analyses of a single spectrum require a unique identifier appended to the default file name (yynnnnD##**A**.RES, yynnnnD##**B**.RES, etc.). The unique file name must be defined prior to saving the .RES file, to **prevent overwriting previous files**.

8 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Standards for Daily QC Checks need not be traceable to the National Institute for Standards and Technology (NIST). All Daily QC monitoring shall be recorded in the gamma spectroscopy run log (~~Form 754~~). **QC parameters must meet the established limits defined in the instrument software.**

8.1 QC MONITORING

8.1.1 DAILY QC ENERGY CALIBRATION CHECKS

A daily QC check involves performing an energy calibration, as well as monitoring the detector resolution (FWHM) and efficiency. Each detector has a labeled calibration standard. Center the appropriate calibration standard on the corresponding detector. Count each daily check standard as described in the procedure above for 20 minutes using the sample ID "Daily Check".

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When the count is complete, select 'DAILY CHECK' under the Application Select menu, then select 'Read MCA' to prompt the edit parameters screen. Select 'OK', as the parameters should be the default.

On the menu bar select 'PEAK SEARCH' as described above, then select 'Q.C.', then 'DETECTOR'. The calibration parameters screen is then prompted. Make sure that the 'ENERGY' bullet is selected.

Select 'OK', choose 'MERGE PSR', then select 'CURVE FIT', then select 'SAVE'. This will save the energy calibration for that day. The program then compares the results of the energy recalibration to the Q.C. parameters (found in the Q.C. editor) established for the specified detector.

8.1.2 CORRECTIVE ACTION FOR DAILY QC FAILURES

If a detector is not within established control limits for any of the bounds tests, corrective action must be taken as follows:

- If one of the centroid exceeds the bounds test (e.g., 662keV), the peak location should be adjusted. This is done by placing a calibration source on the detector (preferably a Laboratory Control Sample, LCS) and starting the detector.

Clear the current spectrum by typing 'F4' (Clear). The acquisition can then be started by typing 'F2'.

Move the cursor to the appropriate centroid (e.g., 662keV) and check the actual location. The peak can be moved by adjusting the fine gain, located on the amplifier. *Note that it only requires a minute adjustment (one click) to move the peak three to five keV.* After the peak has been moved to the correct location, re-run the energy calibration.

- If the failure includes one of the other parameters (e.g., FWHM or efficiency), the daily QC can be re-run. If the QC fails for a second time, the detector is taken off-line and the lab Supervisor is contacted.

NOTE: A pole-zero adjustment can be conducted in the case of a FWHM failure, using the following procedure:

First, **attach a co-axial cable** from the "1 Meg" port associated with the vertical input on the oscilloscope to the "uni" output on the amplifier.

Next, **set the scope settings** as follows:

Volts/Div(Vertical) = 0.1

Polarity = DC

Trigger Selector = EXT(-)

Mode = DC

Triggering Level = 0

Stability = Preset

Time/Div = 20 μ s

Variable = Calibrated

Next, **place a source on the detector** and **adjust the signal** so that it is as close to the baseline as possible by using the 'PZ ADJ' dial found on the amplifier.

The energy calibration can now be run again. If any parameter still fails, tag the detector out of service (SOP 317) and notify the lab Supervisor.

All calibration operations must be recorded in the run log, including fine gain adjustments, bounds re-calculations with start and end dates, and calibration re-runs.

8.2 EFFICIENCY CALIBRATION PROCEDURES

Standards for efficiency calibrations shall be traceable to the National Institute for Standards and Technology (NIST). Standards will normally be of the mixed-gamma, multiple-energy type available from several commercial suppliers. The analysis systems shall be calibrated for each physical form of sample to be analyzed (e.g., water, soil, filter, etc.) at least annually. A FWHM calibration shall also be performed at least annually. Note that there is only one FWHM calibration per detector, and it is not geometry specific. Before starting an efficiency calibration, consult with a Senior Instrument Technician. Record all efficiency calibrations in the gamma spectroscopy run log (~~Form 754~~).

8.2.1 SPECTRUM ACQUISITION

Place the calibration source for the appropriate geometry on the detector to be calibrated. The efficiency calibration will be initiated like that of a sample count. First, an internal workorder number must be obtained from the current non-client workorder notebook (located in the radium/strontium lab). Use this workorder number and follow the same procedure used to count a sample. Be sure to enter the appropriate dates and time for the calibration standard (2 hours and/or a duration long enough to acquire 10,000 cts/per energy line that will be used in the calibration). For calibrations where 10,000 cts/per energy

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line cannot be acquired, Supervisory approval is required.

8.2.2 SPECTRUM ANALYSIS

8.2.2.1 After the acquisition is complete, the MCA of the sample spectrum should be read. In the edit parameters screen, enter the standard calibration origin date, and the appropriate volume/sample size. Select 'PEAK SEARCH', then 'CALIBRATE'. The types of calibrations prompted are: Energy, FWHM and Efficiency. Make sure that the 'EFFICIENCY' bullet is selected. The calibration parameters screen is prompted, at which time the operator must choose the appropriate calibration standard, aliquot size and the appropriate fit formula for the efficiency curve (exponential fit is used in most cases).

Select 'OK' to prompt the calibration workspace. Transfer the peak search results by selecting 'MERGE PSR', then 'CURVE FIT'. View the results of the calibration.

The % difference for the measured efficiency should be less than +/- 5% for all nuclides, but may be up to 10% with specific written approval from the instrument lab Supervisor. If the measured difference exceeds this criterion, the calibration will have to be redone. If efficiency limits are met, select 'OK', then 'SAVE', and then print the calibration.

This calibration should be done annually or when maintenance has been conducted on the detector.

8.2.2.2 If the observed efficiencies need to be adjusted to optimize the fit of the calibration curve, this may be done with the approval of the lab Supervisor. *Do not adjust the Cs-137 efficiency.* If the other efficiencies need to be adjusted, manually calculate the new efficiency, by either increasing or decreasing by a known percentage (usually 5 to 10%).

**DO NOT MANUALLY ADJUST EFFICIENCIES
WITHOUT FIRST CONFERRING WITH A SENIOR
INSTRUMENT TECHNICIAN.**

After adjusting a peak, re-start the calibration process (choose the print to screen option until the efficiencies have been accurately adjusted). Manual adjustments are conducted in the calibration work space.

In all cases, manual adjustments of peak efficiencies will be

noted on the calibration output page.

- 8.2.2.3 After the calibration has been stored, analyze an LCS with the appropriate geometry for 1800 seconds to verify the calibration. This analysis must pass normal LCS acceptance criteria.

8.3 ANALYZE INITIAL DAILY CHECK TO SET CONTROL LIMITS

- 8.3.1 Perform a daily check and set control limits off of observed values.

- 8.3.1.1 Centroid: ± 2 Channels

- 8.3.1.2 FWHM: $\pm 35\%$

- 8.3.1.3 Efficiency: $\pm 10\%$

8.4 FWHM CALIBRATION

- 8.4.1 Place a current calibration source on the detector (typically GEO 1 or GEO 13) and begin acquiring count data. The count time is dictated by the sample activity and achieving 10,000 counts in each energy line used to calibrate. The sample ID is the in-house work order number, detector number, calibration type and standard used (example: 0713001-1 FWHM CAL (824)).

8.4.2 After the count time is complete, ensure that the correct geometry is selected for sample analysis then READ MCA and enter standard reference date as sampling date start/end time. Reference time is 12:00 noon Eastern Standard Time adjust to 10:00 Mountain Standard Time.

8.4.3 Do a peak search on the data read from the MCA. Look for any peak shifts but more importantly peak fit errors (ie small peaks near analyte peaks of interest).

8.4.4 Select QC->FWHM from the tool bar. Make sure that the appropriate standard is selected for the standard file. Do not select a background subtraction file. Then select 'OK'.

~~8.4.4~~ 8.4.5 Merge PSR and fit a curve. View Fit Results. The percent difference (% Diff) for all should be less than 10% for acceptance. Look at data points and curve fit for any points that are significantly out of line with other points. Select 'Done'.

8.4.6 Save FWHM calibration and print data report.

8.5 INITIAL BACKGROUND CALIBRATION

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8.5.1 Perform a normal weekly background analysis. Set interim control limits off of observed values $\pm 10\%$.

8.6 WEEKLY BACKGROUND CALIBRATION

8.6.1 A background calibration is performed weekly. Use the general form, "~~yymmdd ## Weekly Bkgd~~", for the sample ID.

8.6.2 Make sure there is no sample in the detector shield. Consult the gamma spec maintenance logbook to see if the detectors have been cleaned within the past month, if not, the detectors need to be cleaned per Section 8.3.5 below.

8.6.3 Start the counts for 1000 minutes (60000 seconds) for each detector in service. Geometry and aliquot are irrelevant.

8.6.4 Record detectors that have been started in the logbook. After the counts are complete, "Read the MCA" and do a 'PEAK SEARCH' as described above. At this point, review the acquired spectral data for evidence of peak-fit errors and/or gain shift. If the spectral quality is acceptable upon review of the 'PEAK SEARCH' results, save the background calibration by selecting 'SAVE AS BKGSUB'. Save each background file as DET##MMDD.BKG, where '##' is the detector number and 'MM' and 'DD' are the month and day the background was started. Then select 'BACKGROUND' under 'QC' on the menu bar. Select 'OK' to analyze the background and see if the count is within control limits. Record any failures in the run log, clean the detector (see 8.~~3~~6.5 below), and restart the background calibrations.

8.6.5 WEEKLY CALIBRATION FAILURES

The inside of the detector must be thoroughly cleaned with a paper towel dampened with Radiacwash[®], or an equivalent EDTA solution. Then wipe the detector with a paper towel dampened with DI water. Record the cleaning date in the gamma spec maintenance logbook.

After this has been done, the background calibration can be run again. If the detector fails after cleaning, the lab Supervisor must be notified and the detector must be tagged out of service (SOP 317) until the problem is resolved.

8.7 QC SAMPLES

One LCS and blank, per geometry, are to be analyzed with every batch of not more than 20 samples.

9. INTERPRETATION OF DATA

The spectrum analysis capabilities of the analytical software are only as good as the software set up. It is essential that appropriate analysis geometries, efficiency files, and library files be used to ensure accurate analyses. Results data must be reviewed as soon

as it becomes available to ensure that the calibrations are correct, that the spectral quality is adequate, and that all Q.C. acceptance criteria have been met.

All unknown peaks greater than 5 times the listed critical level must be qualitatively identified on the raw data of the first sample for which they appear. The spectrum must also be reviewed to ensure that characteristic peaks, such as K-40 at 1460keV, and the annihilation peak at 511keV, do not show evidence of a gain shift. A gain shift may show up as a secondary peak slightly offset from all the normal characteristic peaks in the spectrum. A spectrum that shows evidence of a gain shift must be rejected and the sample re-counted. The detector showing the gain shift must have the fine gain on the amplifier adjusted as described previously in Step 8.1.2.

10. PERIODIC MAINTENANCE

Each detector has a Dewar filled with liquid nitrogen to keep the germanium detector cold. Twice per week, the detector Dewars must be filled with liquid nitrogen. Allow 15 minutes after filling before resuming data acquisition.

If a Dewar runs out of liquid nitrogen between fillings, the red bias display, located on the 'BIAS SUPPLY' control board, will be shutdown. If this occurs, tag the detector out of service, and do not operate the detector until the Dewar can be re-filled. The detector may need to be cycled through ambient room temperature before being re-cooled. The lab Supervisor must be notified before proceeding.

To fill the Dewar, follow the steps below:

- We use the vertical cryostat mounting arrangement; if liquid nitrogen (LN₂) or cold vapor contacts the top section of the detector the pre-amplifier may malfunction (due to heating and cooling or moisture) and/or the vacuum seal may be breached.
 - Care must be taken to ensure that LN₂ does not contact the cryostat, endcap of electronics section of the detector system.
 - Filling the dewar-flask slowly helps to avoid detector contact between LN₂ and cold vapors. The valve on the LN₂ source can be opened full and the second valve used to control flow.
- Dewar Flange/Silicone Collar: The silicone collar contains two tubes used for gas fill and exhaust. The exhaust tube prevents the LN₂ level from rising to within 6 inches of the dewar flange if there are no leaks at the collar. **It is important not to damage the silicone rubber collar.** Do not use excessive force to attach or remove a hose from the fill tubes.
- Stop immediately when the dewar is full.
- Safety: Relieve pressure at supply dewar and allow hoses to thaw completely before removing.

If detector is being cooled from ambient temperature, manufacturer recommends overnight equilibration./SI 21Mar07

- Record all liquid nitrogen fills and re-fills in the gamma LN₂ fill logbook.

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11. DEVIATIONS FROM THE METHODS

Where EPA drinking water methodologies are required by the client, the LCS and Matrix Spike recovery acceptance criteria shall be $\pm 20\%$, irrespective of the lab's internally derived acceptance criteria.

12. SAFETY, HAZARDS AND WASTE DISPOSAL

12.3 SAFETY AND HAZARDS

All Safety and Hazards are managed in accordance with the current facility plans:

- Chemical Hygiene Plan (CHP)
- Radiation Protection Plan (RPP).
- Emergency and Contingency Plan (ECP)
- Respiratory Protection Plan (RESPP)

~~12.3~~

~~8.3.1 Normal laboratory safety procedures (gloves, safety glasses, and lab coats, where necessary) must be complied with during the conduct of this procedure.~~

~~8.3.1 Bias applied to detectors is typically in the range of 1000 to 4000 volts DC. This can result in electric shock if bias cables are disconnected while bias is applied. To minimize the possibility of electric shock, bias shall be turned off to any detector before any cabling is disconnected.~~

~~8.3.1 The liquid nitrogen used to fill the Dewars is at -196°C . Exposure to the skin can cause severe frostbite. Use insulated gloves when handling frozen lines, valves, etc.~~

~~8.3.1 Large liquid nitrogen spills can displace room oxygen and cause asphyxiation. In case of a large liquid nitrogen spill, open the lab doors and allow the liquid nitrogen to dissipate before re-entering the lab.~~

12.4 WASTE DISPOSAL

All Wastes are disposed of in accordance with the Waste Management Plan (WMP)

~~12.4~~

~~8.4.1 The gamma spec instrument technician is responsible for returning the samples to the sample custodian or to the sample storage area after analysis, completing the internal chain of custody (SOP 318).~~

~~8.4.1 Some samples will be returned to the client after analysis. Samples or sample wastes containing radioactive materials, which are not being returned to the client, must be disposed of according to ALS's procedures for disposal of radioactive materials. Contact the Waste Disposal Coordinator for more information.~~

13. REFERENCES

- 13.3 ANSI N42.14, American National Standards Institute, Calibration and Usage of Germanium Detectors for Measurement of Gamma Ray Emission of Radionuclides, April 1978, Reaffirmed April 1985.
- 13.4 EPA-600/4-80-032, Prescribed Procedures for Measurement of Radioactivity in Drinking Water, "Method 901.1, Gamma Emitting Radionuclides", August 1980.

APPENDIX A COMMON GAMMA ENERGIES AND CHANNEL LOCATIONS

This Section is provided to assist in determining proper channel locations during calibrations and QC checks.

NUCLIDE	*ENERGY (keV)	TARGET CHANNEL
Am-241	59.54	120
Cd-109	88.04	176
Co-57	122.06	244
Cs-137	661.65	1324
Y-88	898.04	1796
Co-60	1173.22	2346
Co-60	1332.49	2664
Y-88	1836.06	3672

* The Kocher's Decay Manual is the primary source (located on the network at work order review) used for determining the energy lines of the gamma photons used in the gamma spectroscopy libraries. Some libraries are set-up according to client specified energy lines in which case the source is unknown.

NOTE: ALS uses a 2.0keV matching tolerance for nuclide/energy matching; this will allow up to a 4 channel deviation from target channels. In addition, the daily QC checks perform energy versus channel calibrations each time they are run, correcting for small changes in peak channel locations.

APPENDIX B
GEOMETRY/EFFICIENCY LIST

Geometry Number	Geometry Description	Default Count Time (min.)	Efficiency file/Standard file number
01	1 liter H ₂ O in 2 liter Marinelli	300	01
07	47mm Filter	60	07
08	Five 10 cm filters	1000	08
09	Hi-Q charcoal cartridge	60	09
13	500g Solid	30	13
11	100g Solid	30	11
*17	215g Solid	30	17
18	1350g Solid	120	18
*26	215g Solid (Ra-226)	30	26
27	1332g Solid (Ra-226)	120	27

* Unless otherwise directed, samples packed for Geo17/26 will be ingrown 21 days before analysis to allow Rn-222 to approach secular equilibrium with its parent, Ra-226.

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APPENDIX C

SUMMARY OF INTERNAL QUALITY CONTROL (QC) PROCEDURES AND CORRECTIVE ACTION

QC Check	Frequency	Acceptance Criteria	Corrective Action
Efficiency Check	Daily	Within derived control limits, as established in instrument software.	Recount, re-evaluate, service instrument, if necessary or document why condition is acceptable.
Peak Resolution Check	Daily	Within derived control limits, as established in instrument software.	Recount, re-evaluate, perform pole-zero adjustment, if necessary, and repeat daily performance checks.
Energy Calibration	Daily	Within derived control limits, as established in instrument software.	Recount, re-evaluate, perform fine gain adjustment, if necessary, and repeat daily performance checks.
Peak Background Calibration	Weekly	Within derived control limits, as established in instrument software.	Clean detector, recount, re-evaluate, or document why condition is acceptable.
Efficiency Calibration	Yearly, for each counting geometry.	Each fitted value is within 5% of the observed value. Subsequent LCSs pass within normal acceptance criteria. *	Tag geometry off-line. Determine and correct problem; verify source activity; recount and/or recalibrate. With supervisors written approval, fitted values may be within 10% of observed value.
Peak Resolution (FWHM) Calibration	Yearly	Each fitted value is within 10% of the observed value. Subsequent LCSs pass within normal acceptance criteria. *	Perform pole-zero adjustment, if necessary, and repeat.
Gain shift	Each sample	Review each spectrum to ensure that characteristic peaks @ 511, 1460 KeV are present, not shifted during the count, and properly ID'd by software.	Recount sample after daily performance checks are successfully performed.

NOTE: This SOP and SOP 715 contain acceptance criteria and corrective action for method blank, laboratory control samples, duplicate samples and matrix spike/matrix spike duplicates.

* as established in the applicable LIMS nickname (e.g., Paragon Standard or as created for a specific client)

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APPENDIX D

GENERAL GAMMA DETECTOR INTALLATION NOTES

Upon receipt of a new or repaired detector the following steps must be taken prior to data acquisition.

- 1) Inspect the detector for damage during transit.
- 2) Review accompanying documentation to ensue the following;
 - a. Quality Assurance Data Sheet. This documents the detector performance after repair/manufacture.
 - b. Spectrum Printout: Supplements the QADS.
 - c. Repair Analysis Report (if detector was repaired). This documents the problems identified with the detector and any corrective action/repairs that were undertaken.
- 3) Cool the detector.

NOTE: The detector must be cooled overnight before applying bias. Do not connect the detector cabling until the assembly has cooled in LN overnight.

- a. Inspect the nitrogen dewar to be used, if necessary.

Note: In all cases, the dewar should not be placed directly on the floor. Insert some vibration absorbing material between the dewar and the floor to minimize microphonic noise (low frequency harmonics) in the detector.
- b. Fill the dewar with LN, to within 3-4" of the top of the neck. Do not allow the LN to overflow or to contact the latex collar, though the collar will be cold after filling.
- c. Allow the collar to warm for 20-30 minutes to allow enough flexibility to insert the detector cryostat.
- d. At this step it is helpful to have a second technician waiting underneath the shield to receive the detector cables and to adjust the position of the dewar, as necessary.
- e. Feed the long grey pre-amp cable through the top of the opening in the shield.
- f. Carefully insert the cryostat through the shield, into the LN dewar. After inserting the cryostat partway, feed the detector leads through the opening. It may be necessary to move the dewar slightly to one side to accomplish this.
- g. After all the cables are clear of the shield and collar, center the dewar and insert the cryostat completely into the LN.

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- h. The initial cooling of the detector may use a significant volume of LN. After the detector has cooled for 2-3 hours, top off the LN, filling the dewar until the LN spills out of the overflow port.

APPENDIX E

EXAMPLE

Gamma Spectrometer Calibration Log

Daily checks are run for 10 minutes on each currently operating detector. Each detector has an individual check source prepared from a dilution of standard #6635A-307, #68681-307 and #64122-307.

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Gamma Spectrometer Calibration Log

Date: _____ Reviewed By/Date: _____

Det. No.	Out Of Service	Background		Source Check			Repeat Source Check			
		Started	OK	Started	OK	Failed Parameter(s)	OK	Failed Parameter(s)	Corrective Action Taken **	Removed from Service
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										

.** Corrective Action:

_____ A

~~Form 754r13a.doc~~
(7/20/07)

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Gamma Spectrometer Run Log

Date: _____ Reviewed By/Date: _____

Sample ID	Ver ¹	Det. No.	Geo ²	Count Dur. (min.) ³	Start Time	Analyst	File ID/Comments	Saved?

¹ Analyst will verify the position, detector, and geometry when the sample is removed from the detector.

² Calibration geometry.

³ Count duration.

KEY:

* sample was counted on a puck
↑ sample was counted with air flow arrow pointing up
↓ sample was counted with air flow arrow pointing down

ALS Standard Operating Procedure

DOCUMENT TITLE:	ANALYSIS OF ALPHA EMITTING RADIONUCLIDES BY ALPHA SPECTROSCOPY
REFERENCED METHOD:	-----
SOP ID:	714
REV. NUMBER:	2
EFFECTIVE DATE:	APRIL 5, 2013

ALS

STANDARD OPERATING PROCEDURE 714 REVISION 12

**TITLE: ANALYSIS OF ALPHA EMITTING RADIONUCLIDES BY
ALPHA SPECTROMETRY**

FORM: APPENDIX B, C

APPROVED BY:

TECHNICAL MANAGER _____ DATE _____

QUALITY ASSURANCE MANAGER _____ DATE _____

LABORATORY MANAGER _____ DATE _____

1. SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the steps necessary to perform spectroscopic analysis of alpha emissions on samples of various media using high-resolution ion implanted silicon alpha spectrometry. This procedure is applicable to all alpha spectrometry analyses performed at ALS. The target analytes are routinely separated from liquids (primarily aqueous) and solid samples (primarily soils, wastes, filters) following equilibration of the sample with a suitable isotopic tracer, and mounted by micro-precipitation onto 25mm, 0.1 micron (μm) pore sized filters, fixed into 31mm stainless steel planchets. Analyte activity is derived from the relative count rates of analyte and tracer isotopes and the known activity of tracer added. When no suitable nuclide is available for use as an isotopic tracer (e.g., ^{237}Np), splits of each sample are prepared following addition of a known quantity of NIST-traceable tracer solution of the target analyte. The chemical yield data generated from split sample analysis is used for the calculation of sample results.

2. SUMMARY

Alpha emissions from radionuclides are detected by an ion-implanted semiconducting silicon wafer, which transfers the energy deposited into a small electronic pulse for each alpha interaction, where the pulse height is proportional to the incident alpha energy. The 600mm² ion implanted silicon detectors are mounted in vacuum chambers and operated at or below 500 milliTorrr absolute pressure to minimize loss of alpha particle energy during the path from the sample to the detector. The data collection and processing is performed through the AlphaVision32[®], v5.3 software package.

3. RESPONSIBILITIES

- 3.1 It is the responsibility of the analyst to perform the analysis according to this SOP and to complete all documentation required for review. The Alpha Spectroscopist is responsible for day-to-day operations, calibrations, troubleshooting, repair of

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the instrument, and related details

- 3.2 It is the analyst's responsibility to ensure that the activity of the calibration sources are properly verified at least annually by comparison to an independent source. In addition, it is the analyst's responsibility to ensure that the independent source has been verified by a NIST-traceable laboratory within a year of use. In practice this means that the independent source can be sent off-site for re-verification at an interval of just less than two years.
- 3.3 It is the responsibility of the analyst to be familiar with the acceptance criteria for the QC samples and other quality indicating parameters, as specified in SOP 715.
- 3.4 Analysis and interpretation of the results are performed by personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this method. This demonstration may come in the form of Supervisory/training review, precision and accuracy tests, or the successful completion of an unknown proficiency test sample.
- 3.5 ALS's LIMS program specification system and associated project analyte nicknames are the means by which client-specific requirements for sample preparation, analysis, data evaluation and reporting are communicated to the laboratory. This system includes automated electronic controls where possible. The criteria defined in the program specification supercede ALS's standard criteria. It is the responsibility of all personnel who work with samples or data involving this method, to consult the applicable LIMS program specification for client-specific requirements prior to initiating handling of samples or data.
- 3.6 The Department Supervisor or designee performs final review and sign-off of the data. Initialing and dating the report components and review checklists indicate that reviews for precision, accuracy, completeness, and reasonableness are complete and satisfactory. Any errors that are found require corrective action, which includes notification to the technician/analyst who performed the work and documentation of measures taken to remediate the data.
- 3.7 It is the responsibility of all personnel who work with samples involving this method to note any anomalies or out-of-control events associated with the analysis of the samples. Any discrepancies must be noted and corrective action taken, documented, and approved by the Department Manager or designee.

4. INTERFERENCES

- 4.1 The presence of excessive precipitate in the final source will lead to degradation of spectrum quality due to self-absorption effects. Excessive tailing, poor peak separation or visible evidence of unusual amounts of solids on the final source may necessitate cleanup of the sample (by dissolving LaF_3 -analyte precipitate in boric/nitric acid, co-precipitating as a ferric hydroxide, dissolving FeOH_3 in HCl

and repeating the microprecipitation steps. Additional column separation may be necessary to remove various interfering constituents).

- 4.2 The levels of activity taken for analysis should be minimized to prevent contamination of the detection system and overwhelming the tracer. Aliquot size should be judged according to expected activities for the samples (refer to pre-screening data available in the work order folder) and should generally be held within the range of less than 30-50pCi.
- 4.3 For the alpha spectrometry system, a sample with elevated activity is defined as one that has more than 200 total disintegrations per minute (DPM) deposited on the planchet. This includes all requested analytes of interest as well as the tracer analyte. When such a sample is encountered, the Preparation Lab and Instrument Lab Supervisors must be notified so that they can investigate the possibility of equipment contamination. At the instrument, a background check of the detector used to count the sample must be performed before any subsequent samples may be counted by that detector. This is performed to ensure that detector contamination did not occur, which could bias subsequent analyses on that detector. Generally, a 1000-minute background calibration is run in order to fulfill the background check requirement. If the new background calibration passes quality control criteria, this calibration replaces the previous weekly background calibration until the next weekly background calibration is performed. If the new background calibration fails to meet quality control criteria, consult the Department Supervisor for corrective action. Please refer to Section 11 of this SOP for background quality control criteria.
- 4.4 The ALS default minimum detectable concentration (MDC) formula referenced in this SOP 708 conservatively assume that background count times equal or exceed sample count times. If extended count times are necessary to meet data quality objectives (DQOs), it is advisable that dedicated background counts be conducted immediately prior to the count to both ensure that count time parity is achieved, and to minimize the potential effect of detector contamination.
- 4.5 The presence of significant peak activity in a spectrum other than that expected (e.g., thorium peaks in a plutonium spectrum) is significant cause for concern. Re-preparation or appropriate sample cleanup may be indicated. Consult with the Department Manager for advice in such cases.
- 4.6 Detectors are segregated into U/Th/Np only and Am/Cm/Pu/Np/Po only due to the progeny resulting from U/Th samples. The U/Th progeny will cause an interference in Am/Cm/Pu measurements.
- 4.7 In some cases, the addition of normal tracer analytes will cause interference in other analytical regions of interest (ROIs). For example, ^{229}Th activity generally “tails” into the ^{230}Th ROI, and ^{243}Am may have measurable ^{241}Am activity present.

These potential interferences must be accounted for in the analytical procedure.

- 4.8 In some cases, two requested analytes may be indistinguishable by alpha spectrometry (e.g. ^{233}U and ^{234}U). In these cases, the combined ROI is reported as a single result for both analytes (e.g. $^{233/234}\text{U}$).

5. APPARATUS, MATERIALS AND REAGENTS

This procedure is conducted with the use of installed alpha detection and analysis equipment consisting of ion implanted silicon detectors mounted in combination vacuum chambers/spectrometers. These spectrometers are controlled by a personal computer based analysis system with multi-channel analyzer interface, integral multi-channel analyzers (MCAs), alpha analysis software, and associated cabling. Currently, the analysis software used to analyze samples is AlphaVision32[®], Version 5.3, by EG&G Ortec Corporation. The alpha detectors used to count samples are Ortec "U-024-600-AS" 600mm² ULTRA_AS ion-implanted detectors, or equivalent. In addition, the following materials are used for routine maintenance of the detectors.

- 5.1 KimWipe[™] lint-free wipes
- 5.2 cotton balls
- 5.3 Methanol, reagent grade
TLV=200ppm
- 5.4 canned (pressurized) air

6. SAMPLE HANDLING

- 6.1 All samples received by the radiochemistry Instrument Lab must be checked in within one business day, using the LIMS internal chain of custody (SOP 318).
- 6.2 Generally, samples with long count times (greater than 360 minutes) are loaded at the end of the day. Samples with shorter count times (less than 360 minutes) may be loaded throughout the day, as time allows
- 6.3 Generally, samples are prioritized for counting based on the client requested due date.
- 6.4 Polonium is generally volatile under the vacuum conditions used in this analysis. Samples for polonium analysis are sealed with a thin film covering to prevent detector contamination. The planchets should be carefully handled on the outside of the planchet, with a gloved hand rather than forceps, to prevent puncturing of the thin film.
- 6.5 In some cases, short-lived analytes or interfering progeny may require samples to be analyzed as quickly as possible. For example, ^{227}Th has an 18.72 day half-life and significant delays in counting will result in elevated detection limits. Also, the ^{232}U - progeny, ^{228}Th ingrows with a half-life of 1.9 years and significant delays in counting will result in ^{228}Th interference in the ^{232}U ROI.

- 6.6 Uranium and thorium analyses, particularly those in high activity samples, should be removed from the detector as soon as possible after the completion of the count to prevent recoil and progeny contamination of the detector.
- 6.7 Standard verifications and proficiency demonstrations should be analyzed and processed within 48 hours of receipt from the prep lab due to the pressing production needs of the Department.
- 6.8 Planchets will be stored in the Instrument Lab for a minimum of three months prior to disposal to allow for reanalysis if necessary.

7. PROCEDURES

Instructions are given for the AlphaVision32[®] program, Version 5.3. Throughout the text of this document, < > defines a computer keystroke, ___ defines a window header, and [] defines a menu option on the AlphaVision software. Basic technician-level access to AlphaVision can be obtained through the user name “user” and the password “user”. See the Department Manager for administrator- and supervisory-level access.

7.1 OPERATING CONDITIONS

The alpha spectrometers are operated in a low vacuum system, less than 500milliTorr absolute pressure, at detector bias voltages of typically 30-50 volts DC. The operating conditions shall be verified weekly by running energy/efficiency and background calibrations on each detector. See Section 11 for quality control procedures.

7.2 SAMPLE PREPARATION

Samples are prepared by radiochemical separation applicable to the radionuclide(s) being evaluated. Samples are prepared in the Actinides Preparation laboratories using chemical separation and deposition processes (refer to the radiochemistry preparations procedural SOPs for specific information). The samples are received in the Instrument Lab in the form of a filter mounted on a labeled planchet or as in the case of ²¹⁰Po, as an electroplated disk to be counted.

7.3 DATA ACQUISITION AND ANALYSIS

7.3.1 Each alpha spec detector is separately contained in a metal housing with an o-ring sealed door hinged at the bottom of the housing. Forceps are used to handle planchets. Planchets are loaded into detectors that are calibrated and have passed all QC checks. Planchets for Uranium or Thorium analysis are loaded only into those detectors that are designated for U/Th. Detector numbers are recorded in the appropriate place on the benchsheet. To load the planchets into the detectors after the vacuum has been properly released from the chamber (see below): Open the door, slide out the tray, place the planchet on the tray, slide the tray back in. Make sure the filter paper on the planchet is centered under the detector. Close the door. *Note*

that the tray position within the chamber should always be in the position of the current calibration; currently that position is the default (top) position in the chamber.

- 7.3.2 Before the analysis can be started, the detector chambers must be evacuated. There is one vacuum line connected to each tower. To evacuate a chamber, turn the knob under the door to the 'PUMP' position. However, once the knob has been turned to apply vacuum to a chamber, all other chambers that are connected to the same vacuum line will temporarily lose vacuum and bias. *If bias to chambers is lost during active counting of samples, the data quality will be compromised!*

On the AlphaVision (AV) grid displayed on the computer, certain colors are set to indicate the status of the chambers:

- **Green** indicates an idle chamber.
- **Red** indicates a detector that is offline.
- **Yellow** indicates a chamber with an active count running.

Therefore, before applying vacuum, chambers where data is being acquired must have the vacuum put on hold by turning the knob under the door to the 'HOLD' position. For example, to start a count in a detector or group of detectors with other samples counting in the same tower (and thus sharing the same vacuum manifold), the vacuum must be put on 'HOLD' for detectors containing the samples that are already counting.

Now it is safe to turn the knobs to the right to 'PUMP' to evacuate all detectors that have been loaded. It is necessary to manually check that all detectors have been properly evacuated. This is done by selecting 'MCA VIEW' by right clicking on that detector with the mouse. Once the spectrum window has opened, select [ACQUIRE] and [ADJUST CONTROLS...]. The vacuum pressure, bias voltage, and current can now be viewed. Once it has been verified that all detectors are pumped down, the detectors that have been placed on 'HOLD' can now be turned to 'PUMP'.

- 7.3.3 Record the Detector Number, Analytical Run, Sample ID, Analyte Type/Matrix, Count Duration, and Analyst's Initials and in the Alpha Spectroscopy Run Log (Form 746).
- 7.3.4 After samples have been loaded, and the counting chambers evacuated,

start spectrum acquisition as follows:

- 7.3.4.1 From the AV menu bar select [PROCESS] then [BATCH].
 - 7.3.4.2 Under General, enter the analytical run (i.e., UAS0608100-2_A) and select the correct template (i.e., iso U or U default) from the drop down menu. Select, [NEXT] which will move to the next screen.
 - 7.3.4.3 In the Batch screen, select the current month and analyte type. Select [NEXT], which will move to the sample screen.
 - 7.3.4.4 In the Sample screen, select [ADD]. A new small screen will open. Enter sample ID of first sample of analytical run only. Select [OK] to close the small screen. Enter the correct sample units (g, L) and sample aliquot size (This may be done in whole numbers instead of entering exact aliquot volumes. In order for LIMS to perform the final calculations, it queries aliquot volumes from the benchsheet, not from the aliquot entry in AV. Therefore, rounding of aliquot sizes in AV does not impact data quality). Select [NEXT], which will move to the Acquisition screen.
 - 7.3.4.5 In the Acquisition screen, enter the run time in minutes. Select [NEXT], which will move to the Analysis Setup screen.
 - 7.3.4.6 In the Analysis Setup screen, select the correct nuclide library, ROI set, and Tracer set from the drop down menus. Enter the Tracer amount from the benchsheet.
 - 7.3.4.7 Select [PREVIOUS] to return to the Sample screen. Enter the remaining sample IDs from the analytical run. Select [FINISH], which will open a screen showing all sample IDs that have been entered.
 - 7.3.4.8 To assign detectors, select a desired detector and drag over to the appropriate sample ID. When all detectors have been assigned, select [START NOW].
- 7.3.5 When unloading samples, release the vacuum as slowly as possible by turning the knob counterclockwise from 'Pump'. Turn the knob slowly the rest of the way to vent. *Air should not be heard rushing into the detector to any appreciable extent as air current stirs up particles and*

potentially contaminates the detector and chamber.

- 7.3.6 When removing the samples from the detector chambers, verify the position by checking the sample removed from the detector against the detector # recorded on the benchsheet. Any discrepancy should be noted on a QASS and/or the benchsheet and the raw data printout. If a discrepancy is found, the sample may need to be re-analyzed.

7.4 SPECTRUM ANALYSIS

Each nuclide emits alpha particles at distinct energies characteristic of the decaying species (see attached Table 1 for a short list of energies). When an alpha particle is incident on the detector, an electrical pulse is generated, the signal produced is analyzed according to pulse height, and is stored as a count in the appropriate channel of the given MCA buffer. As the number of counts stored increases, peaks for each radionuclide begin to form. AV is programmed to conduct an ROI analysis of the spectrum from the data gathered during the count and information that was previously entered (i.e., tracer DPM, target nuclides and relative ROIs, recovery type, etc.). The results of the analysis are then summarized in a raw data results report and a graphical hardcopy printout of the spectrum is produced. The raw data results are also written to the AV database.

- 7.4.1 After sample acquisition has been started, it is possible to examine the spectrum “live” to make a real-time estimate of chemical yield expected for that sample (note that sufficient time must have elapsed for the spectrum to be discernible, 10-15 minutes is usually sufficient).

7.4.1.1 This may be accomplished by selecting the detector with the mouse, right clicking and choosing [MCA VIEW]. At this point, the chemical yield can be estimated from the net area of the peak. The detector may also be manually analyzed in order to get a printout to determine preliminary chemical yields. See Section 9 for the appropriate calculation.

7.4.1.2 Alternately, select the “spectrum” line in the sample entry in the upper right window, right-click the mouse and select [INTERIM ANALYSIS]. This will perform a normal analysis, as described in Section 7.4.2 below, using the data acquired thus far. The analysis report will show calculated yields, activities, etc. as well as a printout of the interim spectrum.

- 7.4.2 When the preset live time has elapsed, the detector icon turns solid green to indicate that the full count duration has elapsed. The spectrum and analysis data is then reviewed prior to printing the raw data and

saving the .pdf image.

- 7.4.2.1 In some cases the software fails to recognize the tracer peak in the spectrum and the analysis sequence is stopped before completion. In this case, at the analyst's discretion, the analytical sequence may be manually taken to completion. Select the analytical parameters by right-clicking the mouse on the spectrum entry in the upper right window. Select [ANALYZE]. In the Analysis window, uncheck the "Shift With Tracer" box, then select [OK]. ROIs may then be evaluated, as described below.
- 7.4.2.2 Select the "analysis" line in the sample entry in the upper right window. This displays the spectrum and ROIs in the "Spectrum" tab. Specific analytical considerations for evaluating and adjusting ROIs are discussed below. *NOTE – due to limitations in the AlphaVision software, if ROI adjustments need to be made, first select [INTERACTIVE ROI ANALYSIS].* Adjust ROIs as necessary. ROIs can be adjusted by dragging the ROI boundaries left and right. Finally, select [INTERACTIVE ROI ANALYSIS] again.
- 7.4.2.3 Select the "Report" tab at the bottom left of the report window to display the raw data report. Select the printer icon at the top left, which will call up the default PDF Factory program. Save the image under the file name designated on the LIMS Instrument Worksheet (e.g., U81925D.PDF), then print a hard copy for further review.
- 7.4.3 After samples have finished counting, perform a cursory review of the raw data printouts to ensure that chemical yield, duplicate error ratio(s) (DER), minimum detectable activity (MDA), tracer counts, blank activity, and laboratory control sample (LCS) values all satisfy applicable data quality objectives. Check the spectra for peak shifts and peak resolution. Verify that a raw data printout and spectrum is present for all counted samples. Determine if there are samples to be recounted or re-prepared. This will give the Preparation Group adequate time to complete a re-extraction if any of these parameters fail to pass acceptance criteria.
- 7.4.4 In the absence of client-specific yield requirements, a sample that has between 15-30% yield recovery may be reported in some cases. In such cases, spectral quality must be acceptable in the analyst's judgment and all other QC criteria must be met. The sample is flagged with a "Y2" flag, a narrative comment is made, and the results are

reported, with Supervisory oversight.

Samples with chemical yields below 15%, those with yields below client-specific yield requirements, or those that do not meet the spectral quality requirements listed above require corrective action. An NCR will be initiated (see SOP 928) and sample re-extraction may be necessary. Samples with low yields may still be reported when a sample is of an uncommon matrix, if re-extraction would not be expected to produce improved chemical yield, or if a second extraction of a sample shows repeated poor chemical yield (generally an indication of matrix interference). Low yield is always documented in a case narrative, and an explanation is included if the sample was not re-analyzed. Consult with the Department Manager and the Project Manager before reporting results for a sample that has shown poor yield.

- 7.4.5 DER values are calculated using the formula found in SOP 715. Compare blank activities to established limits and, if applicable, to client/project-specific data quality objectives. Compare LCS results to the known values for a particular radionuclide for appropriate spikes. The known values are found on the benchsheet; crosscheck this against the standard verification worksheet.
- 7.4.6 Sample measurements are routinely determined by internal addition of isotopic tracer to each sample prior to separation. Samples are traced with adequate activity and counted for a sufficient period of time such that counting uncertainties of approximately 5% (1 sigma) are obtained for the tracer peak (approximately 400 net tracer counts). Samples that do not achieve approximately 400 tracer counts may be counted longer or are re-prepared to achieve the target uncertainty. However, if tracer counts fall below 400 and all other QC criteria are met and assuming that the additional uncertainty is clearly reflected in the reported TPU or clearly documented in the case narrative, then the samples may be reported, with Supervisory oversight.
- 7.4.7 ROIs are areas that encompass spectral peaks. Default values have been set based on the expected energies defining the channels between which specific nuclide peaks are expected to fall. Occasionally, slight adjustment of the ROI by a few channels may be necessary to ensure good fit with the acquired data before a final report can be generated. To adjust the ROI, the general guidelines used consist of:
 - 7.4.7.1 For routine Isotopic Uranium, set the boundaries for ^{238}U and ^{234}U so that they are the same distance from the centroid as they are for the tracer, ^{232}U . The ^{235}U ROI will

encompass an energy range from approximately 4217keV to 4396keV. The count data for this ROI will be abundance corrected for 85.1% of the total alpha activity measured. This technique minimizes the high bias to the ^{235}U results due to tailing of the ^{234}U peak.

For Isotopic Uranium where $^{235/236}\text{U}$ is requested, set the boundaries for ^{238}U and ^{234}U so that they are the same distance from the centroid as they are for the tracer, ^{232}U . The area between the right boundary of ^{238}U and the left boundary of ^{234}U represents $^{235/236}\text{U}$. The ^{238}U , $^{235/236}\text{U}$, and ^{234}U regions should be directly adjacent to each other with no space in between.

7.4.7.2 For Plutonium and Americium, when there are no peaks for the nuclides and the tracer peak resolution is good, ROIs are set to correspond to energies listed in Radioactive Decay Data Tables, David C. Kocher (reference available on ALS network). Set the ROI for the missing nuclide between the higher and lower energies.

7.4.7.3 Samples analyzed for Isotopic Thorium concentrations have a radioactive tracer, ^{229}Th , added to allow for chemical yield determinations in the separation process. A limitation of this method is that all client and QC samples demonstrate the presence of a small amount of characteristic activity in the ^{230}Th region of interest (ROI) that is attributable to ^{229}Th activity. Peak resolution at this level is inherently limited by methodology and software capabilities.

In order to avoid a high bias to the reported ^{230}Th activity concentrations, an arithmetic correction is made to the count rate in the ^{230}Th ROI. A population of method blank samples, which is assumed to be free of ^{230}Th contamination, is analyzed and the average net contribution to the ^{230}Th ROI is used to make the arithmetic correction. The current blank population (established in April 2006) showed the ^{230}Th correction to be 2.73% of the counts acquired in the ^{229}Th ROI. This value is re-evaluated yearly.

The adjusted number of ^{230}Th background counts is, therefore, calculated as (^{230}Th ROI Calibrated Background Counts) + (0.0273 * ^{229}Th ROI Net Counts). This adjusted

background count number is used in all the usual calculations for Net Activity, Counting Uncertainty, and Minimum Detectable Concentration.

This adjustment to the ^{230}Th background counts is made automatically by entering the correction value (2.73%) in the “Contaminated Tracer” box of the “Tracer Information” screen in AlphaVision. This information should only be entered under the supervision of the Department Manager.

For Thorium samples without ^{230}Th activity, set the ROI for the LCS first. This defines the shape of the peaks and gives an idea of the location and the size of the tracer peak. Note the channel for the middle of the tracer peak of the LCS. Additionally, note the channel for the lower energy end of the ROI for the tracer peak of the LCS. The difference in channel number will be used to set the ROI for samples without appreciable ^{230}Th activity. Samples with ^{230}Th activity will have enough peak resolution in order to accurately set ROI boundaries. For a sample without significant ^{230}Th activity, determine the channel number for the middle of the tracer peak, subtract the number of channels determined from the LCS, and set the lower energy ROI at the new channel.

- 7.4.8 The full width at half maximum (FWHM) is defined as the width of the peak distribution at a level that is half the maximum ordinate of the peak. Except for isotopic thorium analyses, in determining acceptable resolution, the tracer FWHM shall be between 40 and 100keV. Consult the Supervisor for samples that do not meet this criterion. If the deviation is minimal and all other criteria are met, results are reported with a narrative comment and supervisory approval.
- 7.4.8.1 Due to limitations in the AV software, the FWHM may need to be manually confirmed, if the reported value falls outside the 40–100 keV range.
- 7.4.8.2 Find the channel inside the peak with the greatest number of counts. Divide this number of counts by 2 to obtain the “half max” value.
- 7.4.8.3 Find the left-most channel of the peak that has counts less than the “half max” value. Move the cursor to the right, counting the number of channels, until the right-most channel of the peak that has counts less than the “half-max”

value is selected. Multiply this number of channels by the slope of the energy calibration (nominally 10.0 keV/CH) to obtain a conservative estimate of the FWHM value, in keV.

- 7.4.8.4 If greater precision in the FWHM estimation is necessary, calculate the partial channels associated with either side of the spectrum by fitting a straight line between the two channels that bound the “half-max” value, and interpolating the precise point at which the “half-max” value is obtained.

For example, suppose that the half-max value is 80 counts, and left-hand side of the peak includes channel 123 with 70 counts, and channel 124 with 95 counts. The slope of the number of counts per channel is 25 cts/CH (i.e., 95cts-70cts).

Determine the portion of the channel where the peak crosses the 80-count level. This point is calculated as $(80 \text{ cts} - 70 \text{ cts}) / (25 \text{ cts/CH})$ or 0.4 channel. Repeat this process for the right side of the peak.

To calculate the FWHM for this peak begin with an initial value of 0.4 CH, start at channel 124 and count to the right as described above, stopping at the channel that has counts greater than the “half-max” value, and add the fraction of a channel calculated for the right side of the peak. Convert this to keV units by multiplying by the slope of the energy equation.

- 7.4.9 Isotopic Thorium uses ^{229}Th as a tracer analyte. Because ^{229}Th occurs at emission energies from approximately 4800-5100keV at various branching ratios, this peak is expected to be much broader than other isotopic tracer peaks. Therefore, the calculated FWHM value is expected to be greater than that for other analyses, and spectral quality is still sufficient for accurate quantification. Inspection of thorium spectra from analyzed quality control samples (method blanks and laboratory control samples) indicates that a FWHM value equal to or less than 160keV still provides adequate spectral quality. Therefore, for thorium analyses, 160keV is used as the upper FWHM limit. As with the other analytes, if deviation from 160keV is minimal and all other criteria are met, results are reported with a narrative comment and Supervisory approval.

- 7.5 MAESTRO (MCA CONTROL OPTION IN ALPHAVISION)
Maestro is used to examine a live spectrum (one that is in the process of being acquired). Maestro can be accessed in AlphaVision by selecting the detector on

the grid, right click on the mouse, and select [MCA VIEW]. Data acquisition can be stopped and started, and the buffer cleared with the normal menu options. After viewing the spectrum, exit Maestro to return to AlphaVision.

7.6 DATA REPORTING

7.6.1 For the final data package, individual results forms, QA results forms, and results summaries are generated. These reports are created in LIMS after uploading data from the AV database in the R:\USER directory. The data is uploaded by double-clicking on the "LIMS DATA TRANSFER" icon, located on the desktop of the AV computer.

REVIEWING HARD COPY REPORT FORMS

Review all forms for completeness. Crosscheck raw data to the Raw Data Report form. Check yields, activity values, MDC values, and other data quality control parameters. Note any flags that require an explanation in the narrative.

7.6.2 NARRATIVES

For most clients, a general narrative template may be used.

The narrative template gives a summary of the samples included in the data package, including preparatory information, any anomalous situations encountered, any quality control deviations, or any other applicable information which may affect data quality. .

7.6.3 NARRATIVE COMMENTS

- Any time there is a Non-Conformance Report (NCR), a narrative comment and a copy of the NCR is required. Any time data quality objectives have not been met, but the deviation is not great enough to prohibit reporting (i.e., activity in the blank, but not greater than the requested MDC; $1.42 < \text{DER} < 2.13$ (warning versus control limits, see SOP 715); requested MDCs not met as a result of small sample aliquot size), a narrative comment is required.
- Minor anomalous situations that have no effect on results usually do not require a narrative comment, but should have a Quality Assurance Summary Sheet (QASS, Form 302). If in doubt, ask the Department Manager regarding the proper way to narrate an anomalous situation.
- **Gross QC failures cannot be narrated without proper NCR documentation!** If any of these types of situations are discovered at the time of reporting, notify the Department Manager and Project Manager immediately. The following types of situations require an NCR and most likely will require

a re-extraction: LCS exceeds control limits; activity in blank greater than requested MDC; DER failure > 2.13; contamination of the sample; chemical yield outside the control limits.

8. CALCULATIONS

Alpha spectra are interpreted and analyzed by a sophisticated mathematical routine that provides for peak identification, peak area analysis, and peak energy determination. Details of calculations performed by the AlphaVision software can be found in the AlphaVision Software Reference Manual (see References Section below, 15.1). ALS's routine alpha spectroscopic analysis of samples employs an ROI approach to spectrum analysis.

The following raw data generated by the AV system are used for sample calculations: Analyte and Tracer Net Counts and Count Time; associated Background Counts for each ROI; Background Count Time and Detector Efficiency. Further data (including Sample Aliquot, Split and Dilution Data, Percent Solids Data, Tracer Concentration and Amount Added, and Estimates of Total Uncertainty as described in SOP 708) from the preparation and standards spiking process, is taken from the electronic benchsheet and merged with the count data during the data reduction step during reporting. Total Efficiency calculations assume that the nuclide used for the tracer is not native to the sample.

Total uranium (a modification of EPA 908.0 by alpha isotopic summation) is calculated using the isotopic uranium results. The net counts are summed and the background counts are summed for ^{234}U , ^{235}U and ^{238}U . The equations depicted in Sop 708 are then used, substituting the 'summed net counts' for 'net counts' and 'summed background counts' for 'background counts', to determine the total uranium (TU) results:

where:

$$\text{SmplNtCts}_{\text{TOT}} = \text{SmplNtCts}_{234} + \text{SmplNtCts}_{235} + \text{SmplNtCts}_{238}$$

$$\text{BkgCts}_{\text{TOT}} = \text{BkgCts}_{234} + \text{BkgCts}_{235} + \text{BkgCts}_{238}$$

9. RESULTS INTERPRETATION

- 9.1 It is essential that appropriate analysis volume and units, tracer information, efficiency files and library files be used to ensure accurate analyses. Results must be reviewed to ensure that the sample type used was appropriate to the analysis type (e.g., Pu, U, Th, etc.) and the report reflects proper sample volume and units.
- 9.2 All target analyte peaks in the spectrum must be matched to the appropriate radionuclide, and, where applicable, the presence of a given radionuclide should be supported by the presence of other significant alpha emissions from that radionuclide.

- 9.3 Although most of the analyses are routine, it is important to note that each radionuclide has a different peak shape. This is especially evident when dealing with high level samples, and radionuclides that do not exhibit clear and defined peak shapes.
- 9.4 Peak shape is most often negatively affected by an unusual sample matrix, which may contribute to the attenuation of alpha particles. This attenuation can cause the spectrum to be interspersed with small non-descript peaks, which must be accounted for when adjusting ROI's. If there is any question as to the placement of ROI's see the Alpha Spectroscopist or the Department Manager.
- 9.5 The radionuclide of interest can also effect the spectrum. For example, thorium spectra usually exhibit more non-descript peak shapes, especially in the ^{229}Th and ^{230}Th ROIs. A typical thorium spectrum is included in Appendix A of this SOP. The other radionuclides analyzed by alpha spectrometry exhibit defined and similarly shaped peaks (i.e., plutonium, uranium, americium, curium, and neptunium). Typical plutonium and uranium spectra are also included.

10. PERIODIC MAINTENANCE

10.1 VACUUM PUMP

The vacuum pump shall be checked weekly. The pressure of both vacuum pumps should be below 250 milliTorr. If the pressure is not below 100milliTorr, see the Department Manager. Note in the Alpha Spec Calibration Log Book, the date and pressure of both vacuum pumps. The pump oil level should be above the "MIN" level mark on the pump. Inform the Primary Alpha Spectroscopist if one or both of the vacuum pumps is above 250 milliTorr. Changing the oil in the vacuum pump usually will bring the vacuum pressure down to or below 250 milliTorr. The vacuum pump oil should be changed annually to prevent any unusual wear on the vacuum pump. Note the oil change date in the Alpha Spec Maintenance Log.

10.2 AIR FILTERS

Air filters are located at the bottom of the MCA NIMBIN. The air filters need to be cleaned annually or as needed by removing and vacuuming. Note the filter cleaning date in the Alpha Spec Maintenance Log Book.

10.3 DETECTOR AND CHAMBER CLEANING

The detector and chamber should be cleaned annually or as indicated by the results of periodic background measurements. Periodic cleaning to reduce background contamination may be performed at any time. To clean the detectors and chambers, always wear gloves to prevent contamination. Remove the detectors with a 5/16" open-end wrench. *Do not attempt to remove the detectors by hand. This can damage the microdot connection!* Clean the chamber using a clean cotton ball and alcohol. The connection between the detector and the chamber needs to be thoroughly cleaned. Using a clean cotton ball and alcohol, clean the detector window, then the top and sides of the detector. Clean the

connection on the top of the detector thoroughly. The detector calibrations (Energy, Efficiency, and Background) must be re-calibrated following cleaning of the chamber, sample tray, or detector.

11. QUALITY CONTROL

11.1 CALIBRATION PROCEDURES

Note that the procedure for acquiring any calibration spectrum is the same as that of a normal sample acquisition. All calibrations must be documented in the Alpha Spec Calibration Log. Calibrations for the alpha spec include energy, efficiency, and background calibrations, and are done every two weeks.

11.1.1 ENERGY AND EFFICIENCY CALIBRATION

Eight electroplated sources are used that consist of ^{241}Am and ^{234}U with a small amount of ^{235}U activity. The sources are counted for approximately 35 minutes. The naming convention for these sources is ALS source ID 97-19-103-XX, where XX is equal to source 01, 02, etc. The energy/efficiency calibrations are typically done first, before the background checks. When the count is finished, the program will compare the locations of the ^{241}Am , ^{234}U and ^{235}U peaks to the primary emissions energies and perform a linear fit of the energy per channel data. This data will then be stored in the appropriate detector file for reference by the analysis program during sample analyses.

- 11.1.1.1 Load calibration planchets into an octet
- 11.1.1.2 Pump down detectors
- 11.1.1.3 Open AlphaVision
- 11.1.1.4 Click on the black calibration button to the upper left on the AlphaVision screen
- 11.1.1.5 Right click on detector you are analyzing and select [MCA VIEW]
- 11.1.1.6 Click [CLEAR], then [GO] for all detectors you are analyzing in that octet
- 11.1.1.7 Go back to the first detector and press [CTRL]+[LEFT or RIGHT ARROW] to move the cursor to the ^{241}Am peak at channel 249, make sure the peak is at channel 249 +/- 1
- 11.1.1.8 If the peak is within range select [STOP], then [CLEAR]
- 11.1.1.9 If the peak is not within range use the small standard screwdriver to move the "e-cal" potentiometer slightly left

or right. Repeat Steps 11.1.1.7 and 11.1.1.8 until the ²⁴¹Am peak is within range.

- 11.1.1.10 Exit “MCA view”
- 11.1.1.11 Click [PROCESS] and then [CALIBRATION]
- 11.1.1.12 In the General screen enter calibration name (Cymmddxx) and template number (the number on the planchet loaded into the detector)

where:

C = Calibration

y = last digit of the year

mm = month

dd = day

xx = detector number

- 11.1.1.13 Click on finish
- 11.1.1.14 After 35 minutes, a small window will appear. Select [CALIBRATION] from drop down menu, then select [CALIBRATE], [SAVE], then [CLOSE]. Repeat for each detector. This saves preliminary calibration data to the database.
- 11.1.1.15 To analyze the calibration, select detector and click on [SPECTRUM] tab on lower left of report window.
- 11.1.1.16 Zoom in on each peak by clicking and dragging a box around the peak, then right click and select [ZOOM IN].
- 11.1.1.17 Move the peak identifier of each peak to the top point of the peak by clicking and dragging the identifier.
- 11.1.1.18 Due to limitations in the AV software, both the peak identifier and the ROI must be adjusted in order for both the energy and efficiency coefficients to be properly saved. Consequently, move any ROI edge over and then back to its original position.
- 11.1.1.19 Right click and select [INTERACTIVE ROI ANALYSIS].
- 11.1.1.20 Repeat Steps 11.1.1.15 through 11.1.1.19 for all detectors in the octet.

- 11.1.1.21 Go back to first detector in the octet and select the [REPORT] tab at the bottom left of the report window.
- 11.1.1.22 Select [PRINT] icon in upper left of the report window.
- 11.1.1.23 In the screen that appears, save under calibration name Cymmddxx in the calibration folder.
- 11.1.1.24 Repeat Steps 11.1.1.21 through 11.1.1.23 for remaining detectors in the octet.

11.1.2 QA TEST FOR ENERGY/EFFICIENCY CALIBRATIONS

The QA test must be completed before reporting any samples through LIMS, otherwise the calibration report page will not show the correct calibration date.

- 11.1.2.1 Select [QA/QC] button to the upper left on the AV screen.
- 11.1.2.2 Select the detector number from list on the upper left and select [CALIBRATION ENERGY].
- 11.1.2.3 Select [CHART] tab from lower left of the report window.
- 11.1.2.4 Select [QA] from the menu options, then [CALIBRATION].
- 11.1.2.5 Select [QA], [DISPLAY], [CUSTOM], then [QUARTER]. Make sure that a dot appears on the chart in correct date.
- 11.1.2.6 Select [REPORT] tab at bottom left of window, then [PRINT] and minimize PDF factory screen.
- 11.1.2.7 Select [CALIBRATION EFFICIENCY].
- 11.1.2.8 Select [CHART] tab from lower left of the report window.
- 11.1.2.9 Repeat Step 11.1.2.5 and select [REPORT] tab at bottom left of window, then [PRINT]. Save as CCymmddxx. Where the “CC” indicates a calibration control chart and all other factors are as defined above.
- 11.1.2.10 Repeat Steps 11.1.2.2 through 11.1.2.9 for remaining detectors in octet.
- 11.1.2.11 Record the results of the calibration in the Alpha Spec Calibration Logbook.

11.1.3 BACKGROUND CALIBRATIONS

A blank filter paper is placed on a numbered planchet, one for every detector. The filter paper is counted for 1000 minutes, typically following the energy/efficiency calibrations. Filter papers and planchets are replaced at least annually.

11.1.3.1 Place the numbered, detector specific, blank filters into the detector chambers. Close the doors and apply vacuum to the chambers.

11.1.3.2 Open AlphaVision. Using the mouse, select the detector(s) that will be started. From the menu bar, choose [PROCESS] then [BACKGROUND].

11.1.3.3 Under General screen, Enter the batch filename as follows: Bymmddxx

where:

B = Background

y = last digit of the year

mm = month

dd = day

xx = M1, M2, M3, etc...for MCB number

11.1.3.4 Select the proper template from the drop-down menu, depending on whether the Octete is designated for U/Th analysis or Am/Pu analysis.

11.1.3.5 Under General screen, Select [NEXT].

11.1.3.6 Under Sample screen select [ADD] and enter sample ID of samples as Bymmddxx, where xx = detector number.

11.1.3.7 Click on [FINISH].

11.1.3.8 A new window will appear with all samples on it. Click and drag desired detector to sample ID. Select [START NOW].

11.1.3.9 After 1000 minutes, a window will appear for each detector.

11.1.3.10 Select [SAVE]. Save as Bymmddxx in calibration folder, where xx = detector number.

11.1.4 QA TEST FOR BACKGROUND CALIBRATIONS

The QA test must be completed before reporting any samples through LIMS, otherwise the calibration report page will not show the correct calibration date.

11.1.4.1 Select [QA/QC] button to the upper left on the AV screen.

11.1.4.2 Select the detector number from list on the upper left and select [BACKGROUND].

11.1.4.3 Select [CHART] tab from lower left of the report window.

11.1.4.4 Select [QA] from the menu options, then [BACKGROUND].

11.1.4.5 Select [QA], [DISPLAY], [CUSTOM], then [QUARTER]. Make sure that a dot appears on the chart in correct date.

11.1.4.6 Select [REPORT] tab at bottom left of window, then [PRINT]. Save as BCmmdxx, where BC = Background Control Chart.

11.1.4.7 Record the results of the calibration in the Alpha Spec Calibration Logbook.

11.2 CALIBRATION ACCEPTANCE CRITERIA

Because calibrations are performed every other week, and the accumulation of 30 data points would be impracticable, acceptance criteria for alpha spec calibrations are based on an initial calibration set rather than a mean and standard deviation of a historical population. Acceptance criteria are updated, at a minimum, when detectors are replaced, or when major service to the Octete is performed.

11.2.1 BACKGROUND ACCEPTANCE CRITERIA

For U/Th detectors, the warning limit is set at 500 counts, and the control limit at 750 counts, over the entire spectrum. Since the background calibration is evaluated over the entire spectrum, elevated counts due to ^{228}Th daughter products (expected progeny) will therefore elevate the entire count. Since these progeny occur at energies higher than most analytes of interest, they do not interfere with data quality, with the exception of ^{228}Th . However, as an additional quality assurance measure, any detectors that exceed the warning limit will be evaluated by the instrument operator to assure that all standard ALS data quality objectives will still be achieved under normal operating conditions.

For all other detectors, the warning limit is 100 counts and the control

limit is 150 counts.

11.2.2 BACKGROUND CALIBRATION CORRECTIVE ACTIONS

If the background determination does not pass acceptance criteria, clean the detectors thoroughly. Most frequently, short-lived decay products are responsible for the failure. Cleaning a detector will often help expedite the process of returning the backgrounds to normal levels. Repeat the background determination. In some cases, the department manager may OK a detector for use if the background counts are elevated as long as the background peaks do not interfere with the analysis performed on that detector. This decision should be clearly documented in the Instrument Calibration Logbook.

11.2.3 ENERGY CALIBRATION ACCEPTANCE CRITERIA

For energy calibrations, the energy calibration equation is used to calculate the energy in keV of the middle channel of the spectrum (256). The initial calibration is used as baseline and the warning limits are set ± 40 keV from the initial value. Control limits are set ± 50 keV from the initial value.

11.2.4 CORRECTIVE ACTION FOR ENERGY CALIBRATION

With the calibration source in place, manually adjust the E-cal pot. on the front of the chamber until the ^{241}Am peak centroid lies in channel 249. At this point the energy calibration must be repeated.

11.2.5 EFFICIENCY CALIBRATION ACCEPTANCE CRITERIA

The initial calibration is used as baseline and the warning limits are set at 3.33% of the initial value. Control limits are set 5% of the initial value.

11.2.6 CORRECTIVE ACTION FOR EFFICIENCY CALIBRATION

If it is determined that the instrument response has drifted relative to the point of initial calibration, the weekly operating limits and specific method calibrations will be re-established prior to analysis of further samples.

11.3 QC MONITORING

Please refer to SOP 715 for further details regarding preparation and monitoring of method blanks, laboratory control samples, duplicates, and chemical recoveries in samples.

12. DEVIATIONS FROM METHOD

This SOP describes a confidential, proprietary procedure developed by ALS. Therefore, there are no deviations from a promulgated method.

13. SAFETY, HAZARDS AND WASTE DISPOSAL

13.1 SAFETY

All Safety and Hazards are managed in accordance with the current facility plans:

- Chemical Hygiene Plan (CHP)
- Radiation Protection Plan (RPP).
- Emergency and Contingency Plan (ECP)
- Respiratory Protection Plan (RESPP)

13.2 HAZARDS

There are no special hazards associated with the conduct of this procedure.

13.3 WASTE DISPOSAL

All Wastes are disposed of in accordance with the Waste Management Plan (WMP)

14. REFERENCES

14.1 AlphaVision Software Reference Manual, Model A-36-BI, Version 5.3.

14.2 ANSI Standard P-N42.23-D2, Measurement and Associated Instrumentation Quality Assurance for Radioassay Laboratories, Final, February 10, 1995.

14.3 ALS SOPs 708 and 715.

TABLE 1

COMMON ENERGIES AND APPROXIMATE CHANNEL LOCATIONS
(to assist the user during calibrations, QA checks and initial spectral interpretation)

<u>Nuclide</u>	<u>*Energy (keV)</u>	<u>Target Channel</u>
Am-241	5485	249
Am-243	5275	228
Cm-242	6112	311
Cm-244	5805	281
Pu-242	4900	190
Pu-238	5499	250
Pu-239	5155	216
Th-228	5423	242
Th-229	4845	184
Th-230	4687	169
Th-232	4010	101
U-232	5320	232
U-234	4775	178
U-235	4396	140
U-238	4196	120

*** The nuclide navigator software that is supplied by alpha vision is the source used to determine the specified library energies. NUDAT (National Nuclear Data Center) of Brookhaven National Laboratory is the database chosen in nuclide navigator.**

NOTE: Actual Target Channels will vary slightly for each detector; peak energy and channel matching is done weekly with the energy calibration process in AlphaVision.

TABLE 2
SUMMARY OF INTERNAL QUALITY CONTROL (QC)
PROCEDURES AND CORRECTIVE ACTION

QC Check	Frequency	Acceptance Criteria	Corrective Action
Energy Calibration	Weekly	The initial calibration is used as baseline Warning limits are set $\pm 40\text{keV}$ from the initial value Control limits are set $\pm 50\text{keV}$ from the initial value	Record failure in the Alpha Spectroscopy Maintenance Log. Check source integrity, detector configuration, recount and reprocess; Tag detector off-line; Determine and correct problem; or Narrate why condition is acceptable
Efficiency Calibration	Weekly	The initial calibration is used as baseline Warning limits are set at 3.33% of the initial value Control limits are set 5% of the initial value	Record failure in the Alpha Spectroscopy Maintenance Log. Check source position and integrity, detector configuration, recount and reprocess; Tag detector off-line; Determine and correct problem; or Narrate why condition is acceptable
Background Calibration	Weekly long background	U/Th detectors - the warning limit is set at 500 counts & the control limit is set at 750 counts, both over the entire spectrum. All other detectors - the warning limit is 100 counts and the control limit is 150 counts.	Clean chamber and detector, repeat check; Tag detector off-line; Determine and correct problem, re-establish limits; or Narrate why condition is acceptable
Vacuum check	Weekly	<100 milliTorr	Check/replace seals; locate and repair leak; or call service
Chemical Yield	Each sample	Each sample meets current control limits for analysis	Re-prep; or Qualify or Narrate why condition is acceptable
Regions of Interest (ROI)	Adjust ROI as needed	ROI is properly set, tailing does not compromise quantitation	Adjust ROI's to fit identified peaks; For tailing, cleanup or re-prep and recount affected samples, consult with Supervisor; Qualify or Narrate why condition is acceptable
Spectral Interferences	Evaluate each spectrum for spectral interferences	Interfering activity does not compromise quantitation	Recount; Clean-up, re-prep/ recount affected samples; Consult with Supervisor or Department Manager; Determine and correct problem; or Qualify or Narrate why condition is acceptable

NOTE: SOP 715 contains acceptance criteria and corrective action for method blank, laboratory control samples, duplicate samples and matrix spike/matrix spike duplicates.

APPENDIX A SAMPLE SPECTRA

The following three spectra examples demonstrate a typical uranium, thorium and plutonium spectra. Note that americium, curium, and neptunium spectra are somewhat similar to the plutonium spectrum, in relation to their peak shapes.

The thorium spectrum contains four analytes. The difficulty with the placement of the ROI's for ^{229}Th and ^{230}Th is due to close proximity of the two peaks. The small peaks to the right of the ^{228}Th peak are ^{228}Th daughter products, which are expected progeny.

The plutonium spectrum contains three analytes, with no other obvious peaks present. Note that uranium, americium, curium, and neptunium spectra should also contain no other peaks, other than those accounted for by existing ROIs.

In detectors used for Uranium and Thorium analyses, persistent background peaks are typically seen in the higher energy regions of the spectra. These peaks are associated with natural decay progeny and do not interfere with U and Th analyses except in the case of ^{228}Th , where the increased detector background is unavoidable and typically results in elevated ^{228}Th MDC values.

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APPENDIX B

ALS

Alpha Spectrometer Instrument Run Log

Date: _____

Detector	Batch ID	Sample ID	Iso/Matrix	Duration	Initial

Detector	Batch ID	Sample ID	Iso/Matrix	Duration	Initial

Notes:

Reviewed
By

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APPENDIX C

QUALITY ASSURANCE SUMMARY SHEET

ALS W.O. # / BATCH _____
TEST _____
METHOD _____
SOP/REV (PREP) _____
SOP/REV (ANAL) _____

Briefly document any QA or other problems or deviations associated with the analysis of samples. Problems could result from: log-in, color, odor, dilution, consistency, scheduling, equipment, or instrumentation, or may include documentation of minor deviations necessary due to unique DQO's or sample characteristics.

TECHNICIAN/ANALYST _____ DATE _____

DEPARTMENT MANAGER _____ DATE _____

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Appendix B
Site-Specific Addendum to the
Health and Safety Plan

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This addendum shall be maintained onsite with the *FINAL Health and Safety Plan (HASP) for Hill Air Force Base (AFB) Performance-Based Remediation Services* (June 2013).

Client: Air Force Civil Engineer Center

Project Name/Number: Performance-Based Remediation at Hill Air Force Base, Contract Number FA8903-09-D-8560-0006, EA Project Number 6236906

Site ID and Site Name: WR-111 Little Mountain Magnesium/Thorium (Mg/Th) Disposal Trench

Site Location/Address: Little Mountain Test Annex (LMTA) Hill AFB, Ogden, Utah

Site Description/History: The LMTA is located approximately 15 miles northwest of Hill AFB (Figure 1). The disposal trench area is roughly 0.5 acre in size situated at the southeast corner of the LMTA. Marquardt Aircraft Company obtained an Atomic Energy Commission license to possess Mg-Th alloy to be used in the manufacture of aircraft parts around 1957. In 1961, Marquardt was granted permission to burn Mg-Th scrap in a burial trench measuring roughly 8 feet wide by 20 feet long and 10 feet deep. Between 1959 and 1961, approximately 5,600 pounds of Mg-Th scrap waste, containing wet collector sludge from pickling tanks, and lathe turning/milling scraps was disposed of in the trench.

AECOM conducted a site characterization of the disposal trench area in 2009. This characterization included geophysical and gamma walkover surveys and surface and subsurface soil sampling. The survey and sampling results indicated elevated levels, compared to background, of thorium 232 (^{232}Th) within the southern three-quarters of the fenced area. The characterization report also indicated that elevated activity may extend beyond the perimeter fence. No groundwater impacts were identified from WR-111 during the 2007 groundwater sampling. Cabrera conducted a characterization to further delineate radiological contamination inside and outside the fenced area. This characterization included gamma walkover surveys and surface and subsurface soil sampling. The characterization report confirmed that elevated activity extends beyond the perimeter fence to the southwest. Cabrera developed a Decommissioning Plan, which is currently undergoing review by the US Nuclear Regulatory Commission (NRC), describing the planned approach for remediation and final status survey of the site.

Work Description: Prior to onsite activity, conduct underground utility clearance in coordination with Hill AFB staff. Set up the site areas, including radiation control areas and laydown pads. Excavate soils exceeding site radiological release limits. Perform remedial support surveys to guide excavation. Stockpile contaminated soils and layback soils in two separate areas of the site. After reaching the limits of excavation confirmed by gamma activity scan results, begin final status survey (FSS). FSS consists of gamma walkover surveys, and systematic and biased soil sample collection for off-site radiological laboratory analysis. Ship radiologically contaminated soils for off-site disposal. Demobilize and await sample results to determine whether the FSS has met the criteria for unrestricted release and the suitability of layback soils for use as backfill. After receiving stakeholder approval, mobilize to the site to backfill and restore the excavation.

APPROVALS:

This Addendum to the HASP has been prepared under the supervision and review of a Certified Industrial Hygienist certified by the American Board of Industrial Hygiene and a Certified Health Physicist.

Pete Garger, CIH, CSP (ABIH No. 3118)
Program Health and Safety Manager

Date

Tony Mason, CHP Certified Health Physicist	Date
---	------

Sandy Staigerwald Senior Project Manager	Date
---	------

Amy Sponaugle Site Project Manager	Date
---------------------------------------	------

EMERGENCY CONTACT INFORMATION:

POLICE, FIRE AND AMBULANCE	
	911 (Cell phone users will receive an off-Base dispatcher; ask to be transferred to Hill AFB.)
EA Emergency Contacts	
Program Health and Safety Manager – Pete Garger	410-790-6338 (cell); 410- 527-2425 (work)
Director of Human Resources – Michele Bailey	410-790-3795 (cell); 410-527-2481 (work)
Senior Project Manager – Sandra Staigerwald	(410) 215-6142 (cell); (801) 896-2076(work)
Deputy Senior Project Manager – Randy Gates	(801) 557-1595 (cell); (385) 474-8520 (work)
Site Project Manager – Amy Sponaugle	(443) 695-3129 (cell); (410) 329-5103 (work)
EA Occupational Physician – AllOne Health	(800) 350-4511
Cabrera Contacts	
Site Super/Waste Coordinator – Wade Fillingame	(865) 300-5789 (cell)
CQCSM/SSHO – Stephan Owe	(443) 610-8850 (cell); (410) 982-0717 (work)
Project HP Tech – Mike Plonski	(860) 794-6915 (cell); (860) 569-0095 (work)
Project HP – Tony Mason	(435) 655-1009 (cell)
Project Manager – Greg Bright	(781) 264-4445 (cell)
Corporate RSO – Hank Siegrist	(860) 416-0196 (cell); (860) 569-0095 (work)
OH&S Manager – Sean Liddy	(443) 553-1403 (cell); (410) 982-0726 (work)
Emergency Contacts/Notification	
Hill AFB, Fire, Ambulance, Police	911
Hill AFB, Consolidated Command Post	(801) 777-3007 (Weekend)
Hill AFB TO Manager, Dr. Barbara Hall	(801) 777-0493
AFCEC COR, Adria Bodour	(210) 395- 8426
Hill AFB Project Manager – Kyle Gorder	(801) 775-2559
Hill AFB Medical Facility	(801) 777-5285
Extended Hours Family Practice Clinic	
Spill Reporting Contacts	
National Response Center	(800) 424-8802
EPA Region 8	(800) 227-8917
Utah Department of Environmental Quality	(801) 536-4123 (24 Hours)
Hill AFB CEVR Spill Response Phone	(801) 430-3860
Hospital	
Davis Hospital and Medical Center	(801) 807-1000
Ogden Regional Medical Center	(801) 479-2111
Utilities	
Electricity – Rocky Mountain Power (Emergencies)	(877) 508-5088
Gas – Questar (Emergencies)	(800) 767-1689
Water – Davis County Public Works (Emergencies)	(801) 451-4150
Base Civil Engineering, Red Stakes	(801) 777-1995
Blue Stakes Utility Notification	(800) 662-4111
North Davis Sewer District (Emergencies)	(801) 825-0712 (daytime) (801) 728-6822 or (801) 625-3028

Central Weber Sewer Improvement District (Emergencies)	(801) 430-5787
Hill AFB Industrial Wastewater Treatment Plant	(801) 777-3189 (daytime) (801) 777-1755 (24/7)

MEDICAL EMERGENCY:

NOTE: Directions and maps to the nearest hospital are provided in Appendix H of the HASP for Performance-Based Remediation at Hill AFB. The directions and map for the site that is the subject of this HASP Addendum can be copied from Appendix H to this page of the HASP Addendum, following a check for consistency with anticipated location of site work and current access restrictions. Maps should be printed in color to make the route visible to the user.

Distance to Nearest Hospital (with emergency room): 21 miles

Hospital Name: Ogden Regional Medical Center

Hospital Phone: (801) 479-2111

Hospital Address: 5475 Adams Ave Pkwy, Ogden, Utah, 84405

Route to Hospital:

Starting Location: **Little Mountain Test Annex**

End Address: **5475 Adams Ave Pkwy, Ogden, Utah, 84405 (Ogden Regional Medical Center)**

1. Exit the site to W 900 S.
2. Continue onto W 1100 S.
3. Continue onto W 1150 S
4. Continue onto UT-39 E/W 1200 S / W 12th Street
5. Turn right onto entrance ramp to I-15S/ I-84E
6. Stay on I-84 E (signs for Cheyenne)
7. Take Exit 85 toward Uintah/So. Weber
8. Turn left onto S 475 E / S 500 E
9. Continue onto Adams Ave Parkway
10. End Ogden Regional Medical Center (801) 479-2111

See map, next page.

HAZARDS OF CONCERN: Check as many as are applicable. See Section 6 of HASP for Chemical, Physical, and Biological Hazards.

- | | | | |
|--|---|--|---|
| <input checked="" type="checkbox"/> Heat Stress | <input type="checkbox"/> Reactive | <input type="checkbox"/> Oxygen Deficient | <input checked="" type="checkbox"/> Insect Bite |
| <input checked="" type="checkbox"/> Cold Stress | <input checked="" type="checkbox"/> Noise | <input type="checkbox"/> Corrosive | <input checked="" type="checkbox"/> Snake Bite |
| <input type="checkbox"/> Explosion/Fire | <input type="checkbox"/> Inorganic | <input type="checkbox"/> Toxic | <input type="checkbox"/> Vegetation |
| <input type="checkbox"/> Biological | <input type="checkbox"/> Organic | <input type="checkbox"/> Inert | <input type="checkbox"/> Electrical |
| <input checked="" type="checkbox"/> Radiological | <input checked="" type="checkbox"/> Utilities | <input checked="" type="checkbox"/> Excavations | |
| <input type="checkbox"/> Volatile | <input checked="" type="checkbox"/> Lifting | <input checked="" type="checkbox"/> General Physical | |
| <input type="checkbox"/> Confined Space (see Section 9 of GHASP) | | | |
| <input type="checkbox"/> Other, specify: _____ | | | |

CONTROLS OR PROTECTIVE MEASURES: Check as many as are applicable.

- ☒ Pre-entry Briefing/Safety Meetings ☒ PPE ☒ Site control
- ☐ Operator Training
- ☒ Permits *Excavation permit, Radiation Work Permits, Red Stakes Permit*
- ☒ Engineering Controls *Set up radiation control area boundaries (i.e., exclusion zone, contamination reduction zone, and support zone, as applicable)*
- ☒ Work Practices *Operating procedures for soil sampling, use of radiological meters, radiological surveys.*
- ☐ Other

EXPOSURE PATHWAYS: ☒ Inhalation ☒ Ingestion ☒ Dermal ☐ Injection

POTENTIALLY IMPACTED MEDIA:

☐ Air ☒ Dust/Soil ☐ Surface Water ☐ Sediment ☐ Groundwater ☐ Other

FIRE/EXPLOSION POTENTIAL: ☐ High ☐ Medium ☒ Low

SURROUNDING POPULATION: ☐ Residential ☐ Industrial ☒ Rural ☐ Urban

ANTICIPATED LEVEL OF CHEMICAL EXPOSURE: (List potential contaminants of concern, media, and concentration levels if known. Include previous air sampling if any):

☐ High ☐ Medium ☒ Low

Radium-226 (²²⁶Ra), thorium-230 (²³⁰Th), and thorium-232 (²³²Th) were detected at a maximum of 15, 448 and 222 picoCuries per gram (pCi/g) in subsurface soils. Typical sample concentrations are less than 10 pCi/g for each radionuclide of concern. Previous site investigations did not identify organic or inorganic constituents of concern.

OVERALL HAZARD RANKING: ☐ High ☐ Medium ☒ Low

JUSTIFICATION OF HAZARD RANKING: (brief narrative of how work activities may encounter hazards and their controls):

There is the potential to encounter surface and subsurface soil with elevated activity during excavation. Excavated soils will be screened using a Ludlum 2221 Portable Scaler/Ratemeter with a 44-20 3X3 NaI Scintillator during excavation.

CHEMICAL HAZARDS (condensed from Table 6-1 of HASP, add/delete as required):

Compound	PEL or TLV/STEL	IDLH	Route of Exposure	Symptoms
Radiological				
Radium-226 (²²⁶ Ra)	25 ppm/35 ppm	300 ppm	Inhalation, Ingestion (solution), Skin and/or Eye Contact (solution/liquid)	Irritation of eyes, nose and throat; dyspnea (breathing difficulty), wheezing, chest pain; pulmonary edema; pink frothy sputum; skin burns, vesiculation
Thorium 230 (²³⁰ Th)	25 ppm/35 ppm	300 ppm	Inhalation, Ingestion (solution), Skin and/or Eye Contact (solution/liquid)	Irritation of eyes, nose and throat; dyspnea (breathing difficulty), wheezing, chest pain; pulmonary edema; pink frothy sputum; skin burns, vesiculation.
Thorium 232 (²³² Th)	25 ppm/35 ppm	300 ppm	Inhalation, Ingestion (solution), Skin and/or Eye Contact (solution/liquid)	Irritation of eyes, nose and throat; dyspnea (breathing difficulty), wheezing, chest pain; pulmonary edema; pink frothy sputum; skin burns, vesiculation.
Chemical				
Diesel fuel	See Table 6-1 of HASP			
Gasoline	See Table 6-1 of HASP			
NOTE: ppm = Parts per million				

WORKING ALONE: (x) No () Yes, explain precautions

UTILITY CLEARANCE:

One-Call Utility Services () Not Required, (x) Required, explain

Blue Stakes will be contacted for utility clearance activities off-base. It is understood that Blue Stakes also locates high pressure gas lines on Hill AFB. Assistance from Blue Stakes personnel will be required to locate all existing utility lines, in the field, before excavation of any kind begins. Blue Stakes utility clearance will require a minimum of 48 hours in advance of the start of the work.

Facility-Provided Clearance or Permit () Not Required (x) Required, explain

Red Stakes will be contacted for utility clearance activities on Hill AFB. EA will notify the Hill AFB Point of Contact when Red Stakes utility clearance is required. Necessary form(s) and required attachments will be prepared and returned, to the Hill AFB Point of Contact, 15 working days prior to the date utility clearance is required. Red Stakes will issue Excavation Permits when utility location is complete.

Geophysical, Pipe Locator, or Other Contractor (x) Not Required () Required, explain

CONTINGENCY PLANS: Summarize below (Evacuation, assembly point, contingency leader)

In the event of an emergency, all onsite personnel will evacuate in an upwind direction. If the winds are from the west, the assembly point will be the treatment building along W 900S located northwest of the disposal trench. If the wind direction is from the east, the assembly point will be located due north of the disposal trench at the intersection of the northerly access road and W 900 S. The Field Site Manager will be the primary onsite leader. The Site Health and Safety Officer will act as the contingency site leader.

DEVIATIONS/VARIATIONS FROM HASP:

None

MEDICAL SURVEILLANCE:

Do Hazardous Waste Site Workers and Supervisor (s) have Documentation of Required Medical Exams?

(x) Yes () No, Explain

Individual certifications and current training records will be maintained onsite.

TRAINING REQUIRED:

(x) HAZWOPER WORKER (x) HAZWOPER SUPERVISOR (x) FIRST AID/CPR

() CONFINED SPACE (x) OTHER, explain

Radiation Worker Training will be required for on-site remediation and survey personnel (Field Site Manager, SSO, HP Technician, craft, and labor). Any additional field staff will require Radiation Awareness Training.

PROTECTIVE EQUIPMENT: Protective equipment should be specified by the type of task and site (e.g., excavation and sampling at excavation). Indicate type and/or material, as necessary. Use additional pages as necessary.

TASK 1: *Mobilization/Demobilization*

INITIAL LEVEL: A - B - C - (D) - Modified (Circle applicable)

Respiratory: (x) Not needed

() SCBA, Airline:

Protective Clothing: (x) Not needed

() Encapsulating Suit:

- | | |
|---------------------------------------|---|
| <input type="checkbox"/> APR: | <input type="checkbox"/> Splash Suit: |
| <input type="checkbox"/> Cartridge: | <input type="checkbox"/> Apron: |
| <input type="checkbox"/> Escape Mask: | <input type="checkbox"/> Tyvek Coverall |
| <input type="checkbox"/> Other: | <input type="checkbox"/> Saranex Coverall |
| | <input type="checkbox"/> Coverall: |
| | <input type="checkbox"/> Other: |

- | | |
|--|--|
| Head and Eye: <input type="checkbox"/> Not needed | <input type="checkbox"/> Other: |
| <input checked="" type="checkbox"/> Safety Glasses: | |
| <input type="checkbox"/> Face Shield: | Gloves: <input type="checkbox"/> Not needed |
| <input type="checkbox"/> Goggles: | <input type="checkbox"/> Undergloves: |
| <input checked="" type="checkbox"/> Hard Hat: | <input checked="" type="checkbox"/> Gloves: <i>Leather or cotton</i> |
| | <input type="checkbox"/> Overgloves: _ |
| Hearing Protection: <input checked="" type="checkbox"/> Not needed | <input type="checkbox"/> Other: |
| <input type="checkbox"/> Plugs: | |
| <input type="checkbox"/> Muffs: | |

- Boots: ☐ Not needed
☒ Safety Boots:
☐ Overboots:

TASK 2: Site Preparation

INITIAL LEVEL: A - B - C – (D) - Modified (Circle applicable)

- | | |
|---|---|
| Respiratory: <input checked="" type="checkbox"/> Not needed | Protective Clothing: <input checked="" type="checkbox"/> Not needed |
| <input type="checkbox"/> SCBA, Airline: | <input type="checkbox"/> Encapsulating Suit: |
| <input type="checkbox"/> APR: | <input type="checkbox"/> Splash Suit: |
| <input type="checkbox"/> Cartridge: | <input type="checkbox"/> Apron: |
| <input type="checkbox"/> Escape Mask: | <input type="checkbox"/> Tyvek Coverall |
| <input type="checkbox"/> Other: | <input type="checkbox"/> Saranex Coverall |
| | <input type="checkbox"/> Coverall: |
| | <input type="checkbox"/> Other: |

- | | |
|--|--|
| Head and Eye: <input type="checkbox"/> Not needed | <input type="checkbox"/> Other: |
| <input checked="" type="checkbox"/> Safety Glasses: | |
| <input type="checkbox"/> Face Shield: | Gloves: <input type="checkbox"/> Not needed |
| <input type="checkbox"/> Goggles: | <input type="checkbox"/> Undergloves: |
| <input checked="" type="checkbox"/> Hard Hat: | <input checked="" type="checkbox"/> Gloves: <i>Leather or cotton</i> |
| | <input type="checkbox"/> Overgloves: _ |
| Hearing Protection: <input checked="" type="checkbox"/> Not needed | <input type="checkbox"/> Other: |
| <input type="checkbox"/> Plugs: | |
| <input type="checkbox"/> Muffs: | |

- Boots: ☐ Not needed
☒ Safety Boots:
☐ Overboots:

TASK 3: Soil Remediation

LEVEL: A - B - C – (D) – (Modified) (Circle applicable)

UPGRADE CRITERIA:

Respiratory: (x) Not needed

() SCBA, Airline:

() APR:

() Cartridge:

() Escape Mask:

() Other:

Head and Eye: () Not needed

(x) Safety Glasses:

() Face Shield:

() Goggles:

(x) Hard Hat:

Hearing Protection: () Not needed

(x) Plugs:

() Muffs:

Boots: () Not needed

(x) Safety Boots:

() Overboots:

Protective Clothing: () Not needed

() Encapsulating Suit:

() Splash Suit:

() Apron:

(x) Tyvek Coverall

() Saranex Coverall

() Coverall:

(x) Other: *Reflective vest*

Gloves: () Not needed

(x) Undergloves: *Nitrile*

(x) Gloves: *General work gloves*

() Overgloves:

() Other:

TASK 4: *Final Status Survey*

LEVEL: A - B - C - (D) - Modified (Circle applicable)

UPGRADE CRITERIA:

Respiratory: (x) Not needed

() SCBA, Airline:

() APR:

() Cartridge:

() Escape Mask:

() Other:

Head and Eye: () Not needed

(x) Safety Glasses:

() Face Shield:

() Goggles:

(x) Hard Hat:

Hearing Protection: () Not needed

(x) Plugs:

() Muffs:

Boots: () Not needed

(x) Safety Boots:

() Overboots:

Protective Clothing: () Not needed

() Encapsulating Suit:

() Splash Suit:

() Apron:

() Tyvek Coverall

() Saranex Coverall

() Coverall:

(x) Other: *Reflective vest*

Gloves: () Not needed

(x) Undergloves: *Nitrile*

() Gloves: *General work gloves*

() Overgloves:

() Other:

TASK 5: *Waste Transportation and Disposal*

LEVEL: A - B - C - (D) - (Modified) (Circle applicable)

UPGRADE CRITERIA:

Respiratory: (x) Not needed
() SCBA, Airline:
() APR:
() Cartridge:
() Escape Mask:
() Other:

Head and Eye: () Not needed
(x) Safety Glasses:
() Face Shield:
() Goggles:
(x) Hard Hat:

Hearing Protection: () Not needed
(x) Plugs:
() Muffs:

Boots: () Not needed
(x) Safety Boots:
() Overboots:

Protective Clothing: () Not needed
() Encapsulating Suit:
() Splash Suit:
() Apron:
(x) Tyvek Coverall
() Saranex Coverall
() Coverall:
(x) Other: *Reflective vest*

Gloves: () Not needed
(x) Undergloves: *Nitrile*
() Gloves: *General work gloves*
() Overgloves:
() Other:

TASK 6: Backfilling and Site Restoration

INITIAL LEVEL: A - B - C – (D) - Modified (Circle applicable)

Respiratory: (x) Not needed
() SCBA, Airline:
() APR:
() Cartridge:
() Escape Mask:
() Other:

Protective Clothing: (x) Not needed
() Encapsulating Suit:
() Splash Suit:
() Apron:
() Tyvek Coverall
() Saranex Coverall
() Coverall:
() Other:

Head and Eye: () Not needed
(x) Safety Glasses:
() Face Shield:
() Goggles:
(x) Hard Hat:

() Other:
Gloves: () Not needed
() Undergloves:
(x) Gloves: *Leather or cotton*
() Overgloves: _
() Other:

Hearing Protection: (x) Not needed
() Plugs:
() Muffs:

Boots: () Not needed
(x) Safety Boots:
() Overboots:

TASK 7: Decontamination of Equipment

INITIAL LEVEL: A - B - C – (D) - Modified (Circle applicable)

Respiratory: (x) Not needed

() SCBA, Airline:

() APR:

() Cartridge:

() Escape Mask:

() Other:

Protective Clothing: (x) Not needed

() Encapsulating Suit:

() Splash Suit:

() Apron:

() Tyvek Coverall

() Saranex Coverall

() Coverall:

() Other:

Head and Eye: () Not needed

(x) Safety Glasses:

() Face Shield:

() Goggles:

(x) Hard Hat:

() Other:

Gloves: () Not needed

() Undergloves:

(x) Gloves: *Leather or cotton*

() Overgloves: _

() Other:

Hearing Protection: (x) Not needed

() Plugs:

() Muffs:

Boots: () Not needed

(x) Safety Boots:

() Overboots:

MONITORING EQUIPMENT: Monitoring equipment should be specified by task and type of site. Indicate type, as necessary. Attach additional sheets, as necessary.

TASKS: *Soil Remediation*

See GHASP for Calibration Procedures or attach if different. Attached table specifies monitoring requirements and action levels

INSTRUMENT

ACTION GUIDELINES

Combustible
Gas Indicator\O₂
(x) Not needed

0-10% LEL Continue.
10-20% LEL Potential explosion hazard, continuous monitoring.
>20% LEL Explosion hazard; interrupt task/evacuate.

Oxygen (O₂) Percentage:

20.8% - O₂ normal.
<20.8% - O₂ deficient, investigate cause.
<19.5% O₂ Interrupt task/evacuate.

Type:

Photoionization Detector
() 11.7 ev () 10.6 ev

Specify: (COCs)
() 09.8 ev () __ ev

Type: *MiniRAE VOC contamination is not expected based on previous sampling events.*

(x) Not needed

Flame Ionization Detector
Specify: (COCs)
Type: *Photovac or OVA (circle applicable or list other):*
(x) Not needed

Detector Tubes
Or Chemical Detector
Specify: (COCs, Range, Interferences)
Type
(x) Not needed

Dust Monitor
Specify: (Radioisotopes; alpha, beta, gamma, x-ray)
Type *Breathing Zone Monitors or General Area Low Volume Air Samplers will be used to measure potential airborne radioactivity during excavation activities. A dust monitor will be kept on-site. Visible dust will be mitigated using water to spray down haul roads and stockpiles, as needed.*
() Not needed

Radiation Survey Meter s (or equivalent)	Specify: (Radioisotopes; alpha, beta, gamma, x-ray)
<i>Ludlum Model 3 with Model 44-9 beta/gamma</i>	> Background Contact RSO/SSHO and PM
<i>Model 2221 with Model 43-93-alpha/beta</i>	3 x Background Notify CHP and stop work
<i>Model 2929 with 43-10-1 alpha/beta</i>	
<i>Microrem meter (gamma exposure)</i>	2.5mR/hour Interrupt task/evacuate
() Not needed	

NOTE: Annual Exposure not to exceed 100 mrem/yr or 50 urem/hour average. Derived Air Concentrations (DAC) determined based on Section 6.3.2 of the Radiological Protection Plan (RPP) and compared to the 10 CFR 20 most conservative DAC value for Th-232 (the most limiting radionuclide of concern) as listed in the RPP. The Cabrera RSO will be notified of measured values greater than 10% of the DAC listed in the RPP. Meter calibration and usage are discussed in the RPP.

Other Instruments
Specify: N/A

TASKS: *Waste Transportation and Disposal*

See GHASP for Calibration Procedures or attach if different. Attached table specifies monitoring requirements and action levels

<u>INSTRUMENT</u>	<u>ACTION GUIDELINES</u>
Combustible Gas Indicator\O ₂ (x) Not needed	0-10% LEL Continue. 10-20% LEL Potential explosion hazard, continuous monitoring. >20% LEL Explosion hazard; interrupt task/evacuate.
Oxygen (O ₂) Percentage:	20.8% - O ₂ normal. <20.8% - O ₂ deficient, investigate cause. <19.5% O ₂ Interrupt task/evacuate.
Type:	
Photoionization Detector () 11.7 ev () 10.6 ev () 09.8 ev () ___ ev	Specify: (COCs)

Type: *MiniRAE VOC contamination is not expected based on previous sampling events.*

(x) Not needed

Flame Ionization Detector Specify: (COCs)

Type: *Photovac or OVA (circle applicable or list other):*

(x) Not needed

Detector Tubes Or Chemical Detector Specify: (COCs, Range, Interferences)

Type

(x) Not needed

Dust Monitor Specify: (Radioisotopes; alpha, beta, gamma, x-ray)

Type *Breathing Zone Monitors or General Area Low Volume Air Samplers will be used to measure potential airborne radioactivity during excavation activities. A dust monitor will be kept on-site. Visible dust will be mitigated using water to spray down haul roads and stockpiles, as needed.*

() Not needed

Radiation Survey Meter s (or equivalent)	Specify: (Radioisotopes; alpha, beta, gamma, x-ray)
<i>Ludlum Model 3 with Model 44-9 beta/gamma</i>	<i>> Background</i>
<i>Model 2221 with Model 43-93-alpha/beta</i>	<i>3 x Background</i>
<i>Model 2929 with 43-10-1 alpha/beta</i>	
<i>Bicron Microrem meter (gamma exposure)</i>	<i>2.5mR/hour</i>
() Not needed	

NOTE: Annual Exposure not to exceed 100 mrem/yr or 50 urem/hour average. Derived Air Concentrations (DAC) determined based on Section 6.3.2 of the Radiological Protection Plan (RPP) and compared to the 10 CFR 20 most conservative DAC value for Th-232 (the most limiting radionuclide of concern) as listed in the RPP. The Cabrera RSO will be notified of measured values greater than 10% of the DAC listed in the RPP. Meter calibration and usage are discussed in the RPP.

Other Instruments Specify: N/A

DECONTAMINATION PROCEDURES:

Summarize personnel decontamination/containment and disposal method

() Not needed

Decontamination of personnel is described in the Radiation Protection Plan. Samplers will wear disposable gloves that will be collected and properly discarded following soil sample collection. Personnel entering the RCA will wear Modified Level D (anti-contamination clothing [e.g., Tyvek], gloves, boot covers).

Summarize equipment decontamination/containment and disposal method

() Not needed

Equipment decontamination is not anticipated. If it is required, dry decontamination methods will be employed (dry wire brushing, masselin decontamination wipes). More details are provided in the Radiation Protection Plan.

Summarize heavy equipment decontamination/containment and disposal method

☐ Not needed

Equipment decontamination is not anticipated. If it is required, dry decontamination methods will be employed (dry wire brushing, masselin decontamination wipes). More details are provided in the Radiation Protection Plan.

Investigation Derived Waste (IDW) and Waste Disposal

☐ Not needed

IDW will be containerized and staged within the fenced disposal trench area in accordance with the Hill Air Force Base Remediation Waste Management Plan. No liquid IDW is anticipated to be generated since dry decontamination methods (masselin decontamination wipes) and radiological clearance surveys will be utilized for equipment decontamination. It is not anticipated that stormwater or groundwater will infiltrate the excavations and require pumping and collection. PPE IDW will be added to the contaminated soil waste stream.

Project/Site : _____
Project No.: _____

[illegible]

HEALTH AND SAFETY ACTIVITY REPORT

Site:		Location:	
Weather Conditions:		Onsite Hours:	From: To:

Changes in PPE Levels*	Work Operations	Reasons for Change

Site Safety and Health Plan Violations	Corrective Action Specified	Corrective Action Taken (Yes/No)

Observations and Comments:

Completed by:

Site Health and Safety Supervisor

Date

* Only Site Safety and Health Officer may change PPE levels, using only criteria specified in Generic Health and Safety Plan.

ENVIRONMENTAL MONITORING RECORD

SITE: _____
PROJECT NO.: _____
INSTRUMENT: _____

CALIBRATION: Gas: _____ Conc: _____ Span: _____

Time	Monitoring Location	Reading	Corrective Action Taken ^(a)

Comments:

(a) Corrective actions taken must be documented whenever readings at or above action levels are reached. Monitoring equipment and action levels should be specified in the site-specific Generic Health and Safety Plan addendum

Recorded By:

Site Health and Safety Supervisor

Date

ENVIRONMENTAL MONITORING REQUIREMENTS

Instrument	Location of Monitoring	Frequency	General Action Level	Site-Specific Action Level	Response
Total Volatile Organics Detector (PID/FID) (if necessary)	Breathing Zone	Initially and every 30 minutes	Above background	<u>Same</u>	Begin perimeter monitoring for possible PPE upgrade.
	Perimeter monitoring	2 times per day	Continuous response above background Above action level established in site specific HASP	<u>Same</u> Above action level established in site specific HASP	Withdraw from site, evaluate potential source and meter response Shut down operations and identify source of contamination and cover.
Combustible Gas Indicator (if necessary)	Borehole, excavation or well opening at ground surface	For each sample, initially and every 10 minutes	0-10% of LEL* 10-20% of LEL	0-10% of LEL* 10-20% of LEL	Determine source of meter response Monitor continuously, prepare to shutdown
Oxygen Meter (if necessary)	Breathing Zone	Initially and every 30 minutes	>20% of LEL	>20% of LEL	Shutdown immediately, evacuate
Dust Monitor (if necessary)	Breathing Zone	Initially and every 30 minutes	<19.5% or >22% >1 mg/m ³	<19.5% or >22% <u>Same</u>	Shutdown immediately, evacuate Upgrade to Level C PPE and monitor continuously
<p>* The readings must remain <10% of LEL in order to enter an excavation or other area containing combustible gas. Action levels represent concentrations or percentages that are sustained for the monitoring period specified under "Frequency" and do not reflect peak levels.</p> <p>General Action Levels represent worst-case conditions for unknown contaminants/concentrations. Table 8-1 can be modified in GHASP addenda to reflect site-specific conditions.</p>					

Appendix C

Radiation Protection Plan

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*WR111 Little Mountain Test Annex
Magnesium-Thorium Disposal Trench
Hill Air Force Base, Utah*

Radiation Protection Plan

Hill Air Force Base
Contract No: FA8903-09-D-8560
Task Order 0006

Prepared for:
EA Engineering, Science, and Technology, Inc.
2363 N. Hill Field Road, Suite 116
Layton, UT 84041

Prepared by:



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

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August 2014

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A	Radiation Safety Program/ Standard Operating Procedures
---	---

Acronyms and Abbreviations

AFB	Air Force Base
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
bgs	Below ground surface
BZ	Breathing zone
Cabrera	Cabrera Services, Inc.
cfm	Cubic feet per minute
cm ²	Square centimeter(s)
cpm	Counts per minute
CRZ	Contamination Reduction Zone
DAC	Derived air concentration
DDE	Deep dose equivalent
DOT	U.S. Department of Transportation
dpm	Disintegrations per minute
EA	EA Engineering, Science, and Technology, Inc.
EPA	U.S. Environmental Protection Agency
GM	Geiger-Mueller
HAZWOPER	Hazardous waste operations
HP	Health physics
LMTA	Little Mountain Test Annex
lpm	Liters per minute
LV	Low volume
MDA	Minimum Detectable Activity
μCi/mL	Microcuries per milliliter
mrem	Millirem
NRC	U.S. Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Program
OP	Operating procedure
OSHA	Occupational Safety and Health Administration
PM	Project Manager
PPE	Personal protective equipment
pCi/g	picoCuries per gram

QAPP	Quality Assurance Project Plan
RA	Restricted Area
²²⁶ Ra	radium-226
RCA	Radiological Control Area
RD/RAWP	Remedial Design/Remedial Action Work Plan
ROCs	Radionuclides of concern
RPP	Radiation Protection Plan
RPT	Radiation Protection Technician
RSO	Cabrera Corporate Radiation Safety Officer
RSP	Cabrera Radiation Safety Program
RWP	Radiation Work Permit
SRSL	Site Radiation Safety Lead
SZ	Support Zone
TEDE	Total Effective Dose Equivalent
²³⁰ Th	thorium-230
²³² Th	thorium-232
USACE	U.S. Army Corps of Engineers

1.0 Introduction

1.1 Purpose and Objectives

Cabrera Services, Inc. (Cabrera) has been contracted by EA Engineering, Science, and Technology, Inc. (EA) to perform radiological investigation and health physics support for the Remedial Action at WR111 Little Mountain Test Annex (LMTA) Magnesium-Thorium Disposal Trench in Ogden, Utah. This Radiation Protection Plan (RPP) addresses field work to be performed at this site.

The purpose of this plan is to establish radiation protection procedures for site personnel, contractors, and government personnel involved in site work, which involves potential exposure to radiological hazards. This RPP also serves to ensure the health and safety of the general public and to protect the environment during site activities. The objective of this RPP is to anticipate, identify, evaluate, and control radiological hazards.

Site activities will be performed in accordance with this RPP, Cabrera's NRC decommissioning radioactive materials license (#06-30556-01), and other applicable health and safety regulations including Cabrera's *Radiation Safety Program* (RSP) (Cabrera, 2010) and those of the Nuclear Regulatory Commission (NRC) and Occupational Safety and Health Administration (OSHA). Cabrera standard operating procedures (OP) referenced within this RPP are licensed radiological procedures from Cabrera's RSP. The RSP, with current procedures, will be maintained onsite and accessible to personnel. Where cited throughout this RPP, these radiological standard operating procedures will be referred to as "RSP" followed by the individual procedure number. The entire Cabrera RSP is cited in Section 11.0, *References*, and not as individual procedures; however, the individual procedures have been provided in Appendix A.

The levels of personal protection and procedures specified in this plan are based on the best information available from reference documents and current site data. Therefore, these recommendations represent the minimum health and safety requirements to be observed by personnel engaged in this project. Unforeseeable site conditions may warrant a reassessment of the recommended protection levels and controls. Revisions to this RPP must have prior approval by the project technical team, with representatives from Cabrera, EA, and Hill Air Force Base (AFB).

1.2 Site Information

A description of the site history, including location, information on the site, a physical description, and previous investigations are provided in Section 1.0 of the *Remedial Design/Remedial Action Work Plan* (RD/RAWP).

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2.0 Organizational Structure

Key project personnel are identified in Section 2.0 (Worksheet 4) of the *Site-Specific Supplemental Quality Assurance Project Plan* (QAPP), including the EA and Cabrera Project Managers (PMs), Safety and Health Officers (specifically, Corporate Radiation Safety Officer [RSO]) and Site Manager. Information provided includes the organizational structure of the project team, personnel responsibilities and authority, lines of reporting, phone numbers of key project personnel, and an organizational chart. Below are detailed responsibilities of key field radiation control personnel.

2.1 Site Radiation Safety Lead

The Site Manager will also be the Site Radiation Safety Lead (SRSL) for the project. The SRSL possesses qualifications including, but not limited to: formal and “hands-on” training in radiation protection, knowledge of radiation physics, use of monitoring instruments, and knowledge of applicable regulations.

The SRSL is responsible for ensuring that radiation health and safety procedures designed to protect field personnel and the public are maintained throughout the project. The SRSL coordinates the establishment of radiological control areas (RCAs), monitoring radiation exposure levels, and inspecting all material/equipment entering and leaving RCAs for compliance with the RPP and other applicable requirements. The SRSL is also responsible for overseeing the maintenance and quality control check of the onsite radiological instruments and will provide instrument data records for storage in onsite files.

The SRSL, who reports directly to the Corporate RSO and coordinates with the Site Manager, and PM, has the following project responsibilities to:

- Assist the Site Manager in the daily tailgate safety meetings as far as radiological issues and report any incidents that occur onsite to the Site Manager and Corporate RSO
- Note changes in site conditions or procedures and suggest revisions to the general health and safety plan and site procedures as necessary to ensure adequate safety precautions are in place
- Acquire and implement input from the Corporate RSO, as necessary, to maintain the site radiological safety program
- Provide onsite administration of the personnel exposure monitoring procedures for onsite personnel
- Ensure compliance with all applicable regulations concerning the handling and transportation of radioactive material
- Provide radiation training to all onsite personnel who may be exposed to ionizing radiation
- Perform periodic instrument checks, perform gamma surveys, collect soil/samples, establish and maintain radiological zones and controls, perform surveys of personnel and equipment, complete instrument and data records

- Act in the capacity of Authorized User to implement and ensure that licensed materials, if present, are used under the supervision of individuals who meet Cabrera NRC License condition 11.

2.2 Radiation Protection Technician

A Radiation Protection Technician (RPT) is supporting field personnel that will report to the Site Manager. The RPT will have the following responsibilities:

- Provide oversight to the excavation crew to access and setup at remediation locations while implementing the radiation-control criteria established in this RPP
- Perform remedial support surveys, assist in the decontamination of remediation equipment, and perform incoming/release surveys on all equipment
- Maintain appropriate radiation control documentation and logs
- Perform the gamma walkover surveys and final status surveys.

3.0 Hazard Assessment

Potential radiological exposure to project personnel for this work is not significant. The potential radiological hazards that this RPP addresses are those that would be caused by exposure to thorium-containing soil. The review of radiological hazards pertaining to this site considered the level of contamination, the environment in the work area, and the type of work being performed before making a determination of the required levels of personal protective equipment (PPE). Non-radiological hazards are reviewed and evaluated in the general health and safety plan. The SRSL, with the concurrence of the RSO, will make a final determination of radiological controls and levels of PPE prior to the start of site preparation and work activities. The extent of PPE required will be limited to the minimum level required to protect against potential hazards.

3.1 Tasks to be Performed

The following presents a listing of the work for the site:

1. **Site Mobilization/Demobilization** – This activity will include mobilizing/demobilizing all labor, materials, and equipment necessary to perform the work on site in a timely manner in order to support the schedule. The first demobilization will occur after contaminated soils are shipped off-site for disposal, FSS activities are completed, and samples have been shipped off-site for analysis. A second mobilization/demobilization will occur after approval to backfill and restore the Site is received from Hill AFB and the Air Force Radioisotope Committee.
2. **Site Preparation** - Activities include delineation of work zones, staging areas and setup of equipment, calibration, and initial quality control checks of instrumentation and instrument systems. It will also include installation of temporary facilities such as trailers, offices, utilities, consumable materials, and other support equipment and set up of provisions for security and communications. Temporary facilities and controls will be established and maintained, including temporary barriers (a combination of traffic cones, grade stakes, and caution tape, rope, and/or fencing) around the work area; potable water for use in dust suppression, setup of a temporary staging for soils; and setup of spill kits (including absorbent booms and pads) for use in responding to a hydraulic or diesel oil leak from construction equipment used on the project.
3. **Soil Remediation** - Soil remediation of the WR111 trench soils will be performed. Contaminated soils will be transported to a Radiological Staging area using a front end loader or excavator. The adequacy of remedial efforts will be confirmed by remedial support surveys, consisting of gross gamma activity scans.
4. **Final Status Survey** – FSS sampling will be performed following remediation of contaminated soils. This task will be performed within the excavation to ensure there is no residual radiological contamination above derived concentration guidelines levels (DCGLs) after the remediation. The FSS will be performed in accordance with the *Final Status Survey Plan* (FSSP; see Appendix D of the *Decommissioning Plan* [EA/Cabrera, 2014]).
5. **Waste Transportation and Disposal** – Stockpiled contaminated soils will be loaded into trucks using a front-end loader with a bucket scale and transported to US Ecology in Grand View, Idaho or Energy Solutions, located in Clive, Utah.

6. **Backfilling and Site Restoration** - The excavated area will be backfilled with layback soils from the site and clean material from an off-site source. The area will be re-graded and re-seeded to restore the area to pre-remediation conditions.
7. **Decontamination of Equipment**—This task consists of the decontamination and radiological surveys of potentially contaminated equipment and materials prior to removing from the controlled areas for disposition.

3.2 Hazard Communication

Hazards applicable to site contaminants and to hazardous materials brought on site during the investigation will be communicated to site personnel in accordance with the OSHA Hazard Communication Standard, 29 CFR 1910.1200 as described in Cabrera's *Corporate Health and Safety Manual*, Safety Procedure HSM-002, Hazard Communication (Cabrera, 2007).

3.2.1 Radiological Hazards

Table 3-1 provides information on the radionuclides of concern (ROC) for the site, thorium-230 (^{230}Th), thorium-232 (^{232}Th), and radium-226 (^{226}Ra). Monitoring and surveys will be performed to verify radiation levels and radionuclide concentrations in or on materials that are affected by work activities.

3.2.2 Activity Hazard Analysis

The hazard analysis for radiological activity is an on-going process, from the initiation of the RPP preparation, through the implementation and completion of this project. The minimum site-specific radiological hazards associated with the activities of each task, and the proposed control measures, are provided in Table 3-2. If surveys indicate actual radiological conditions are different than expected, additional controls will be evaluated for implementation by the Cabrera Health Physics (HP) field team. Changes recommended by Cabrera must be approved by EA and Hill AFB.

TABLE 3-1
 ROCs Magnesium-Thorium Disposal Trench
Radiation Protection Plan, Remedial Design/Remedial Action

Radionuclide	Name	Half-Life	Principal Emissions ¹
²²⁶ Ra	Radium-226	1.6E3 yr	4.8 MeV alpha, 0.186 MeV gamma
²³⁰ Th	Thorium-230	7.7E4 yr	4.62, 4.69 MeV alpha
²³² Th	Thorium-232	1.4E10 yr	4.01, 3.95 MeV alpha

1. Principal emissions do not include contributions from decay progeny in equilibrium with listed parent nuclide(s).
 MeV – megaelectron volts

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TABLE 3-2
Radiological Activity Hazard Analysis
Radiation Protection Plan, Remedial Design/Remedial Action

Task	Radiological Hazards	Radiological Hazard Control
All Tasks	Housekeeping.	<ul style="list-style-type: none"> ➤ Materials will be stored to prevent intrusion into the work areas. ➤ All work areas will be kept as clean as possible to avoid cross-contamination of clean equipment. ➤ Limit bringing non-essential materials (packing materials, cardboard boxes) into RCAs/work areas to minimize potential generation of low-level radioactive wastes or performance or radiological surveys to release.
All Tasks	Hand tools, manual and power.	<ul style="list-style-type: none"> ➤ Tools/equipment/sample containers removed from the RCA shall be surveyed for radioactivity in accordance with license limits. ➤ All hand and power tools will remain within the RCA until the end of the specified task. ➤ Local and general air sampling and respiratory protection may be required when power tools are used for intrusive activities and conditions are such that generation of airborne radioactivity is possible.
1-Mobilization /Demobilization; 2-Site Preparation; 4-Final Status Survey; 6-Backfilling and Site Restoration;	<ul style="list-style-type: none"> ➤ Non-intrusive activities – therefore, the only significant risk is through external exposure. 	<ul style="list-style-type: none"> ➤ All personnel will participate in As Low As Reasonably Achievable (ALARA) pre-job briefings prior to start of work. ➤ Routine radiological surveys and activities will be performed throughout RCAs and Support Areas to monitor exposures and limit the spread of contamination (personnel and equipment) to ensure the controls and levels of protection are ALARA. ➤ Effluent air sampling will be performed using onsite air sample results during all intrusive onsite activities.
3-Remediation; 6-Waste Transportation and Disposal; 7-Decontamination of Equipment	<ul style="list-style-type: none"> ➤ These tasks involve intrusive activities with additional potential for airborne contamination in addition to the external radiation hazards discussed in Tasks above. ➤ Onsite activities have the potential for generating airborne radioactivity that could impact the general public in adjacent properties. ➤ Tasks 3 and 6 involve handling soil with increased risk of skin exposure to radioactive material. ➤ Task 7 could result in transfer of radioactive material onto worker's gloves or hands or generate airborne contamination. 	<ul style="list-style-type: none"> ➤ These tasks include activities working around potentially contaminated soils and the handling of potentially contaminated materials; the minimum PPE required will be Level D. ➤ All personnel will participate in ALARA pre-job briefings prior to start of work. ➤ Controls will include establishing contamination and contamination reduction zones, including "step-off-areas" and frisker stations at the work area entry/egress points. ➤ Samples for removable contamination shall be surveyed for alpha and beta radioactivity in accordance with Table AP-005-01 Surface Activity Guidelines, located in RSP AP-005, ALARA. ➤ Routine radiological surveys and activities will be performed throughout RCAs and Support Areas to monitor exposures and limit the spread of contamination (personnel and equipment) to ensure the controls and levels of protection are ALARA. Contamination limits for release will be those provided in the current Cabrera Radiation Safety Manual. These are consistent with NRC Regulatory Guide 1.86. ➤ Use decontamination methods that are least likely to disperse contamination. An evaluation will be performed to determine if these initial air monitoring results warrant additional controls, and to determine if continued sampling is necessary. ➤ Effluent and breathing zone air sampling will be performed using on-site air sample results during all on-site activities.

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4.0 Personnel Requirements

Site workers will have received generic and site/project-specific radiation protection training and Hazardous Waste Operators (HAZWOPER) training, and will have been medically-cleared by an occupational physician prior to performing intrusive/remedial activities. Site visitors will receive project-specific awareness training prior to entering the site and will be continuously accompanied by a trained radiation site worker while in the RCA.

4.1 Training

The training requirement section of the *QAPP* addresses general access, respiratory protection, and PPE training requirements for this project. This section also addresses the use of daily tailgate safety meetings and required information for recordkeeping purposes. Radiological safety will be included as part of the daily safety meetings. Each employee involved in intrusive/remedial activities is required to provide evidence of Cabrera's Radiation Worker training completion within the past 12 months. This training shall be in conformance with Cabrera's RSP AP-009, *Training*, and will include the following topics required by 10 CFR 20 (NRC, 2008) and 10 CFR 19.12 (NRC, 1995):

- Site-specific procedures for handling and storing radioactive materials
- Health and safety hazards associated with exposure to site-specific radioactive materials
- Familiarity with this RPP and other project-specific procedures regarding protection from radiation exposure
- Worker responsibility to report unsafe acts or procedures which might result in worker exposure to radiation
- Worker response to onsite events and occurrences with radioactive material
- Worker's rights and responsibilities with respect to working with radioactive material
- NRC NUREG 8.13 regarding risk to embryo/fetus with women radiation workers

Equipment, inspection, and training requirements for each radiological activity are identified in Table 4-1. Inspection and training requirements are hereby included by reference from the Cabrera *Health and Safety Manual, Rev 3* (Cabrera, 2007). Health and safety equipment, such as PPE and monitoring instruments, is specified in the *Site Specific Addendum to the Health and Safety Plan* (Appendix B of the *Work Plan*). A minimum of one copy of the Cabrera RSP radiological standard operating procedures, as referenced throughout this RPP, will be maintained on site.

4.2 Medical

Each employee involved in field activities will also be required to provide the medical approval to perform site work.

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TABLE 4-1
Equipment and Training Requirements
Radiation Protection Plan, Remedial Design/Remedial Action

Activity	Equipment	Inspection	Training
“Non-intrusive activities” – including mobilization and site preparation; setting up zones and controls; and work in support areas of the site.	<ul style="list-style-type: none"> ➤ Portable radiation detection equipment; 	<ul style="list-style-type: none"> ➤ Daily source and background checks shall be performed and documented. ➤ Radiation sources used for calibration shall have appropriate licensing, documentation, and surveillance. 	<ul style="list-style-type: none"> ➤ Onsite workers are required to have current OSHA 40-hour HAZWOPER training, including training in radiological hazards. ➤ Cabrera workers are required to have current Cabrera Radiation Safety Training. All other site workers performing non-intrusive tasks only will be given radiation-hazard awareness training during the mobilization phase. ➤ Onsite workers are required to have site-specific ALARA training and participate in pre-job ALARA briefings as required. ➤ Workers are required to acknowledge reading and understanding site-specific plans. ➤ Qualified operators knowledgeable and trained in the operation of the radiation survey equipment and interpretation of results will operate equipment.
“Intrusive activities” or activities that could generate airborne particulate, including remediation, final status survey surface soil sampling, waste transportation, and decontamination of equipment;	<ul style="list-style-type: none"> ➤ Hand tools and powered equipment; ➤ Portable radiation detection equipment; 	<ul style="list-style-type: none"> ➤ In addition to any routine equipment inspections, equipment shall be surveyed for fixed and loose surface radioactive contamination. ➤ Daily source and background checks shall be performed and documented on all instruments. ➤ Radiation sources used for calibration shall have appropriate licensing, documentation, and surveillance. 	<ul style="list-style-type: none"> ➤ Onsite workers are required to have current OSHA 40-hour HAZWOPER training, including training in radiological hazards. ➤ Workers performing intrusive activities are required to have current Cabrera Radiation Safety Training. ➤ Onsite workers are required to have site-specific ALARA training and participate in pre-job ALARA briefings as required. ➤ Workers are required to acknowledge reading and understanding site-specific plans. ➤ Qualified Radiation Control Technicians knowledgeable and trained in the operation of the radiation survey equipment and interpretation of results will operate radiac equipment. ➤ Technicians will be knowledgeable in Cabrera and site-specific procedures for collection of samples, decontamination of equipment and materials, prevention of cross-contamination, and monitoring.

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5.0 Site Control

Survey and sample collection activities performed in posted RCAs will be controlled through the use of Restricted Area (RA), Contamination Reduction Zones (CRZs), and Support Zones (SZs), as described below.

5.1 General Site Access

General site access is discussed in the project work plan.

5.2 Radiological Control Areas

RCAs are designed to prevent employees, contractors, visitors, and the surrounding environment from receiving unnecessary exposure to radiation and radiological contamination during site activities.

Project-specific RCAs will be established by the SRS. If tasks are being performed concurrently at separate areas of the site, several RCAs may be established to support the work. These areas will require visible delineation and posting as RCAs. Movement of personnel and equipment between work areas as well as on and off the site will be controlled by means of designated access points. The minimum PPE for work in each RCA will be based upon radiological monitoring data. Contaminated equipment and materials will be stored in a RCA.

5.2.1 Airborne Radioactivity Area

An Airborne Radioactivity Area is designated as an area in which airborne radioactive materials, composed wholly or partly of licensed/regulated material, exist in concentrations in excess of the derived air concentrations (DAC), in units of microcuries per milliliter ($\mu\text{Ci/mL}$), as specified in 10 CFR 20, *Standards for Protection Against Radiation*, Appendix B, Table 1, Column 3 or to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake or 12 derived air concentration (DAC)-hours. This is a conservative value that is administered by Cabrera's Radiation Protection Program in an effort to keep employee dose ALARA. The DAC values for the site ROCs are shown in Table 5-1. Class (or lung class or inhalation class) refers to a classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times: for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days. The DAC values indicated in the table represent the most conservative Class for the radionuclide.

In addition, effluent air samples will be compared to action level concentrations derived from NRC published limits in Appendix B of 10 CFR Part 20. The project action level concentrations are set to 20 percent of the values published in Column 1 of Table 2 of 10 CFR 20 Appendix B. The Column 1 Appendix B values are equivalent to the radionuclide concentrations which, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equivalent (TEDE) of 50 millirem (mrem) per year. The reduction to 20 percent of these values allows consistency with EPA's 10 mrem/year standard for effluent releases published in 40 CFR 61.102. A list of site ROCs with the published effluent concentrations and calculated project action levels is provided in Table 5-2.

5.2.2 Contamination Reduction Zone

CRZs will be established to control ingress and egress between RAs and non-contaminated areas. Personnel and equipment that enter and exit a RA will do so through the CRZ. Equipment and initial vehicle decontamination may be performed in a RA. However, personnel and final equipment decontamination shall be located in the CRZ. The CRZ will contain the equipment necessary for personnel decontamination and decontamination verification, and may be equipped with designated “step-off areas” for personnel following removal of potentially contaminated PPE.

There will be localized CRZs established during performance of site activities specific to the access/egress points for access to the sampling activities. These areas will be determined with approval of the SRS� and Site Manager prior to the start of activities within the site. CRZ locations will be discussed with personnel as part of pre-job briefings.

5.2.3 RCA Entry and Exit

When entering or exiting a RCA, personnel and equipment must pass through the CRZ. Potentially contaminated PPE will be removed in the CRZ upon exiting. Decontamination shall be performed prior to exiting the CRZ if contamination is detected above the field screening limits.

5.2.4 Support Zones

SZs are uncontrolled “clean” areas throughout the site. SZs encompass both the overall support infrastructure (e.g., vehicles, sanitary facilities) as well as smaller, task-specific SZs that may be established adjacent to CRZs. These SZs may consist of break areas, equipment and PPE staging areas, and engineering control support centers such as air-sampling stations. PPE will not normally be required in exterior areas of a SZ. The site staging and equipment/material laydown areas will be designated as clean support areas. Although empty equipment and materials staged in the SZs will be radiologically surveyed to be clean prior to moving/storing in this area.

If personnel are performing work in a RCA wearing modified Level D PPE or above (Section 7 of this RPP), a minimum of one person will be in the SZ at all times.

TABLE 5-1

Occupational DAC Values for Site ROCs

Radiation Protection Plan, Remedial Design/Remedial Action

ROC	Class	10CFR20 App B DAC ($\mu\text{Ci/mL}$)
²²⁶ Ra	W	3E-10
²³⁰ Th	W	3E-12
²³² Th	W	5E-13 (NOTE 1)

1. Most limiting for primary alpha-emitting ROC.

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TABLE 5-2

Effluent Air Concentrations and Project Action Limits for Site ROC

Radiation Protection Plan, Remedial Design/Remedial Action

RO	Class	10CFR20 App B Effluent Concentration [$\mu\text{Ci/mL}$]	Project Action Level [$\mu\text{Ci/mL}$]
²²⁶ Ra	W	9E-13	1.8E-13
²³⁰ Th	W	2E-14	4E-15
²³² Th	W	4E-15 (Note 1)	8E-16

1. Most limiting for primary alpha-emitting ROC.

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6.0 Radiation Safety Program

The Cabrera RSP will be implemented to protect workers' health and safety during site activities. The SRSL ensures that: contamination control activities are effective; samples and areas are not cross-contaminated; occupational doses are maintained ALARA; workers, the general public, and the environment are protected; and, that activities comply with radiological procedures in the RSP. This will require a method to identify and prevent the release of potentially contaminated items from RCAs. Methods and programs used to protect the workers, site visitors, the general public, and the environment are discussed in the following sections.

6.1 ALARA

The ALARA principle is to maintain personnel exposures to ionizing radiation as low as reasonably achievable. The principle assures that exposures are consistent with the purpose for which the activity is undertaken, and takes into account technologies and the economics of improvements in relation to benefits to the public health and safety and other societal and socioeconomic considerations. There will be no radiation exposure without a commensurate benefit.

No individuals under age 18 will perform work in RCAs for Cabrera at this site and currently there are no employees that have declared being pregnant.

In accordance with Cabrera RSP AP-005, *ALARA*, administrative action levels for exposure to ionizing radiation have been established based on the Total Effective Dose Equivalent (TEDE) which is the sum of the deep dose equivalent (DDE) and the committed effective dose equivalent to any organ or tissue. The ALARA occupational dose limits are the action levels at which Corporate RSO intervention and potential additional engineering controls will be instituted for future dose abatement. The TEDE will be reviewed for each individual upon receipt of the DDE based on TLD dosimeter data and any calculated internal doses, and compared to the action level. Table 6-1 summarizes the action levels requiring a formal job review.

6.1.1 ALARA Planning and Tracking

Pre-job briefings, performed in accordance with AP-005 *ALARA*, must be performed for each task with conditions that could exceed the stated risk factors. Based on historical data, it is not anticipated that any characterization activity will trigger an ALARA review.

6.2 Radiation Work Permits

The Radiation Work Permit (RWP) serves as a tool in protecting workers from the radiation hazards per Cabrera SOP, AP-012, *Radiation Work Permits* (Cabrera 2010). In this permit, the levels of PPE will be detailed per Cabrera SOP, AP-010, *Radiation Personnel Protective Equipment Used Within Radiological Controlled Areas* (Cabrera 2010), as well as the levels of radioactive materials expected, general area dose rates, airborne radioactivity levels, total and removable radioactivity limits, and other pertinent information. If any of the radioactivity levels on the RWP are exceeded, the SRSL will contact the Corporate RSO immediately. The Corporate RSO has the authority to stop work if there is an exceedance of the radioactivity levels on the RWP. The Corporate RSO, SRSL, and PM will agree on the appropriate action to be taken (i.e. additional administrative controls, increased PPE, etc.) before work can continue.

6.3 Radiation Surveys and Monitoring

6.3.1 Survey Methods

Dose rate and contamination surveys will be performed in accordance with Cabrera RSP OP-001, *Radiological Surveys*. Dose rate surveys will include surface contact and general area surveys. Contamination surveys will include removable contamination (smear) and total radioactivity (direct measurement) surveys on ground surfaces and equipment or other potentially contaminated items originating from RCAs. Types of dose rate instruments are presented in Table 6-2, and contamination survey instruments described in Section 6.3.3.

6.3.2 Survey Documentation

Original copies of field data, field records, analytical data, training records, and other project-specific documentation will be retained in the Cabrera Baltimore Office in accordance with Cabrera procedure OP-187, *Records Management*.

6.3.3 Contamination Surveys

Contamination surveys will be conducted upon arrival/receipt onsite of equipment that will enter any RCA, on equipment and personnel prior to leaving a RCA, and structural and ground surfaces to determine that materials, working surfaces, equipment, and personnel are not contaminated with radioactive material above the acceptable surface contamination levels in Table 6-4. The SRS will identify areas subject to routine smear surveys to be analyzed for gross alpha and gross beta contamination. These areas could include, but are not limited to, the following areas:

- RCA/CRZ access/egress points
- Work trailers and areas where radiological instrumentation is stored or used
- RCA access/egress points
- Personnel and vehicle traffic areas within the RCA
- Work surfaces in support areas.

Table 6-2 provides examples of instruments (or their equivalent) that will be used to perform frisking, direct measurements, and smear counting for contamination surveys:

Contamination surveys will be performed with direct measurements for total radioactivity and smear surveys for removable contamination. Direct measurements are performed using calibrated and daily source checked radiation detection instruments capable of detecting alpha, beta, and gamma radiation. Smears will be collected over a finite surface area, ideally 100 square centimeters (cm²), and analyzed using onsite counting equipment for alpha and beta radioactive contamination per Cabrera RSP, OP-004 *Unconditional Release of Materials from Radiological Control Areas*.

The required minimum detectable activity (MDA) of these instruments will be 50 percent of the applicable acceptable surface contamination limits listed for equipment and materials (or no greater than 90 percent of the MDA if 50 percent is not achievable). For example, the MDA for removable alpha contamination would be 50% of 20 disintegrations per minute per 100 square centimeters (dpm/100cm²)

removable alpha contamination limit from Table 6-4, or 10 dpm/100cm². Survey and counting instruments are source checked on a daily basis and their performances tracked on spreadsheets or control charts. The sources for daily source counts will be handled per Cabrera RSP OP-009, *Use and Control of Radioactive Check Sources*. Procedures for calibration and operation of the instruments are in Cabrera RSP OP-020, *Operation of Contamination Survey Meters* and RSP OP-021, *Alpha-Beta Counting Instrumentation*.

6.3.4 Personnel Contamination Surveys

Geiger-Mueller (GM) detectors may be used to detect beta-gamma surface activity for personnel monitoring. These detectors will detect surface contamination when held within one-half inch of the skin or clothing surface and slowly scanned over the surface. When using the detector for personnel monitoring, the detector shall be used in a background radiation level of less than 100 counts per minute (cpm). If background levels are greater than 100 cpm, the instrument shall be relocated to an area of lower background radiation levels or the area shall be shielded to reduce the background. If an area has readings greater than twice background, the surveyor will pause the detector over the area to verify that the readings are elevated. Further details about personnel frisking are provided in Table 6-3.

Alpha scintillation detectors may be used to detect alpha activity by holding the detector as close as possible to the surface (preferably within one-quarter of an inch) while slowly scanning. For detection of low-level alpha activity, the detector should be held in one position at key locations such as hands, bottoms of shoes, and nose/mouth for approximately five seconds while listening for audible clicks.

Surveying for personnel contamination is the responsibility of individuals who are trained and qualified as radiation workers. Health physics technicians shall survey all other personnel. The instructions for using the equipment, the acceptable limits of contamination, and actions to be taken if any individual exceeds the limits shall be addressed by the SRS prior to work activities within a RCA. The instructions summarized in Table 6-3, shall be adhered to for personnel frisking at all times.

6.4 Acceptable Surface Contamination Limits

Table 6-4 of the USACE *Radiation Protection Manual*, Engineer Manual-385-1-80 provides limits for surface contamination. These limits are presented in Table 6-4. The values for ²²⁶Ra will be applied as the surface contamination release criteria for this project, with an alpha removable contamination limit of 20 dpm/100cm², and average and maximum contamination limits of 100 and 300 dpm/100cm², respectively.

6.5 Airborne Radioactivity Surveys

Radiological airborne hazards may be generated by handling of contaminated subsurface soils or by traffic over contaminated surfaces. Therefore, air sampling will be performed during these work activities to monitor occupational and off-site effluent airborne concentrations. Airborne contamination surveys will be provided utilizing low-volume air samplers at flow rates of approximately 80 liters per minute (lpm) or high-volume (LV) air samplers at flow rates of approximately 15 cubic feet per minute (cfm). The selection of HV versus LV will be based on flow rates; estimated standard run times, total volume of air collected during standard monitoring durations, and required instrument detection capabilities to ensure compliance with regulatory and project-specific limits.

Tables 5–1 and 5-2 present Occupational DAC Values and Effluent Air Concentrations for site ROCs. Additional detail regarding the air sampling program is provided in Section 7.2 of the *Decommissioning Plan* (EA/Cabrera, 2014).

6.5.1 Occupational Air Monitoring

Occupational air monitoring will be performed during all intrusive activities. A breathing zone (BZ) air sampler will be worn by the two workers located nearest to the exposed subsurface soils. BZ air samplers will have filters installed that are exchanged after sufficient volume has been collected to ensure 50 percent of MDA is met.

Work zone/general area air sampling will be provided utilizing one low-volume air samplers (LV-1) at flow rates of approximately 80-100 liters per minute (lpm). LV-1 air samplers will be placed at downwind location surrounding the work area at a distance that will be safe from damage due to equipment operation but close enough to be representative of an occupational airborne exposure to workers. Sampler location and distances from the work area will be documented. Filters from LV-1s will be exchanged after 10 hours of use.

Cabrera RSP OP-002, *Air Sampling and Analysis*, requires that air sampling be conducted where a potential exists to exceed 10 percent of any DAC. If these levels are exceeded, tracking of DAC-hours for all affected workers must be performed. Engineering controls, such as ventilation measures or respiratory protection may also be implemented as mitigation tools.

6.5.2 Effluent Air Monitoring

Site effluent airborne sampling will be performed to monitor and protect the general public. These monitors will be located at the boundary of the RA. High Volume air samplers (HVs) will be utilized to obtain sufficient air volumes to achieve required analytical sensitivities. Filters from HVs will be exchanged daily.

6.5.3 Air Sample Analysis

Filters from air samplers may be allowed to decay prior to counting to reduce impacts due to radon contribution. Cabrera RSP OP-002, *Air Sampling and Analysis*, provides specific instructions regarding collection and decay of air samples. Airborne concentrations will be calculated from the filter counting results using the following equation (alpha airborne concentrations are adjusted upward by a factor of 1.3 to account for alpha self-absorption within non-BZ filter media):

$$\text{Air Concentration} \left(\frac{\mu\text{Ci}}{\text{cm}^3} \right) = \frac{\alpha \text{ or } \beta \text{ (dpm)}}{(2.22 \times 10^6 \frac{\text{dpm}}{\mu\text{Ci}})(\text{Sample Volume, cm}^3)}$$

Air sample filters will be counted for sufficient time to meet required instrument detection capabilities of 50 percent of the Project Action Limit. Airborne concentration MDAs will be calculated using the following equation:

$$\text{MDA} \left(\frac{\mu\text{Ci}}{\text{cm}^3} \right) = \frac{3 + 2k_a \sqrt{(R_b T_{s+b} \left(1 + \frac{T_{S+B}}{T_B} \right))}}{(2.22 \times 10^6)(E)(V)T_{s+b}}$$

where:

E	=	counter 4π efficiency in percent (cpm/dpm)
R_b	=	background count rate in cpm
T_b	=	background count time in minutes
T_{s+b}	=	sample count time in minutes
V	=	sample volume in cm^3
2.22×10^6	=	disintegrations per minute per μCi conversion factor
k_α	=	1.645 for a confidence level of 95 percent

6.6 Vehicle and Package Survey Limits

Vehicles (i.e., dump trucks) and sample shipments will be radiologically surveyed for release from the site in accordance with U.S. Department of Transportation (DOT) criteria in 49 CFR 173, Subpart I, *Class 7 (Radioactive) Materials* (DOT, 2004). These criteria include radiation level (dose rate) and contamination (removable) limits and are summarized in Table 6-5, as applicable to these project activities. These are the most restrictive DOT regulations for a radioactive material shipment, which apply to shipping excepted packages for limited quantity of radioactive material. Each package must be designed and prepared such that, under conditions normally incident to transportation, the specified radiation levels are not exceeded. The levels of removable contamination on the external surfaces of the packages and vehicles will be determined by smearing an area of 300 cm^2 of the surface and converting the measured results to the specified area in the Table 6-5 limits, and must also be kept ALARA.

6.7 Personnel Radiological Monitoring

6.7.1 Dosimetry

The potential for external exposure for Site employees working in RCAs and with potentially radioactive material or equipment is low based on known and expected site conditions. Therefore, the potential external dose contribution to a Site employee's exposure is expected to be well below the Project exposure limits in Table 6-1. However, site employees who enter an RCA will be issued radiation dosimetry (thermoluminescent dosimeters). Unless specified otherwise on an RWP, the radiation measuring dosimeter will be worn on the front of the torso, between the waist and neck, i.e., chest. Dosimeters shall be supplied and processed by a vendor holding current accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology and approved for the type of radiation(s) expected to be encountered at the Site. Dosimeters shall be processed quarterly (once every three months) or more frequently as determined by the Corporate RSO or SRS. This will be a temporary dose with final official doses provided by the NVLAP accredited facility at the end of the year.

Calculation of occupational exposure from external sources of radiation will be conducted in accordance with the guidance in NRC Regulatory Guide 8.34, *"Monitoring Criteria and Methods to Calculate Occupational Radiation Doses"* (NRC, 1992).

6.7.2 External Radiation Monitoring

Dose rate surveys will be used to monitor the radiological working conditions over the course of the project. Surveys will include routine monitoring and operational health physics coverage to ensure that radiological conditions remain within acceptable limits as defined in this RPP. Survey areas will include, but are not limited to, the following:

- Around the exteriors of the RCA
- Inside the excavation
- Within temporary facilities such as staging or storage areas.

A Bicron MicroRem meter (or equivalent) will be used to perform dose rate surveys.

6.7.3 Internal Dose Monitoring

There is a potential for internal exposure to the site ROCs during sampling activities. Initial internal dose monitoring will be performed via air sampling and DAC-hour tracking to ensure that any unforeseen airborne hazards are detected and evaluated promptly during intrusive activities. Airborne levels are not expected to exceed 10 percent of DAC. Therefore, there is an expectation that no internal dose evaluation will be required.

TABLE 6-1

ALARA Formal Job Review for Following Conditions

Radiation Protection Plan, Remedial Design/Remedial Action

Work Conditions (AP-005, ALARA, Rev.1, April 2006)

1. Any individual dose is expected to exceed 25 millirem (mrem).
 2. The collective dose for the job exceeds 0.1 person-rem.
 3. Airborne exposures exceed 12 DAC-hours per week for any single individual.
 4. General area dose rates exceed 1 mrem/hour.
 5. Contamination levels exceed 100 times the values in "Surface Activity Guidelines" (AP-005-01).
 6. Use of supplemental engineering controls (high-efficiency particulate air [HEPA] filter systems, glove bags, tents, and other similar devices) and respiratory protection to reduce potential internal exposures.
 7. Installation, removal, or modification of temporary shielding.
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TABLE 6-2

Radiological Field Instrumentation

Radiation Protection Plan, Remedial Design/Remedial Action

Instrument	Detector	Radiation Detected	Function
Ludlum Model 3 ratemeter	Ludlum Model 44-9 Geiger-Mueller	Alpha-beta-gamma	Frisking - personnel, equipment, surfaces
Ludlum Model 2360 scaler/ratemeter	Ludlum Model 43-93 scintillator (or equivalent)	Alpha-beta	Direct contamination and frisking – personnel, equipment, surfaces
Ludlum Model 2929 dual channel scaler, or Ludlum Model 2360 dual channel scaler if alternating current power supply is not available	Ludlum Model 43-10-1 scintillator	Alpha-beta	Smear and air filter counting
Bicron MicroRem meter	Integrated plastic scintillator	Gamma	Dose equivalent rates

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TABLE 6-3

Guidelines for Frisking Performance

Radiation Protection Plan, Remedial Design/Remedial Action

General Requirements and Performance	
1.	Verify that the instrument is in service, set to the lowest scale, and the audio output can be heard during frisking.
2.	Frisk the hands before picking up the detector.
3.	Hold the beta-gamma detector less than ½-inch and the alpha detector approximately ¼-inch from the skin/clothing surface.
4.	Move the detector over the skin/clothing surface at a rate of approximately one detector width per second.
5.	Perform the frisk in the following order: <ul style="list-style-type: none"> • Head (pause at the mouth and nose for approximately 5-seconds). • Neck and Shoulders • Arms (pause at each elbow) • Chest and Abdomen • Back, Hips, and Seat of pants • Legs (pause at each knee) • Shoe Tops • Shoe Bottoms (pause at sole and heel) • Personal and supplemental dosimeters.
6.	If the count rate increases, pause for five to 10 seconds over the area to provide adequate time for instrument stabilization and response.
7.	If the count rate increases to a value greater than 2-times background or the instrument alarms, remain in the area and notify an Radiation Protection Technician (RPT) or the SRSL.
8.	The whole body frisk should take two to three minutes depending on the sizes of the detector's active area and the person. When completed, return the detector to its holder. The detector should be placed on the side or face-up to allow the next person to frisk their hands before handling the detector.

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TABLE 6-4

Acceptable Surface Contamination Limits

Radiation Protection Plan, Remedial Design/Remedial Action

RCOPC⁽¹⁾	Average^(2,3) (dpm/100 cm²)	Maximum^(2,4) (dpm/100 cm²)	Removable^(2,5) (dpm/100 cm²)
²²⁶ Ra, ²³⁰ Th	100	300	20
Th-nat, ²³² Th	1,000	3,000	200

NOTES:

1. Where surface contamination by both alpha and beta-gamma emitting nuclides exists, the limits established for alpha and beta-gamma emitting nuclides should apply independently.
2. As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
3. Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each object.
4. The maximum contamination level applies to an area of not more than 100 cm².
5. The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper (swipe), applying moderate pressure, and assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionately and the entire surface should be swiped.

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TABLE 6-5

Vehicle and Sample Container Survey Limits (49 CFR 173, Subpart I)

Radiation Protection Plan, Remedial Design/Remedial Action

Parameter	Limit
Radiation (Dose Rate)	0.5 mrem/hr at any point on the external surface of the package
Contamination (Removable)	
<i>Beta and gamma emitters and low toxicity alpha emitters</i>	22 dpm/cm ² (2200 dpm/100cm ²)
<i>All other alpha emitting radionuclides</i>	2.2 dpm/cm ² (220 dpm/100cm ²)

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7.0 Levels of Protection

All personnel performing operations onsite shall be required to use the appropriate level of protection. The minimum levels of protection to begin each activity of this project are shown in Table 7-1 and are described in the following subsections. The most conservative levels of protection from this list and the PPE required, as per the project general health and safety plan, will be implemented. If conditions are identified requiring a change in the level of protection, then PPE will be upgraded or downgraded according to guidelines in this RPP prior to continuing work activities.

7.1 Level D PPE

Level D PPE will be worn during non-intrusive activities where no known contamination is present. Level D PPE consists of the following:

- Work clothes, e.g., coveralls (cotton), or full-length pants and long-sleeve shirt
- Work gloves, leather or cotton as necessary for physical hazards
- Safety shoes, certified to the American Society for Testing and Materials (ASTM) F2413-05 standard
- Safety glasses with side shields certified to the American National Standards Institute (ANSI) Z87.1 standard, as necessary for physical hazards
- Hard hats, as necessary for physical hazards
- Hearing protection (while Geoprobe is operating).

7.2 Modified Level D PPE

Modified Level D PPE will be employed when conducting activities with known or potential contact with radioactively contaminated materials. In addition to the Level D components listed above, the following items will be added:

- Shoe covers or booties
- Gloves, nitrile or latex inner for handling/packaging of quality assurance sources, samples or used air filters
- Tyvek™, or equivalent paper suits (workers may wear water-resistant suits if utilizing water spraying or pressure washing for decontamination)
- Eye protection (safety glasses or goggles), meeting ANSI specifications.

7.3 Level C PPE

It is not anticipated that work activities for these tasks have the potential to generate airborne contamination or exposures that would exceed the limits requiring Level C PPE. However, if it is determined that this potential exists, PPE required in addition to the Modified Level D components listed above will include a full-face respirator with P-100 or combination particulate/volatile organic compound cartridge.

If conditions change that require an upgrade to more protective PPE, then that decision will be made by the SRS� with the concurrence of the Corporate RSO. Conditions that may warrant changes in PPE may include, but are not limited to, elevated ambient airborne contamination that cannot be adequately mitigated through engineering controls or encountering potentially hazardous conditions that have not been previously evaluated.

TABLE 7-1

Minimum Level of Protection Requirements

Radiation Protection Plan, Remedial Design/Remedial Action

Task	Activity	Level of Protection
1	Mobilization/Demobilization	Level D
2	Site Preparation	Level D
3	Remediation	Modified Level D/Level D
4	Final Status Survey	Level D
5	Waste Transportation and Disposal	Modified Level D/Level D
6	Backfilling and Site Restoration	Level D
7	Decontamination of Equipment	Level D

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8.0 Decontamination Procedures

The types of radiological decontamination to be addressed for this project are:

- **Equipment and Materials**—To remove contamination from equipment to ensure compliance with release criteria.
- **Vehicles**—To remove contamination from vehicles to prevent spread of contamination and ensure compliance with release criteria.
- **Personnel**—To remove contamination from clothing or personnel to prevent personnel exposure to radiation and prevent the spread of contamination.

Radiological decontamination of equipment and materials shall be performed using the guidance presented in Cabrera's RSP, OP-018, *Decontamination of Equipment and Tools*. Limits to be used for unrestricted release of equipment and materials are provided in Table 6-4 – Acceptable Surface Contamination Limits. Personnel decontamination and evaluation are addressed in detail in the following subsections.

8.1 Personnel Decontamination

Methods and procedures for decontamination will follow Cabrera RSP, OP-243, *Personnel Monitoring and Decontamination*. Contamination may be removed from personnel clothing by patting the affected area with tape and resurveying to determine if additional decontamination is necessary. If contamination cannot be reduced to levels below the applicable limit the clothing will be removed from service for disposal as low-level radioactive waste. Where radon contamination is suspected, HP personnel may remove and secure the clothing to allow time to ventilate and decay, then re-survey at a later time to determine if contamination is below the applicable limit and ALARA.

Only HP personnel and qualified medical personnel are permitted to decontaminate personnel with skin contamination. The following protocols will be adhered to when performing skin decontamination:

1. Survey the affected area and record the types and initial levels of contamination.
2. If possible, remove particles of contamination with tape and save the particles for evaluation.
3. Attempt localized washing with warm water and soap, ensuring the contamination is not spread to uncontaminated parts of the body. Resurvey the affected area to determine if the contamination has been reduced to levels below the applicable levels and ALARA.
4. If contamination persists, decontamination attempts and resurveys may be repeated multiple times but should stop if these methods are ineffective or skin irritation occurs.
5. If area cannot be decontaminated sufficiently with soap and water, the area may be covered (e.g., with plastic or by wearing latex gloves) to allow contamination to remove itself through perspiration.

6. Contaminated wounds of any kind will be decontaminated under the supervision of the SRSL or project HP. Severe wounds will be decontaminated under the supervision of medical personnel.
7. Personnel skin contamination must be reported to the Corporate RSO to determine if a skin dose assessment must be performed.
8. The results of bodily contamination must be recorded on a Personnel Contamination Report. At a minimum, the information provided in this report will consist of:
 - Employee name, date, social security number, and project, supervisor
 - When contamination occurred, description of the cause, and where it happened/what specific task
 - How could contamination have been prevented/corrective actions
 - Survey data – surveyor, instrument information, pre-decontamination, after each decontamination attempt, radionuclide/form, decontamination method(s), and whole body results (if applicable)
 - A human figure (front and back views) to locate contamination
 - Affected employees and SRSL/Corporate RSO signatures with signature dates
 - Comments/additional information section.

The information requested, in this report, must be provided as completely and accurately as possible for evaluation of subsequent actions, personnel dose, and for required documentation. This report shall be maintained in the employee's radiation exposure file.

Emergency medical care should be administered immediately for injuries affected by radioactive materials. Medical treatment of injuries shall take precedence over radiological considerations. The SRSL and project HP staff will provide medical personnel with any necessary radiological support in regards to contamination control and monitoring of the patient and medical staff. The treatment of radiologically contaminated injuries should include:

- Treatment of contaminated wounds by medically qualified individuals
- Monitoring of wounds, bandages, and medical instruments and equipment for contamination
- Radionuclide identification.

8.2 Personnel Contamination Evaluation

Evaluation by a qualified individual (e.g., the SRSL or RSO) is required to accurately assess the need for immediate medical action when personnel contamination exceeds the levels (above background) shown in Table 8-1. A contamination evaluation will be performed in accordance with Cabrera OP-243, *Personnel Monitoring and Decontamination*.

An *in vivo* and/or *in vitro* bioassay procedure shall be required in the following circumstances:

- a. Nasal, mouth, or open wound smears exceeding (above background):
 - 20 dpm alpha, or
 - 1,000 dpm beta-gamma
- b. Any detectable radioactivity on nasal or mouth smears (above background)
 - Skin or clothing contamination exceeding 1,000 dpm alpha, or 5,000 dpm beta-gamma
- c. Facial contamination exceeding (above background):
 - 1,000 dpm alpha, or
 - 5,000 dpm beta-gamma

A skin dose calculation shall be required if skin contamination exceeds background by:

- 1,000 dpm alpha, or
- 5,000 dpm beta-gamma.

When an incident above these criteria is encountered, the Corporate RSO shall be immediately notified. If an *in vivo* bioassay procedure is required, the affected person(s) shall be transported directly to a whole body counter facility as soon as practicable after the incident.

If the RSO recommends *in vitro* bioassay, as a result of the incident, the affected person(s) shall continue supplying samples until directed to stop.

Bioassay evaluations at levels of contamination lower than the limits above may be recommended at the discretion of the Corporate RSO.

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TABLE 8-1

Personnel Contamination Limits

Radiation Protection Plan, Remedial Design/Remedial Action

Location	Beta-gamma Contamination (dpm/100cm²)	Alpha Contamination (dpm/100cm²)
Facial	5,000 (Total)	1,000 (Total)
Nasal or Mouth Smear	1,000	20
Open Wound Smear	1,000	20

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9.0 Emergency Response

Emergency telephone numbers, a map providing directions to the nearest hospital, and requirements for posting this material are presented in the Site-Specific Addendum to the Health and Safety Plan (Appendix B of the RD/RAWP).

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10.0 Medical Surveillance and Training Requirements

Cabrera's requirements for worker training and medical surveillance are presented in the *Site-Wide Health and Safety Plan* (EA, 2013). Specific requirements for radiation safety training are discussed in Section 4.1 of this *RPP*.

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11.0 References

- Cabrera Services, Inc. (Cabrera), 2007. Cabrera Services Health and Safety Manual; Cabrera Services, Inc. 2007.
- Cabrera, 2010. Cabrera Radiation Safety Program, Rev1; Cabrera Services, Inc.; May 2010; including all current revisions of AP- and OP- standard radiological operating procedures.
- EA Engineering (EA)/Cabrera, 2014. *Decommissioning Plan WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench*. May 2014.
- Department of Transportation, 2004. Class 7 (Radioactive) Materials; U.S. Department of Transportation; 49CFR 173 Subpart I 2004.
- EA, 2013. *Quality Project Plan Hill Air Force Base*, also includes the *Site-Wide Work Plan* and *Health and Safety Plan*. June 2013.
- Nuclear Regulatory Commission (NRC), 1992. "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses." NRC Regulatory Guide 8.34. July 1992.
- NRC, 1995. Instructions to Workers; U.S. Nuclear Regulatory Commission; 10 CFR 19.12; July 1995.
- NRC, 2008. Standards for Protection Against Radiation; U.S. Nuclear Regulatory Commission; 10 CFR 20, January 2008 Edition.
- Occupational Safety and Health Administration (OSHA), 2004. Labor; U.S. Occupational Safety and Health Administration, Title 29 Code of Federal Regulations; July 2004.
- U.S. Army Corps of Engineers (USACE), 1997. Radiological Safety; U.S. Army Corps of Engineers, ER 385-1-80; May 1997.
- USACE, 2003. Health and Safety for Hazardous, Toxic, and Radioactive Waste Activities; U.S. Army Corps of Engineers, ER 385-1-92; July 2003.
- USACE, 2008. Safety and Health Requirements; U.S. Army Corps of Engineers, Engineer Manual 385-1-1; September 2008.

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Attachment A
**Radiation Safety Program/
Standard Operating Procedures**

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ATTACHMENT A
Radiation Safety Program/Safety Standard Operating Procedures

List of Procedures

- RSP AP-005 *ALARA*
- RSP AP-009 *Radiation Worker Training*
- RSP AP-010 *Radiation Personnel Protective Equipment Used Within Radiological
Controlled Areas*
- RSP AP-012 *Radiation Work Permits*
- RSP OP-001 *Radiological Surveys*
- RSP OP-002 *Air Sampling and Analysis*
- RSP OP-004 *Unconditional Release of Materials from Radiological Control Areas*
- RSP OP-009 *Use and Control of Radioactive Check Sources*
- RSP OP-018 *Decontamination of Equipment and Tools*
- RSP OP-020 *Operation of Contamination Survey Meters*
- RSP OP-021 *Alpha-Beta Counting Instrumentation*
- RSP OP-243 *Personnel Monitoring and Decontamination*



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

RADIATION SAFETY PROCEDURE

FOR

ALARA

AP-005

Revision 2.0

Reviewed by:

David Wunsch

David Wunsch, Quality Assurance Manager

4/8/13

Date

Approved by:

Henry M. Siegrist

Henry Siegrist, CHP, PE, Radiation Safety Officer

4/8/13

Date

1.0 PURPOSE

This procedure provides the requirements and methods Cabrera Services Inc. (CABRERA) personnel will utilize for conducting As Low As Reasonably Achievable (ALARA) reviews and briefings.

2.0 APPLICABILITY

This procedure applies to formal ALARA reviews and briefings conducted by the Project Radiation Safety Committee (RSC), which includes the Radiation Safety Officer (RSO). Records created from the operation of this procedure are used by project radiological safety personnel to document work evolution, and maintain doses ALARA. ALARA reviews are initiated based on dose trigger levels.

3.0 DEFINITIONS

As Low As Reasonably Achievable (ALARA) – Process to make use of every reasonable effort to maintain exposures to radiation as far below the dose limits, as is practical. Reducing radiation exposures at a site to ALARA levels strikes a balance between what is possible through additional planning and management, remediation, and the use of additional resources to achieve a lower collective dose level.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

There are no special precautions associated with this procedure.

4.2 Limitations

There are no special limitations associated with this procedure.

4.3 Requirements

4.3.1 Work activities performed, under this procedure, will use the most current radiological data for the project and will be in accordance with the Radiation Work Permit (RWP), Health and Safety Program (HASP), and Radiation Safety Program (RSP).

4.3.2 Documents created from use of this procedure will be maintained in accordance with OP-187, *Records Management*.

4.3.3 Radiation dose histories for site workers will be obtained prior to the start of the project, as appropriate.

5.0 EQUIPMENT

There is no equipment associated with this procedure.

6.0 RESPONSIBILITIES

- 6.1 Radiation Safety Committee (RSC) – The RSC is responsible for high level review, evaluation, and action on ALARA issues that affect the Radiation Safety Program.
- 6.2 Project Manager (PM) – The PM is responsible for the radiological safety of all personnel onsite; and ensuring that, if they work in radiologically controlled areas, that they know and understand with this procedure, adequately trained in its use, and have readily available access to a copy.
- 6.3 Radiation Safety Officer (RSO) – The RSO will ensure that personnel who work with radioactive material are trained, and have an adequate understanding of ALARA principles and the use of this procedure. The RSO is also responsible for reviewing and approving ALARA documents, as well as conducting, reviewing and/or approving ALARA reviews and briefings described in this procedure.
- 6.4 Site Radiation Safety Lead (SRSL) – The SRSL acts as the RSO's duly authorized representative for radiological issues when the RSO and NRC-listed License Authorized Users are not onsite. When on site, the SRSL will ensure the requirements established in this procedure are implemented.
- 6.5 Radiation Protection Technician (RPT) – The RPT is responsible for the control of radioactive material, coverage of radiation workers, general safety protection and counseling workers to maintain exposures ALARA. The RPT is responsible for fully understanding and complying with this procedure.

7.0 PROCEDURE

- 7.1 This procedure sets the minimum standards for performance of formal ALARA reviews and briefings. It does not prohibit the performance of any reviews by the client's Radiation Protection Department that are in addition to those established by this procedure.
 - 7.1.1 The RSO will discuss with the PM, if necessary, the dose reduction techniques pertinent to project tasks that do not meet the criteria for formal reviews, as set by this procedure.
 - 7.1.2 All personnel involved in the project are expected to participate in and support efforts to perform ALARA related activities. They will discuss any ALARA concerns with the PM or RSO, as appropriate.

7.1.3 Dose rate reduction methods will be identified and recorded prior to and during job performance.

7.2 Conducting ALARA Reviews and Briefings

7.2.1 Documented ALARA reviews and briefings for work conditions listed in Exhibit 1 will be in accordance with their associated risk factor listed in the same table.

Exhibit 1: Formal ALARA Job Review and Briefing Requirements

WORK CONDITIONS	RISK FACTOR*	REVIEW CONDUCTED BY	REVIEW APPROVED BY	BRIEFING CONDUCTED BY
1. Any individual dose is expected to exceed 25 millirem (mrem).	1-5X	RPT/SRSL	RSO/ RSC	RPT/SRSL
2. The collective dose for the job exceeds 0.1 person rem.				
3. Airborne exposures exceed 12 Derived Air Concentration (DAC)-hours per week for any single individual.	5-10X	RSO/RSC	RSO/RSC	RSO
4. General area dose rates exceed 1 millirem per hour (mrem/hr).	>10X	RSO/RSC	RSO/RSC	RSO
5. Contamination levels exceed 100 times the values in "Surface Activity Guidelines" (Attachment A)				
6. Use of supplemental engineering controls (HEPA filter systems, glove bags, tents, and other similar devices) and respiratory protection to reduce potential internal exposures.	These work conditions have non-readily determined risk factors associated with them, and will be reviewed and approved by the RSO or RSC in all instances.			
7. Installation, removal, or modification or temporary shielding.				
* The risk factor is multiplied by the expected dose to decide who will conduct the reviews, approvals and briefings. (e.g., a risk factor of 5 multiplied by work condition 4's dose of 1 mrem/hr will determine that the RSO/RSC will conduct and approve the review, and the briefing will be conducted by the RSO).				

7.2.2 A pre-job review will include the RWP, Project ALARA Review Form (Attachment B), survey records, previous job performance records, and technical work control documents, as appropriate.

7.2.3 The appropriate designee, listed in Exhibit 1, will conduct job reviews and briefings. Periodic ALARA job-in-progress reviews will be conducted if work conditions extend beyond one week. The PM will provide any pertinent information regarding ALARA controls for the project.

- 7.2.4 Pre-job and job-in-progress briefings will be performed and documented using the attached “ALARA Briefing Record” (Attachment C) and the “ALARA Briefing Attendance Record” in Attachment D.
- 7.2.5 Attendance at post-job reviews will include, at a minimum, all personnel that were involved in ensuring radiation safety at the jobsite. The radiation safety individual that conducted the pre-job review will conduct the post-job review, if practical.

7.3 Review and Briefing Recordkeeping

- 7.3.1 All reviews will be documented on the “Project ALARA Review Form” found in Attachment B.
- 7.3.2 If initial person-rem estimates need to be revised, then they will be recorded in the final section of the Project ALARA Review Form; and, the explanations for all revisions will be documented with annotated sheets to the form.
- 7.3.3 If additional ALARA requirements are identified during the pre-job or job-in-progress briefings, then they will be added to the Special Instructions section of the RWP.
- 7.3.4 Any additional information obtained from task workers, or personnel ensuring radiation safety of the project, will be annotated in the Corrective Action section of the form.
- 7.3.5 During the performance of the job, any information collected that could reduce collective or individual dose rates, for future work, will be documented on pages attached to the form.
- 7.3.6 Original copies of all documentation generated from the use of this procedure will be forwarded to the RSO for processing, including arrangement and filing. They are used in the RSP to document contamination levels of work areas and materials onsite. Selected items may be included in the Radiological Conditions Awareness Log or Radiological Conditions Awareness Report (see AP-003, *Radiological Conditions Awareness Report*), as appropriate.

8.0 REFERENCES

- Title 10, Code of Federal Regulations, Part 20, *Standards for Protection Against Radiation*.
- Health and Safety Program, Cabrera Services Inc., Manual
- Radiation Safety Program, Cabrera Services Inc., Manual

- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure

9.0 REQUIRED RECORDS

- Procedure training records
- Dose rate reduction methods
- Surface Activity Guidelines
- Project ALARA Review Form
- ALARA Briefing Record
- ALARA Briefing Attendance Record

10.0 ATTACHMENTS

- Attachment A – Surface Activity Guidelines
- Attachment B – Project ALARA Review Form
- Attachment C – ALARA Briefing Record
- Attachment D – ALARA Briefing Attendance Record

Attachment A

Surface Activity Guidelines

Surface Activity Guidelines

ALLOWABLE TOTAL RESIDUAL SURFACE ACTIVITY (DPM/100CM ²) ⁽¹⁾			
RADIONUCLIDES ⁽²⁾	AVERAGE ^(3,4)	MAXIMUM ^(4,5)	REMOVABLE ⁽⁶⁾
Transuranics, ¹²⁵ I, ¹²⁹ I, ²²⁷ Ac, ²²⁶ Ra, ²²⁸ Ra, ²²⁸ Th, ²³⁰ Th, ²³¹ Pa	100	300	20
Th-natural, ⁹⁰ Sr, ¹²⁶ I, ¹³¹ I, ²²³ Ra, ²²⁴ Ra, ²³² U, ²³² Th	1,000	3,000	200
U-natural, ²³⁵ U, ²³⁸ U, and associated decay products, alpha emitters	5,000 α	15,000 α	1,000 α
Beta-gamma emitters ⁽⁷⁾ (radionuclides with decay modes other than alpha emission or spontaneous fission) except ⁹⁰ Sr and others noted above	5,000 β γ	15,000 β γ	1,000 β γ

Notes:

- (1) As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
- (2) Where surface contamination by both alpha and beta-gamma emitting radionuclides exists, the limits established for alpha and beta-gamma emitting radionuclides should apply independently.
- (3) Measurements of average contamination should not be averaged over an area of more than one m². For objects of less surface area, the average should be derived for each object.
- (4) The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr, respectively, at 1 m.
- (5) The maximum contamination level applies to an area of not more than 100 cm².
- (6) The amount of removable material per 100 cm² of surface area should be determined by wiping an area of that size with dry filter or absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping media with an appropriate instrument of known efficiency. When removable contamination on objects of surface area of less than 100 cm² is determined, the activity per unit area should be based on the actual area, and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if detector scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.
- (7) This category of radionuclides includes mixed fission products, including ⁹⁰Sr, which has been separated from the other fission products, or mixtures where the ⁹⁰Sr has been enriched.

Attachment B

Project ALARA Review Form

Project ALARA Review Form

RWP #		Revision		Task Location			
Pre-Job Review Date				Conducted by			
In Progress/Post-Job Review Date				Conducted by			
ALARA Goals:		person-rem		DDE		CEDE	
						TEDE	
REVIEW CRITERIA				ACTION		COMMENTS	
PRE-JOB REVIEW	1.	Are technical work documents that accurately define the work available?		Yes			
				No			
				N/A			
	2.	Has the procedure been verified through walk-downs or prior performance?		Yes			
				No			
				N/A			
	3.	Do procedures/work checklists/documents have approved hold points?		Yes			
				No			
				N/A			
	4.	Are there specific points in the work evolution at which radiological conditions are subject to change? If yes, are these addressed as hold points in work documents?		Yes			
				No			
				N/A			
	5.	Has the work force performed this previously?		Yes			
				No			
				N/A			
	6.	Is specific training required prior to job performance?		Yes			
				No			
				N/A			

Project ALARA Review Form (Continued)

PRE-JOB REVIEW	7.	Are photographs, videos, and or drawings of the areas(s) to be worked available?		Yes	
				No	
				N/A	
	8.	Has the size of the work crew needed to perform the job been evaluated?		Yes	
				No	
				N/A	
	9.	Have all identified support groups been notified of scheduled work and briefing requirements?		Yes	
				No	
				N/A	
	10.	Have the primary sources of exposure been identified?		Yes	
				No	
				N/A	
	11.	Any significant increase in airborne radioactive materials likely as a result of the work being performed?		Yes	
				No	
				N/A	
	12.	Have engineering controls including HEPA filtration devices been selected to reduce the potential for airborne releases?		Yes	
				No	
				N/A	
	13.	If the release of airborne radioactive materials cannot be eliminated through the use of engineering and process controls has the use of respirators been evaluated in accordance with HASP and TEDE ALARA principles?		Yes	
				No	
				N/A	
	14.	Can work be moved to a lower dose rate area?		Yes	
				No	
				N/A	
15.	Have ALARA low dose rate areas been identified and their use explained to the workers?		Yes		
			No		
			N/A		

Project ALARA Review Form (Continued)

PRE-JOB REVIEW	16.	Are stay times appropriate for reduction of individual doses?		Yes	
				No	
				N/A	
	17.	Have travel routes to and from work areas been selected and discussed with workers?		Yes	
				No	
				N/A	
	18.	Can remote tools and/or robotics be utilized?		Yes	
				No	
				N/A	
	19.	Is any special equipment or procedural restriction required to ensure worker safety during work performance including lockout/tagout requirements?		Yes	
				No	
				N/A	
	20.	Is heat or cold stress a concern? Have stay times been evaluated for heat or cold stress considerations?		Yes	
				No	
				N/A	
	21.	Does the work involve the use or generation of hazardous materials? Can this result in additional collective dose?		Yes	
				No	
				N/A	
	22.	Will the work involve waste being generated? Is mixed waste a concern?		Yes	
				No	
				N/A	
	23.	Has the handling and disposal of waste products been determined?		Yes	
				No	
				N/A	
	24.	Will liquids be generated, collected, and/or routed to drains? Have necessary permits been obtained?		Yes	
				No	
				N/A	

Project ALARA Review Form (Continued)

PRE-JOB REVIEW	25.	Are whole-body thermoluminescent dosimeters (TLDs) sufficient to monitor potential exposures expected to be encountered?		Yes	
				No	
				N/A	
	26.	Is multi-badging required?		Yes	
				No	
				N/A	
	27.	Is extremity badging required?		Yes	
				No	
				N/A	
	28.	Does the work involve any criticality concerns? Have controls been identified?		Yes	
				No	
				N/A	
	29.	Are Alarming Radiation Monitors (ARMs) or Continuous Air Monitors (CAMs) going to be used during this work evolution?		Yes	
				No	
				N/A	
	30.	Is a bioassay program required during or following the completion of work?		Yes	
				No	
				N/A	
	31.	Are any non-routine items of protective clothing required (face shields, heavy rubber gloves, bubble hoods, etc.)?		Yes	
				No	
				N/A	
	32.	Will on-the-job photographs or videos be made to record job conditions or step completion?		Yes	
				No	
				N/A	
	33.	Are administrative radiation control limits in place for workers as required?		Yes	
				No	
				N/A	

Project ALARA Review Form (Continued)

PRE-JOB REVIEW	34.	Is work being performed as required by technical work documents and the RWP(s)?	<input type="checkbox"/>	Yes	
			<input type="checkbox"/>	No	
			<input type="checkbox"/>	N/A	
	35.	Are workers knowledgeable of radiological conditions and protective equipment requirements in the work area?	<input type="checkbox"/>	Yes	
			<input type="checkbox"/>	No	
			<input type="checkbox"/>	N/A	
	36.	Are workers aware of their exposure to date?	<input type="checkbox"/>	Yes	
			<input type="checkbox"/>	No	
			<input type="checkbox"/>	N/A	
	37.	Are tools and equipment available at the job site adequate for the tasks to be performed?	<input type="checkbox"/>	Yes	
			<input type="checkbox"/>	No	
			<input type="checkbox"/>	N/A	

REVIEW CRITERIA			ACTION		COMMENTS
IN PROGRESS/POST-JOB REVIEW	1.	Are tagout/lockout procedures being followed?	<input type="checkbox"/>	Yes	
			<input type="checkbox"/>	No	
			<input type="checkbox"/>	N/A	
	2.	Were any unanticipated radiological conditions encountered?	<input type="checkbox"/>	Yes	
			<input type="checkbox"/>	No	
			<input type="checkbox"/>	N/A	
	3.	Can additional dose reduction measures be applied to further reduce worker doses?	<input type="checkbox"/>	Yes	
			<input type="checkbox"/>	No	
			<input type="checkbox"/>	N/A	
	4.	Is dosimetry being worn and stored properly?	<input type="checkbox"/>	Yes	
			<input type="checkbox"/>	No	
			<input type="checkbox"/>	N/A	
	5.	Were equipment needs and the materials needed for the job identified in the procedure?	<input type="checkbox"/>	Yes	
			<input type="checkbox"/>	No	
			<input type="checkbox"/>	N/A	

Project ALARA Review Form (Continued)

IN PROGRESS/POST-JOB REVIEW	6.	Were prerequisite activities completed prior to the start of the job?		Yes	
				No	
				N/A	
	7.	Were support groups present when required for the job evolution?		Yes	
				No	
				N/A	
	8.	Was job-specific training completed for this job? Was it adequate for the job?		Yes	
				No	
				N/A	
	9.	Were any unplanned or unanticipated conditions encountered? If yes, explain.		Yes	
				No	
				N/A	
	10.	Were estimated manpower requirements exceeded? If yes, explain.		Yes	
				No	
				N/A	
	11.	Were low dose rate areas and staging used? If yes, were they effective?		Yes	
				No	
				N/A	
	12.	Were required services available (electrical, ventilation, lights, etc.)?		Yes	
				No	
				N/A	
	13.	Was temporary shielding used? Was it adequate?		Yes	
				No	
				N/A	
	14.	Were engineering controls used to reduce potential for airborne radioactive materials? Were they effective?		Yes	
				No	
				N/A	

Project ALARA Review Form (Continued)

IN PROGRESS/POST-JOB REVIEW	15.	Were c ontamination c ontrol pr actices followed? Were t hey effective?		Yes	
				No	
				N/A	
	16.	Were respirators o r o ther ai rborne pr o tective eq uipment utilized? Did they impact job performance?		Yes	
				No	
				N/A	
	17.	Were p rocedure changes needed dur ing work evolutions t o accommodate lessons learned?		Yes	
				No	
				N/A	
	18.	Were addi tional radiological hol d po ints needed dur ing work evolutions?		Yes	
				No	
				N/A	
	19.	Are e quipment or pr ocess c hanges needed t o help r educe exposures for the next job performance? If yes, explain.		Yes	
				No	
				N/A	
	20.	Were person-rem goals exceeded? If yes, explain.		Yes	
				No	
				N/A	
	21.	Could ac tivities or s cheduled pl an o f ac tivities be en done differently t o r educe e xposures t he nex t t ime t his j ob i s performed? If yes, explain.		Yes	
				No	
				N/A	

Additional comments may be annotated on pages attached to this form and referenced to the criteria number in the ALARA review

Corrective actions recommended or taken (specify actions required by RSO, or RSC) _____

ALARA Estimates:**DDE****CEDE****TEDE**

Original person rem goal _____ + _____ = _____

Final person rem values _____ + _____ = _____

Review performed by _____ (print and sign) _____ (date)

RSO/RSC approval _____ (print and sign) _____ (date)

PM approval _____ (print and sign) _____ (date)

Attachment C

ALARA Briefing Record

ALARA Briefing Record

RWP#: _____ Revision: _____ Start Date: _____

Task Description: _____

Radiation Safety: _____ (Print/Sign)

Project Manager: _____ (Print/Sign)

Site Radiation Safety Lead: _____ (Print/Sign)

Attachment D

ALARA Briefing Attendance Record

ALARA Briefing Attendance Record

DATE	NAME		SSN/ID#	BRIEFING SUBJECT
	PRINT	SIGN		

Comments _____

Instructor: _____ (Print/Sign) Date: _____



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

RADIATION WORKER TRAINING

AP-009

REVISION 2.0

Reviewed by:

David Wunsch, Quality Assurance Manager

4/12/2013

Date

Approved by:

Henry Siegrist
Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

This procedure establishes the Cabrera Services Inc., (CABRERA) training program that, upon satisfactory completion, will grant individuals permission to perform work with U.S. Nuclear Regulatory Commission (NRC) licensed radioactive material and enter work sites that have radioactive materials.

2.0 APPLICABILITY

This procedure will be used for all CABRERA project work involving both licensed and non-licensed radioactive materials. Compliance with the training provided along with site-specific instruction, will provide a reasonable assurance that project personnel will be aware of their surroundings, the hazards associated with the type of material in the work area, and the type of work conducted.

3.0 DEFINITIONS

- 3.1 Procedure – A logical, concise document describing the general requirements and methods to be used regarding a specific topic.
- 3.2 Training – The transfer of information, by instruction, to ensure knowledgeable personnel.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

No individual will be allowed to work with licensed radioactive materials without training qualification and documentation under this program. Certain non-licensed radioactive materials will also require training in receipt and use of dosimetry devices (TLD or OSL).

4.2 Limitations

Any person successfully completing this program will be qualified for a period of one year. Annual refresher training is required to maintain training qualifications. An individual's training will be considered expired 2 weeks after the one year period.

4.3 Requirements

- 4.3.1 Records of training (training sign-in sheet, qualification test, and/or signed and dated test cover sheet) will be maintained for a period of 3 years. Documentation of previous training, for which credit is being given, will include: individual's name, date of training, topics covered, and name of the certifying individual. The exam cover sheet must be signed and dated for it to be valid.

4.3.2 The training program for employees and contractors, requiring access to licensed radioactive material will ensure, at a minimum, that the following regulatory requirements are met:

- Title 10 of the Code of Federal Regulations, Part 19.12 (10 CFR 19.12) sets the training requirements for workers, who in the course of employment, are likely to receive an occupational dose in excess of 100 millirem (mrem) (1 milliSievert [mSv]) in a year. They are:
 - At a minimum, four (4) hours of Radiation Safety Training will be required for subcontracted personnel and any worker meeting the condition stated in 10 CFR 19.12(a). This 4 hour training will cover: the topics required in 10 CFR 19.12 (a)(1) through (a)(6); any other pertinent information in 10 CFR Parts 19 and 20; and, the site's NRC license and standard operating procedures.
 - It is mandatory that any females participating in this program receive specific training materials on prenatal radiation exposure (see reference 2).
 - An annual refresher course in Radiation Safety may also be required, and as be such provided and documented. In lieu of the annual refresher course, the individual may take a challenge test consisting of the same questions as presented as part of the 4 hour Radiation Safety Training.
- CABRERA employees who are currently certified by the American Board of Health Physics may be exempted from the 4 hours Radiation Safety Training requirement described in the previous bullet point.

4.3.3 The RSO, or duly authorized representative, will ensure that the training materials and examination given are current, accurate and complete.

4.3.4 Individuals performing a specific limited task, non-invasive work, or requiring access for observation or similar purposes, will be exempt from the requirements in Section 4.3.2, and may be allowed on site if the following requirements are met:

- Prior to entry, the individual has, or will be given, the appropriate radiation, hazardous operations, Right-to-Know, and other site-specific information necessary for the radiological and other hazardous conditions that they may expect to encounter.
- The individual will have the approval of the Radiation Safety Officer (RSO), or duly authorized representative, to enter the site. The RSO, or duly authorized representative, will document this approval by co-signing the individual(s) entry in the site access log or equivalent document.

- Such persons will also have a continuous escort by, or be within continuous view of, a fully trained site representative (e.g. RSO, Site Radiation Safety Lead, or Radiation Protection Technicians).

5.0 EQUIPMENT

- CABRERA Radiation Worker Training Sign-In Sheet
- CABRERA Radiation Worker Presentation
- Radiation Worker Training Instructor Outline (Attachment A)
- Regulatory Guide 8.13 “Instruction Concerning Prenatal Radiation Exposure”
- CABRERA Radiation Worker Qualification Test

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – The PM is responsible for ensuring that personnel assigned the task of training are adequately trained in the use of this procedure and are knowledgeable in the course subject matter found in Attachment A.
- 6.2 Radiation Safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in implementing actions described in this procedure.
- 6.3 Site Radiation Safety Lead (SRSL) – During field assignments, the SRSL is responsible for ensuring that this procedure is implemented and is responsible for identifying training needs. When the RSO is not on site, the SRSL will act as the RSO’s duly authorized representative for radiological issues.
- 6.4 Radiation Protection Technician (RPT) – An RPT is responsible for radiation and general safety protection and for counseling workers in proper personal protection from potential hazards. The RPT, performing requirements of this procedure, is responsible for understanding and complying with this procedure.
- 6.5 All CABRERA Personnel – Are responsible to ensure that their training needs are met to ensure safe and efficient completion of projects.

7.0 PROCEDURE

- 7.1 This program is designed to include approximately four (4) hours of classroom instruction, practical training as necessary, and time to complete a 50 question multiple choice exam.
- 7.2 Each individual will be required to achieve, at a minimum, a passing score of 80%. Any individual that scores below 80% but greater than 65% will be

allowed to re-take the test. Those scoring less than 65% will be required to take the 4 hour course again.

- 7.3 Additional site-specific training will be provided during initial site mobilization. The course instructor may use training aids, which include, but are not be limited to slides, handouts, instruments, etc. to increase trainee understanding of the material being presented.

Note: It is mandatory that any females participating in this program and/or allowed access to radioactive materials, at the site, receive initial specific training materials on prenatal radiation exposure (see Sections 5.0 and 8.0).

7.4 Four Hour Radiation Worker Training

Attachment A is an outline of topics to be covered in the 4 hour radiation worker training. This outline will serve as a general curriculum for instructors. Additional site-specific training includes description of radioisotopes present at the site and equipment used to measure and control exposure to radioactive material while at the site.

- 7.5 Procedures for operation of instruments, methods of job completion, information important to emergency response, and methods of personnel protection will be discussed with all personnel prior to their job assignments which involve these activities.
- 7.6 An individual training record will be maintained for each individual assigned to work at CABRERA work sites.
- 7.7 A review of personnel qualifications will be completed by the individual and reviewed by the PM for each individual hired to perform a specific job function at the project site.
- 7.8 On-the-job training is as important as other types of training and should be documented when it occurs. An instructor will validate on-the-job training as it occurs. The PM may provide this validation in the absence of an instructor.

8.0 REFERENCES

- NRC, Regulatory Guide 8.29, *Instruction Concerning Risks from Occupational Radiation Exposure*, 1996.
- NRC, Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure*, 1999.
- Institute of Nuclear Power Operations, INPO 93-009, *Guidelines for General Employee Training*.
- Radiation Safety Program, Cabrera Services Inc., Manual
- Radiation Safety Training Manual, Cabrera Services Inc.

- Title 10 Code of Federal Regulation Part 19, *Notices, Instructions and Reports to Workers: Inspection and Investigations*.
- Title 10 Code of Federal Regulation Part 20, *Standards for Protection Against Radiation*.

9.0 REQUIRED RECORDS

- Documentation of on-the-job training
- Individual training record for each employee
- CABRERA Radiation Worker Training Sign-In Sheet
- CABRERA Radiation Worker Qualification Test or, at a minimum, the signed and dated cover sheet will be kept in the students file folder, by the RSO, at the corporate office.

10.0 ATTACHMENTS

Attachment A – Radiation Worker Training Instructor Outline

Attachment A

Radiation Worker Training Instructor Outline

RADIATION WORKER TRAINING INSTRUCTOR OUTLINE

A. INTRODUCTION

1. Goal

Upon successful completion of this program, the individual will have sufficient understanding of Site procedures and basic principles of radiation protection.

2. Health Physics

- a. State the purpose of Health Physics "To protect people and their environment from the harmful effects of ionizing radiation"
- b. Present a description of the Health Physics Department including the basic responsibilities of:
 - i. Radiation Safety Officer (RSO)
 - ii. Site Radiation Safety Lead (SRSL)
 - iii. Radiation Protection Technicians (RPT)

3. Site history

- a. Give a brief description of the history of the Site including:
 - i. chronological history
 - ii. known hazardous materials
 - iii. locations of buried materials

4. Scope of current activities and licensed operations

- a. Give a brief presentation of current activities and licensed activities involving radioactive material on the site. Present general information on the current status of accessible (above ground if any) site contamination. Describe any other hazards that workers may encounter during present and upcoming activities.

B. RADIATION PROTECTION

1. Atomic Structure

- a. Atom; Describe the basic structure of the atom
 - i. Proton - Relative size 1 AMU Positive (+) electrical charge
number of protons determines element
 - ii. Neutron - Relative size 1 AMU, No electrical charge Protons
& Neutrons reside in the Nucleus
 - iii. Electron - Relative size 1/2000 AMU Negative (-) electrical
charge Orbits Nucleus
- b. A standard atom has equal number of protons and electrons for neutral
electrical charge
- c. Proton to Neutron ratio equal to 1 in lighter atoms. As atoms get heavier
additional neutrons > 1/1 ratio are required for the nucleus to maintain
internal balance (stable).

Example:

Hydrogen	1 Proton	0 Neutrons
Oxygen	8 Protons	8 Neutrons
Potassium	19 Protons	20 Neutrons
Iron	26 Protons	30 Neutrons
Lead	82 Protons	126 Neutrons
Thorium	90 Protons	142 Neutrons

- d. Isotope; Family of atoms within an element where the nuclei have the
same number of protons but differing number of neutrons.

Example:

Element: Thorium, Isotopes: Th-230, Th-232

Th-230: 90 Protons, 140 Neutrons

Th-232: 90 Protons, 142 Neutrons

- e. Imbalance in neutron / proton ratio causes atom to be unstable i.e. RADIOACTIVE.
- f. Nature strives to be in balance, to stabilize an unbalanced atom the atom emits radiation.

2. Radioactive Material

An unstable atom or group of atoms that, in an effort to become stable emit ionizing radiation.

a. Radioactive Contamination:

- i. Radioactive atoms on the surface of non-radioactive material (loose or fixed)
- ii. Radioactive material where we don't want it.

b Nuclear Activation:

- i. Material not originally radioactive, but activated by exposure to a Nuclear Reactor Core, neutron source, etc.

Example:



c. Naturally occurring:

- i. Radioactive atoms occurring in nature.

3. Radiation

In an effort to balance N/P ratio radioactive isotopes emit ionizing radiation.

Ionization - The removal of an orbiting electron from its parent atom.

There are 4 types of ionizing radiation emitted from unstable atoms. This lecture will deal only with only the 3 natural types of ionizing radiation.

a. Alpha Particles

- i. 2 protons (++) 2 neutrons, no electrons (Helium nucleus).
- ii. Emitted from nucleus of heavy isotopes.
- iii. Ionizes by electrical attraction of electrons (-) by protons (++) in the Alpha particle.
- iv. Moves at 1/20 the speed of light (slow by nuclear standards).
- v. Ionizes very readily due to slow speed and high electrical (++) charge stopped by sheet of paper.
- vi. Hazard to body only if taken internally. Dead layer of skin protects from external sources.
- vii. Alpha radiation is greatest internal hazard of the radiation's emitted by isotopes of thorium.

b. Beta Particle

- i. Particle emitted from the nucleus of unstable isotope.
- ii. Generally (-) electrical charge.
- iii. Generated in the nucleus by transformation of a neutron into (+) proton and (-) Beta.
- iv. Ionizes by electrical repulsion (-) beta repels electrons.
- v. Moves 1/10 the speed of light.
- vi. Due to the smaller electrical charge than Alpha, Beta penetrates deeper into materials.
- vii. Shielded by 1/4 to 1/2 inch of most solid materials.
- viii. External hazard to skin and eyes.
- ix. Internal hazard

c. Gamma Ray

- i. Packet of energy, no mass (other examples light, radiant heat, radio).
- ii. No electrical charge, moves at the speed of light.
- iii. Emitted in conjunction with beta radiation's.
- iv. Ionizes by other indirect methods based on energy (offer to discuss after class).
- v. Very high penetrating power due to no electrical interaction.
- vi. Major external radiation hazard with some internal hazard also.

Note: Ensure students understand difference between radiation and radioactive material.

4. Units

- a. rem - The unit of measurement for reporting biological damage to humans from radiation energy absorbed in human tissue.

- i. Generally reported in fractions of a rem or millirem.
 $1000 \text{ millirem} = 1 \text{ rem}.$
- ii. Used to report total dose
- iii. Used to report dose rate ($2 \text{ rem/hour} = 2000 \text{ mrem/hr}$)

Note: Ensure students have firm understanding of dose and dose rate concepts.

- b. DPM - Disintegration Per Minute (Unit of activity)

- i. A disintegration is the spontaneous emission of particles (and associated gamma rays) from an unstable nuclei.
- ii. DPM - Disintegration Per Minute

5. Measurement

- a. TLD

- i. Used to measure total external dose (Deep, Skin, Eye)
 - ii. Demonstrate how worn (Whole Body, Wrist, Finger Rings)
 - iii. What to do when lost or damaged.
 - iv. What to do when not in use (storage).
 - v. Used to determine legal external dose
 - vi. Used to comply with 10 CFR 19 and 20
- b. Personnel Friskers
 - i. Used to measure contamination.
 - ii. Demonstrate instrument and show proper frisking techniques.
 - iii. Show how to determine background and readings greater than background
- c. Radiation Survey Meter
 - i. Describe general use of dose rate survey meter.
 - ii. Compare dose rate reading with total dose reading from TLD.
- d. Breathing Zone Air Sampler
 - i. Discuss use of BZ.
 - ii. Discuss basic principles of airborne monitoring (DAC) hours.
- e. Whole Body Counter / Bioassay
 - i. As appropriate discuss basic principles of whole body counting (Analysis of gamma rays emitted by RAM in the body).
 - ii. Discuss Allowable Limit of Intake (ALI-maximum allowable amount of RAM taken inside the body in one year).

- iii. Mention other types of BIOASSAY (urine, fecal analysis).
 - f. Smear Survey
 - i. Used for determining levels of loose surface contamination.
 - ii. Explain units DPM/100 cm².
 - iii. Discuss smears.
 - iv. Discuss loose surface contamination limits (clean):
 - ≤ 20 DPM/100 cm² Alpha
 - ≤ 200 DPM/100 cm² Beta/Gamma for Strontium-90 and ≤ 1000 DPM/100 cm² Beta/Gamma for all other Beta/Gamma emitters
 - g. Fixed Contamination Survey
 - i. Discuss fixed contamination.
 - ii. Limit for fixed surface:
 - 100 DPM/100 cm² Alpha
 - 5000 DPM/100 cm² Beta/Gamma or 1000 DPM/100 cm² Beta/Gamma
- Note:** Ensure that all students know that only radiation protection staff may perform radiation and contamination surveys (only exception personnel frisking of body and clothes).
- 6. Background Radiation
 - a. Natural sources
 - i. Radon approximately 200 mrem/year (Rn²²⁰ from Th²³², Rn²²² from U²³⁸). Top 12" in 1 mile² average in USA 2000 lbs. U, 6000 lbs. Th
 - ii. Other than Radon approximately 100 mrem/year (Cosmic, K⁴⁰)

b. Man made

- i. Medical, approximately 53 mrem/yr (39 mrem diagnostic x-rays, 14 mrem nuclear medicine)
- ii. Fallout < 4.0 mrem/yr (historical bomb testing)
- iii. Nuclear fuel cycle <0.1 mrem/yr (U mining, transportation, Nuclear plants, waste disposal).

Note: Maximum allowable public exposure from licensed operations is 100 mrem/yr.

- iv. Consumer Products <10.0 mrem/yr (tobacco products, building materials, smoke detectors, drinking water, natural gas)

The average person by age 50 will have a total dose of 30 rem (30,000 mrem) from all sources

The total average dose for all people is 620 mrem/year. This total is based on the total exposure for all Americans divided by population. An individual's dose is dependent on factors such as geographic location and medical history.

7. Occupational Dose

1992: 250,000 Individuals monitored for occupational exposure

125,000 no measurable exposure

125,000 average exposure of 300 mrem

8. Biological Effects

a. Radiation effects on cells of the body.

- i. Cell will die.
- ii. Cell will repair itself.
- iii. No damage.

- iv. Cell is damaged, survives, and cannot reproduce.
 - v. Cell genetic material is damaged, damage is passed on to next generation (mutation).
- b. Acute vs Chronic Exposure
- i. Acute Exposure - High dose in short period.
 - ii. Acute effects
 - <25 rem no readily detectable effects
 - >25 rem exposure slight changes in blood (MD)
 - >100 rem vomiting, diarrhea, loss of hair
 - 450 rem LD-50 with no medical intervention
 - 600 rem LD-100 with no medical intervention
- c. Chronic exposure - Low dose over long period of time.
- Chronic exposure is the basis for our Radiation Program.
- d. Stochastic Damage (Cancer)
- i. A particular cells level of cancer risk is dependent on how fast the cells reproduce themselves. "Radiosensitivity"
 - ii. Cancer Statistics, 20% of all adults will develop a fatal cancer from all possible causes.
 - In a group of 10,000 workers, 2000 will die from cancer.
 - Expose this same group to 1 rem of ionizing radiation (DDE)
 - statistically 4 additional cancers will result (2000 - 2004).
 - For 100 rem 400 additional cancers.
 - iii. Relative Risk Table:

<u>Hazard</u>	<u>Est. of days lost</u>
Pack of Cigarettes/day	2370 days

20% overweight	985 days
Home accidents	95 days
1 rem lifetime exposure	1 day

Note: Other statistics are available in reg guide 8.29

- iv. Somatic Effects - Effects that appear in the exposed individual
- v. Genetic Effects - Effects that appear in the exposed individual's offspring

Note: There is no statistical evidence of genetic effects appearing in humans. Genetic effects have been observed in laboratory animals at very high doses.

9. Exposure Limits

a. External Dose Limits

- i. Skin SDE 50 rem/yr
- ii. Max. Extremity 50 rem/yr
- iii. Eyes LDE 15 rem/yr (Cataracts).

b. Total Effective Dose Equivalent TEDE

Limit based on total dose to the body from external sources (Deep Dose [gamma] Equivalent) and doses to the body from internal sources.

$$\text{TEDE} = \text{DDE} + \text{CEDE}$$

$$\text{CEDE} = \% \text{ALI}, 1 \text{ ALI} = 5 \text{ rem CEDE}$$

$$2000 \text{ DAC hours} = 1 \text{ ALI}$$

$$\text{TEDE Limit} = 5 \text{ rem/yr NRC}$$

c. Declared Pregnant Woman (Dose to Embryo/Fetus)

500 mrem TEDE for duration of pregnancy

Low limit due to high radiosensitivity of developing cells

10. Exposure Control

- a. Basic concepts for reducing exposure.
 - i. Time
 - ii. Distance
 - iii. Shielding
 - iv. Source Reduction
- b. Radiation Work Permit (RWP)
 - i. Required for all work with RAM.
 - ii. Must be modified if work scope changes.
 - iii. Must be authorized to work under RWP, authorized personnel must be trained.
 - iv. Contact Radiation Protection to initiate or to add names to an existing RWP.
- c. ALARA As Low As is Reasonably Achievable
 - i. Discuss concept of ALARA principle.
 - ii. Management's responsibility to provide adequate work facilities and provide training.
 - iii. Health Physics responsibilities:
 - Awareness of jobs in progress
 - Perform proper surveys
 - Surveillance of work areas
 - iv. Workers responsibilities:
 - Proper knowledge of job requirements
 - Inform HP of work scope and changes

- Follow all rules & procedures

Note: Important to stress to all radiation workers that nobody has better control over your actions than yourself. Every rad worker has final responsibility for ensuring a radiologically safe working environment.

11. Posting

Discuss standard posting procedures, include Tri-foil symbol, standard yellow & magenta colors, rad rope and step off pads.

a. Radioactive Material

- i. RAM posting indicates the presence of Radioactive Material within the posted area.

b. Radiation Area

- i. Indicates that within the posted area radiation dose rates are greater than or equal to 5.0 mrem/hr at 30 centimeters from the radiation source or any surface that the radiation penetrates.

c. Contaminated Area.

- i. Indicates that within the posted area loose surface contamination may exist with levels in excess of 20 DPM/100 cm² α or 200 DPM/100 cm² β, γ .
- ii. Requirements for entry into a contaminated area are:
 - 1) Protective Clothing
 - 2) RWP [or HP permission].

12. Miscellaneous Practical Information

a. RAD Waste.

The cost of waste storage for potential disposal is very high

every effort will be made to limit the generation waste.

b. Airborne Contamination.

- i. One potential for unnecessary radiation exposure working at a radiologically contaminated site comes from breathing contaminated air.
- ii. Sources of airborne contamination:
 - Equipment disassembly & repair
 - Decontamination operations
 - Filing & Grinding
 - Mechanical Shock
 - Routine equipment operations
- iii. It is very important that HP be notified anytime unplanned operations are taking place that could create an airborne situation.

c. Pathways for internal contamination

- i. Inhalation
- ii. Oral ingestion
- iii. Cuts or other skin openings

d. Protective Clothing

- i. Display and discuss standard protective clothing, to include:
 - Coveralls
 - Lab Coat
 - Hood
 - Shoe Covers
 - Gloves (plastic, latex, cloth)

- Safety Glasses

- ii. Using a working copy of an RWP select one student to demonstrate proper dressing.
- iii. Review other types of protective clothing such as plastic (tyvek) suites, and face shield.

- e. Emergencies

- i. For medical emergencies:
 - For minor illness leave the area & report to the HSA.
 - If minor cuts occur, contact HP prior to reporting to medical.

Note: All cuts, scratches, or other skin openings must be checked by HP prior to entry into any contaminated area, or working with radioactive materials.

Note: If major illness or injury occurs DO NOT remove the individual, if qualified perform first aid, if not get help.

The time utilized in removing an individual from a radiological control area during a medical emergency will have a much greater effect on that persons health than any negative effects of treating the individual within the radiological controlled area.

13. Workers' Rights & Responsibilities

- a. NRC Form 3

- i. Show copy of Form 3, discuss. Give the locations found.

How to report potential violations to the NRC. Rights to obtaining exposure history. Protection from discrimination.

- b. Workers responsibilities

- i. Stress to all students that they have the greatest responsibility in ensuring a safe working environment.
- ii. All persons working with RAM have a legal responsibility to comply with all RWPs, procedures, license requirements and NRC regulations.

Note: Individuals willfully violating safety requirements can be held criminally liable.

c. House Keeping

- i. All persons working inside any HP restricted area is responsible for general cleanliness in addition to radiological responsibilities.

14. Facilities Tour & Site-Specific Training

- a. All persons unfamiliar with the Site will have a tour of the work areas and a review of the following.
 - i. Entry and exit requirements including Personnel frisking.
 - ii. Discussion of contaminated areas including:
Step Off Pads - Posting - Waste Containers
 - iii. Use of Protective Clothing & Dress out area
 - iv. Health Physics Office



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

PERSONNEL PROTECTIVE EQUIPMENT USED WITHIN RADIOLOGICAL CONTROL AREAS

AP-010

REVISION 1.0

Reviewed by:

David Wunsch, Quality Assurance Manager

4/12/2013

Date

Approved by:

Henry Siegrist
Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013
Date

1.0 PURPOSE

This procedure provides the methods Cabrera Services Inc. (CABRERA) uses to: determine the need for protective equipment; select and wear protective clothing while working in contaminated areas; and, remove protective clothing when exiting contaminated areas under CABRERA control. Adherence to this procedure provides a reasonable assurance that personnel will remain free of contamination and that contamination will not be spread beyond a designated contamination area.

2.0 APPLICABILITY

The protocols and procedures presented apply to all CABRERA personnel, or their subcontractors, working with radioactive materials or within radiologically controlled areas.

3.0 DEFINITIONS

- 3.1 Restricted Area – An area where access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.
- 3.2 Contamination Survey – A survey technique to determine fixed and removable radioactive contamination on components and facilities.
- 3.3 Radiation Survey – An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation.
- 3.4 ALARA – An approach to radiation exposure control to maintain personnel radiation exposures as far below the federal limit as technical, economical and practical considerations permit.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

There are no precautions associated with this procedure.

4.2 Limitations

This procedure is limited to the donning and doffing of personnel protective clothing. Any usage instructions for personnel protective equipment (PPE) used for particular contaminants at work sites will be covered in the implementation of a site-specific training program for each project site.

4.3 Requirements

ALARA practices will be maintained when using PPE.

5.0 EQUIPMENT

PPE will be selected based on job specific requirements and the Radiation Work Permit (RWP); and, will be specified in Site-Specific Work Plans.

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – Ensuring that personnel assigned the task of working in contaminated areas are know and understand this procedure, and are adequately trained in its use.
- 6.2 Radiation Safety Officer (RSO) – Training of personnel in the selection, use, and removal of protective clothing and equipment; as well as, training workers in proper personnel survey techniques when exiting a contaminated area.
- 6.3 Site Radiation Safety Lead (SRSL) – During field assignments, the SRSL is ensures that this procedure is properly implemented. When the RSO is not on site, the SRSL will act as the RSO's duly authorized representative for radiological issues.
- 6.4 Radiation Protection Technicians (RPT) – Complying with the provisions of this procedure when using protective clothing.

7.0 PROCEDURE

Plan work activities before putting on protective clothing and obtain all necessary supplies, instruments, and tools to be used in work activities. This equipment is placed at the entrance to the contaminated area so it can be taken into the area when entry is made. Instrumentation should be placed at the exit or be available for personal surveys when exiting the area.

- 7.1 Selection of Protective Clothing
 - 7.1.1 Protective clothing is selected to provide a barrier between personnel clothing/skin and radioactive materials that exist in a contaminated area, as defined in the Radiation Safety Program (RSP).
 - 7.1.2 Boots or overshoes are used to prevent contamination spread beyond the designated contamination area.
 - 7.1.3 Cloth or vinyl coveralls are used to intercept contamination before contacting personnel clothing and skin.
 - 7.1.4 Cotton, vinyl, or latex gloves are used to prevent contamination from adhering to hands while handling contaminated surfaces and items in a contaminated area.
 - 7.1.5 Cloth or vinyl caps or hoods are worn to prevent contamination from overhead surfaces from contaminating hair and exposed skin while

working in contaminated areas.

7.2 Methods of Dressing in Protective Clothing

Note: Dress/undress instructions are based on the assumption of using zippered or buttoned protective clothing.

- 7.2.1 All protective clothing is selected and donned before entering the contaminated area.
- 7.2.2 First put on coveralls and close flaps provided on the coveralls. If specified on the RWP, place a strip of tape over pocket openings and front zipper or button flaps. Fold over the tape at one end to provide a tab for easier removal of the tape when exiting the area.
- 7.2.3 Put cloth or plastic booties on over personnel shoes, overshoes over booties and place coverall pant legs over the overshoe tops. Tape the overall pant legs to the bootie tops leaving a tape tab for easy removal of bootie top.
- 7.2.4 Place cloth cap or hood on head. If using a hood, tape flap to outside of coveralls. If wearing a respirator, ensure hood is taped to respirator.
- 7.2.5 Put on gloves with coverall sleeves over the gloves. Tape coverall cuffs to gloves to provide a seal at the joints. Leave tab at the end of tape for easy removal. If high levels of contamination are anticipated, a second pair of gloves may be worn under the taped pair.
- 7.2.6 After entering the contaminated area, a complete survey of clothing must be made, as described in Section 7.3, before exiting the area.
- 7.2.7 If light work activities (such as surveys) are performed in the contaminated area, taping coverall sleeves, cuffs, and flaps is not required.

7.3 Work Techniques and Contamination Area Hygiene

- 7.3.1 While working in a contaminated area, minimize contact with surfaces and items to the extent possible. All surfaces and items located in a contaminated area are considered contaminated and contact with surfaces and items will transfer contamination to protective clothing.
- 7.3.2 While in the contaminated area, do not touch face, glasses, or exposed skin with gloves or other protective clothing.
- 7.3.3 If clothing became torn or ripped during work activities, cover opening with tape to prevent contamination from further penetration of protective clothing.
- 7.3.4 Avoid work activities that may create airborne activity, to the extent possible.
- 7.3.5 Workers must not eat, drink, chew, or smoke while wearing protective

clothing in a contaminated area.

7.4 Procedures for exiting a contaminated area

- 7.4.1 Protective clothing is removed when exiting a contaminated area, in such a manner, as to control contamination from spreading beyond the designated boundary of the contaminated area.
- 7.4.2 If a second set of gloves is used, the outer set of gloves is removed before starting the un-suiting procedure.
- 7.4.3 Remove hood coveralls cuffs and coverall pant legs, if used.
- 7.4.4 Remove hood or cap by handling external surfaces and place in a protective clothing receptacle.
- 7.4.5 Remove overshoes, by only handling external surfaces, and place them in a protective clothing receptacle. With the overshoes removed, retain plastic booties and remain inside the area to continue removing protective clothing.
- 7.4.6 Undo the coverall flap and remove, by handling only the external surfaces. Slip coverall pant legs over booties and place them in a protective clothing receptacle.
- 7.4.7 With your back toward the step-off pad, remove the plastic booties and step off the pad with personnel shoes on.
- 7.4.8 While standing on the step-off pad, remove the gloves by handling external surfaces and deposit them in a protective clothing receptacle.
- 7.4.9 Perform a personnel survey by first surveying hands with an alpha and/or beta survey meter. After determining hands are free of contamination, pick up instrument and survey shoes, personnel clothing, face, and hair with a survey meter to determine if surfaces are contaminated. If contamination is found above limits in the RSP, contact RSO, or their duly authorized representative at the site, for decontamination instructions.

8.0 REFERENCES

- Radiation Safety Program, Cabrera Services Inc., Manual
- OP-001, *Radiological Surveys*, Cabrera Services Inc., Operating Procedure
- OP-020, *Operation of Contamination Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure

9.0 REQUIRED RECORDS

There are no required records associated with this procedure.

10.0 ATTACHMENTS

None



CABRERA SERVICES

RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

RADIATION WORK PERMITS

AP-012

REVISION 3.0

Reviewed by:

David Wunsch, Quality Assurance Manager

4/12/13

Date

Approved by:



Henry Siegrist, CHP, PE, Radiation Safety Officer*

4/12/2013

Date

1.0 PURPOSE

This procedure describes the circumstances under which a Radiation Work Permit (RWP) is required for a Cabrera Services Inc. (CABRERA) project and addresses the requirements for planning, developing, issuing, using, modifying and terminating RWPs. This procedure also describes the radiological surveys required to generate an RWP and provides guidelines to specific protective measures required based upon the radiological conditions in the work area. Adherence to this procedure will provide assurance that personnel exposures will be below specified limits, personnel will remain free of contamination and radioactive material contamination will not be spread beyond the designated contamination area location.

2.0 APPLICABILITY

This procedure will be used by the Project Manager (PM) to initiate an RWP prior to jobs in which CABRERA personnel enter areas where: contamination is present above the limits specified in the Radiation Safety Program (RSP), when radiation dose rates classify the work area as a radiation area or higher category level, when air concentrations could exceed 10% of the Derived Air Concentration (DAC), or when in areas containing or when handling Nuclear Regulatory Commission (NRC) or Agreement State Licensed materials.

3.0 DEFINITIONS

- 3.1 Radiation Work Permit (RWP) – A document that provides a complete description that addresses existing radiological conditions, work scope, radiological limitations, specific protective requirements, As Low As Reasonably Achievable or “ALARA” (see AP-005) considerations and instructions to radiation workers.
- 3.2 Airborne Radioactivity Area – A room, enclosure, or area in which radioactive material is dispersed, in the air, in the form of dust, fumes, particulates, mists, vapors, or gases and the concentration of the dispersed radioactive material is in excess of:
- The Derived Air Concentrations (DAC) specified in Table 1, Column 3 of Appendix B, Title 10, Code of Federal Regulations, Part 20 (10 CFR 20), or
 - Concentrations such that an individual present, in an area without respiratory protective equipment, could exceed, during the hours the individual is present in a week, an intake of 0.6% of the Annual Limit on Intake or 12 DAC-hours.
- 3.3 Annual Limit on Intake (ALI) – A derived limit for the permissible amount of radioactive material taken into the body, of an adult radiation worker, by inhalation or ingestion in a year. It is the smaller of two values of intake, of a

given radionuclide in a year, by the reference person that would result in either (1) a committed effective dose equivalent (CEDE) of 5 rem (0.05 Sievert [Sv]) or (2) a committed dose equivalent (CDE) of 50 rem (0.5 Sv) to any individual organ or tissue.

- 3.4 As Low As Reasonably Achievable (ALARA) – An approach to radiation exposure control to maintain personnel radiation exposures as far below the federal limit as technical, economical, and practical considerations permit.
- 3.5 Committed Dose Equivalent (CDE) – The dose equivalent to organs or tissues of an individual during the 50-year period following an intake of radioactive material.
- 3.6 Committed Effective Dose Equivalent (CEDE) – The sum of the products of all organs or tissues with CDE and their respective weighting factors.
- 3.7 Contaminated Area – A contaminated area is a restricted area that has radioactive materials, above the limits specified in the RSP, in the form of dusts, particulates, and contaminants that could adhere to personnel clothing and skin while working in the area. Levels of fixed contamination, above the limits specified in the RSP, are considered to be radiological controlled or restricted areas.
- 3.8 Derived Air Concentration (DAC) – The concentration of a given radionuclide in air which, if breathed by the reference person for a working year of 2,000 hours (i.e., 40 hours per week for 50 weeks) under conditions of light work (inhalation rate of 1.2 cubic meters of air per hour), results in an intake of one ALI.
- 3.9 DAC-hour – The product of the concentration of radioactive material in air, expressed as a fraction or multiple of the DAC for each radionuclide, and the time of exposure to that radionuclide, in hours. A licensee may take 2,000 DAC-hours to represent one ALI, equivalent to a CEDE of 5 rem (0.05 Sv).
- 3.10 Personnel Survey – A survey that utilizes radiation detection instrumentation to measure the amount of radioactive materials on a person's clothing or skin surfaces.
- 3.11 Radiation Area – Any area accessible to personnel where ionizing radiation exists, at dose rates that could result in an individual receiving a deep dose equivalent (DDE), in excess of 5 millirem (mrem) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.
- 3.12 Restricted Area – An area to which access is controlled in order to prevent individuals from undue risk from exposure to radiation and radioactive materials.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- 4.1.1 No work involving licensed radioactive material should be performed without initiation of an RWP unless otherwise directed by the Radiation Safety Officer (RSO) or their duly authorized representative.
- 4.1.2 Personnel must know and understand the requirements set forth in the current version of this procedure.

4.2 Limitations

There are no limitations associated with this procedure.

4.3 Requirements

- 4.3.1 All work activities performed under this procedure will be in accordance with the project-specific Site Safety and Health Plan (SSHP) and the RSP.
- 4.3.2 Airborne radioactivity will be controlled using engineering controls when practical, and in accordance with OP-002, *Air Sampling and Analysis*. Engineering controls include, but are not limited to: decontamination, High Efficiency Particulate Air (HEPA) vacuums, ventilation, and containment.
- 4.3.3 A control point will be set up at the location of the entrance/exit to the area, if contamination levels in a restricted area are above the values presented in Table 1 of the RSP. Anyone exiting the control point, of a contaminated area, will frisk all materials and, at a minimum, hands and feet. The Site Radiation Safety Lead will be notified as such contamination levels are determined.

5.0 EQUIPMENT

There is no equipment associated with this procedure.

6.0 RESPONSIBILITIES

- 6.1 Radiation Safety Officer (RSO) – The RSO or their duly authorized representative will monitor compliance and ensure training of personnel working with this procedure and ensure that personnel are qualified, by training and experience, to perform the requirements of this procedure. The RSO or their duly authorized representative is responsible for issue, control, and termination of RWPs.
- 6.2 All CABRERA Personnel – Responsible for reading, understanding, signing, and complying with the provisions of the RWP.

- 6.3 Project Manager (PM) – Responsible for the radiological safety of all personnel onsite, ensuring that, if they work in radiologically controlled areas, they are know and understand this procedure and are adequately trained in its use.
- 6.4 The Site Radiation Safety Lead (SRSL) – Acts as the RSO's duly authorized representative for radiological issues when the RSO is offsite. The SRSL will be onsite when work is in progress and perform the requirements established in this procedure, ensuring that they are properly implemented during field assignments. The SRSL will stop work if any unsafe condition exists in the work area, there is non-compliance with procedural requirements, or if significant changes in radiological conditions occur.

7.0 PROCEDURE

7.1 Conditions Requiring an RWP

7.1.1 Any work involving licensed radioactive material, or conditions exceeding that described below, will require an RWP unless otherwise directed by the RSO. The RSO or duly authorized representative will make the final determination on whether a job requires an RWP. The following list, which is not all inclusive, contains examples of jobs that require an RWP:

- Work on or with material having total fixed activity in excess of 1,000 to 5,000 disintegrations per minute/100 square centimeters (dpm/100 cm²) beta-gamma (β , γ) depending on the radionuclide and/or 100 dpm/100 cm² alpha (α).
- Work on or with material having loose surface activity in excess of 20 dpm/100 cm² α and/or 200 dpm/100 cm² β , γ to 1,000 dpm/100 cm² β , γ depending on the nuclide(s) present.
- Filter change-outs of contaminated or potentially contaminated systems (i.e., Pre-filter, HEPA filters).
- Work on any contaminated or potentially contaminated ventilation system where the integrity of the system may be breached or the interior accessed.
- When air operated tools are to be used in a manner that is likely to generate airborne contamination.
- Any job requiring welding, grinding or burning on contaminated material or equipment.
- Work in a posted Airborne Radioactivity Area.
- Work in a posted Radiation Area.
- Work in a posted Contaminated Area (loose non-fixed contamination).

- When working in areas with NRC or Agreement State Licensed materials.

7.1.2 Direct surveillance, by a qualified RSO or duly authorized representative, may be used in lieu of an RWP in an emergency situation. The RSO has the authority to direct all matters associated with radiation protection and will specify the radiological requirements to control personnel exposure to radiation.

7.2 RWP Initiation

7.2.1 An RWP (form supplied in Attachment A) will be initiated by the individual responsible for the task. The "Radiation Work Permit Addition Sheet" (supplied in Attachment B) will be used, as needed, and attached to the RWP. The initiator will indicate the location of work, a clearly detailed work description, and the job supervisor on the RWP.

7.2.2 A unique numerical identifier will be used to label each RWP. This will consist of a project number prefix, followed by the next available sequential number. The RWP identifier will be recorded on the RWP and the "Radiation Work Permit Log" (supplied in Attachment C), and will contain a brief work description, the date issued, and the date terminated.

7.2.3 The RSO, or duly authorized representative, will review and approve the RWP before implementation; it will not be approved unless the detailed work description can be clearly understood. The RSO, or duly authorized representative, may request that a detailed procedure be prepared if, in his/her opinion, the work description is unclear or the safety risks are considered to be high.

7.2.4 The RSO, or duly authorized representative, will complete the summary of radiological conditions and required radiological control sections of the RWP. Historical and/or pre-job surveys may be used for the radiological condition section.

7.2.5 An RWP may remain in effect for the duration of the job. It will be reviewed and re-authorized on a monthly basis for the duration of the project.

7.3 RWP Implementation

7.3.1 Any personnel authorized to work, under the RWP, will print and sign their name on the original copy of the RWP to indicate that they have read and understood its requirements. They will also be trained in the requirements of this procedure. The RSO, or duly authorized representative, will ensure proper implementation of the RWP.

7.3.2 A copy of the RWP will be kept at the worksite; the RSO or duly authorized representative will keep the original.

- 7.3.3 Individuals may be added to a non-terminated RWP and are required to sign both the original and working copy.
- 7.3.4 Changes made to a non-terminated RWP will be authorized by the RSO, or duly authorized representative, and will be made to both the original and worksite copies. Alterations to the RWP will be made in the following manner:
- Documented information will be clear, neat, accurate, concise, and prepared in dark, waterproof ink.
 - Data will not be obliterated by erasing, with whiteout, or by any other means.
 - To make a correction or to change the RWP, a single line will be struck through the error, and the corrector will initial and date the line.
- 7.3.5 If the scope of work or radiological conditions are significantly different than those expected when the RWP was generated, then it will be terminated and a new RWP will be issued.

7.4 RWP Termination

- 7.4.1 The RSO or duly authorized representative may terminate an RWP for any of the following reasons:
- Work is complete;
 - Scope of work or radiological conditions differ significantly from the current RWP; and
 - At the discretion of the RSO or duly authorized representative.
- 7.4.2 The terminated RWP package will consist of the following:
- Pre-job survey(s) and/or historical information;
 - Post-job survey (if applicable);
 - All copies of the RWP; and
 - Copies of air sample results from individuals working under the RWP (if applicable).
- 7.4.3 The RWP package will be reviewed, terminated, and maintained for future review by the RSO or duly authorized representative. The RSO, or duly authorized representative, will also maintain any records of work performed under or directly related to an RWP, in keeping with OP-187, *Records Management*.

8.0 REFERENCES

- Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation, Appendix B.
- Radiation Safety Program, Cabrera Services Inc., Manual
- AP-005, *ALARA*, Cabrera Services Inc., Operating Procedure
- OP-002, *Radioactive Air Sampling and Analysis*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure

9.0 REQUIRED RECORDS

- Radiation Work Permit
- Radiation Work Permit Additional Sheet
- Radiation Work Permit Log
- Terminated RWP package(s) including:
 - Pre-job survey(s) and/or historical information;
 - Post-job survey (if applicable); and
 - Copies of air sample results from individuals working under the RWP (if applicable).

10.0 ATTACHMENTS

- Attachment A – Radiation Work Permit
- Attachment B – Radiation Work Permit Additional Sheet
- Attachment C – Radiation Work Permit Log

Attachment A

Radiation Work Permit

RADIATION WORK PERMIT			
Job Supervisor:		Date:	RWP #:
Location of Work:			
Description of Work:			
SUMMARY OF RADIOLOGICAL CONDITIONS			
LOCATION	CONTAMINATION LEVELS	RADIATION LEVELS	AIRBORNE CONCENTRATIONS
REQUIRED RADIOLOGICAL CONTROLS			
<div style="display: flex; flex-wrap: wrap;"> <div style="width: 33%;"><input type="checkbox"/> Coveralls</div> <div style="width: 33%;"><input type="checkbox"/> Glove Liners</div> <div style="width: 33%;"><input type="checkbox"/> BZ/Lapel Air Sampler</div> <div style="width: 33%;"><input type="checkbox"/> Hood</div> <div style="width: 33%;"><input type="checkbox"/> Plastic Shoe Covers</div> <div style="width: 33%;"><input type="checkbox"/> Lab Coat</div> <div style="width: 33%;"><input type="checkbox"/> Surgeon's Cap</div> <div style="width: 33%;"><input type="checkbox"/> Rubber Shoe Covers</div> <div style="width: 33%;"><input type="checkbox"/> Pre-Job Meeting</div> <div style="width: 33%;"><input type="checkbox"/> Surgeon's Gloves</div> <div style="width: 33%;"><input type="checkbox"/> Tape Gloves to Sleeves</div> <div style="width: 33%;"><input type="checkbox"/> Continuous HP Coverage</div> <div style="width: 33%;"><input type="checkbox"/> Rubber Gloves</div> <div style="width: 33%;"><input type="checkbox"/> Plastic Suit</div> <div style="width: 33%;"><input type="checkbox"/> TLD/OSL</div> <div style="width: 33%;"><input type="checkbox"/> Trained Radiation Worker(s)</div> <div style="width: 33%;"><input type="checkbox"/> Other</div> </div>			
Special Instructions:			
<i>YOUR SIGNATURE INDICATES THAT YOU HAVE READ AND UNDERSTAND THE RADIOLOGICAL CONDITIONS AND CONTROLS.</i>			
NAME	SIGNATURE	NAME	SIGNATURE
<div style="display: flex; justify-content: space-between; margin-bottom: 10px;"> <div>_____ Approved by (print name)</div> <div>_____ Signature</div> <div>_____ Date</div> </div> <div style="display: flex; justify-content: space-between; margin-bottom: 10px;"> <div>_____ Re-approved by (print name)</div> <div>_____ Signature</div> <div>_____ Date</div> </div> <div style="display: flex; justify-content: space-between;"> <div>_____ RWP Terminated by (print name)</div> <div>_____ Signature</div> <div>_____ Date</div> </div>			

Attachment B

Radiation Work Permit Additional Sheet

RADIATION WORK PERMIT ADDITIONAL SHEET			
RWP #			
NAME	SIGNATURE	NAME	SIGNATURE
Reviewed by (print name) _____ Signature _____ Date _____			

Attachment C

Radiation Work Permit Log

RADIATION WORK PERMIT LOG			
RWP #	GENERAL DESCRIPTION	DATE ISSUED	DATE TERMINATED
Reviewed by (print name) _____ Signature _____ Date _____			



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

RADIOLOGICAL SURVEYS

OP-001

Revision 3.0

Reviewed by:

David Wunsch, Quality Assurance Manager

Date

Approved by:

Henry Siegrist, CHP, PE, Radiation Safety Officer

Date

1.0 PURPOSE

The purpose of this procedure is to establish the framework and to define the requirements for Cabrera Services Inc., (CABRERA) personnel performing radiological surveys. Adherence to this procedure will provide reasonable assurance that the radiological surveys performed yield reproducible results. In addition, adherence to this procedure will provide adequate control of radiation exposures As Low As Reasonably Achievable (ALARA).

2.0 APPLICABILITY

- 2.1 This procedure provides the requirements and general guidelines for identifying, scheduling, and performing routine, radiation, contamination, and airborne surveys by radiation safety personnel. Remediation and facility areas that are radiologically controlled (restricted areas) due to the potential for fixed or transferable contamination are considered for routine survey performance.
- 2.2 The following types of surveys may be performed using this procedure:
 - Surveys for shipping radioactive materials (Department of Transportation [DOT] regulations may require additional consideration).
 - Surveys performed to characterize facilities, sites, and/or release items potentially contaminated with radioactive materials from restricted areas.
 - Surveys performed to provide information used to guide or direct decontamination and decommissioning of facilities and sites.
- 2.3 This procedure does not include survey requirements for radiation generating devices and survey requirements specified in radiation work permits (RWPs).
- 2.4 Approved work plans may require more or fewer surveys and controls to be applied at the site than described in this procedure.

3.0 DEFINITIONS

- 3.1 Radiological Control/Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.
- 3.2 Contamination Survey – A survey technique to determine fixed and removable radioactive contamination on components and facilities.
- 3.3 Radiation Survey – An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation.

- 3.4 As Low As Reasonably Achievable (ALARA) – An approach to radiation exposure control to maintain personnel exposures as far below the federal limits as the technical, economical and practical considerations permit.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- 4.1.1 Instruments used to perform routine surveys should be operated in accordance with the respective operating procedures or manufacturer's recommendations.
- 4.1.2 Large area smears (LAS) may be used to augment (but not replace) the one hundred square centimeter (100 cm²) smear survey. LAS may be counted with a Ludlum Model 3 and 44-9 probe or Ludlum Model 2224-1 and 43-93 probe or equivalent. LAS are used to obtain immediate information concerning loose contamination for the purpose of radiological protection and to minimize time spent performing smears on an item easily identified as contaminated.
- 4.1.3 Personnel performing routine surveys must be logged in on a RWP in accordance with AP-012, *Radiation Work Permits* (if applicable).
- 4.1.4 Audible response instruments should be used during direct scan surveys.
- 4.1.5 The instruments used for routine surveys must be within current calibration and must have had a performance test check performed daily, or before use, in accordance with the instrument's operating procedure.

4.2 Limitations

- 4.2.1 The maximum probe speed during direct scan surveys of surfaces must be 3 centimeters per second (cm/sec).
- 4.2.2 The probe face must be held within ¼ inch of the surface being surveyed for alpha radiation, and within ½ inch of the surface being surveyed for beta-gamma radiation.
- 4.2.3 If an instrument used to perform routine surveys fails operational checks, it will be removed from service. Data collected during the period of instrument failure must be evaluated by the Radiation Safety Officer (RSO) or duly authorized representative.
- 4.2.4 Posting of radiological control areas must be performed in accordance with OP-019, *Radiological Posting*.

4.3 Requirements

- 4.3.1 Individuals performing surveys will obtain and review any previous surveys performed in the area, or on the object, to determine radiation conditions that may be encountered.
- 4.3.2 Only qualified individuals will perform surveys. Qualification will be determined on a case-by-case basis by the Project Manager, Radiation Safety Officer or their duly authorized representative. Qualification considers prior training, experience, and certifications such as Radiation Protection Technician or National Registry of Radiation Protection Technologists.
- 4.3.3 Survey samples must be analyzed in a low-background area, whenever practical, to ensure achieving the required sensitivity of measurements.
- 4.3.4 At a minimum, dose rate surveys must be performed in locations where workers are exposed to radiation levels that might result in: radiation doses in excess of 10% of the occupational dose limits – or – where an individual is working in a dose rate area of 2.0 millirem per hour (mrem/hr), or more.
- 4.3.5 Prevent access to unrestricted areas if contamination is found and immediately notify the RSO or duly authorized representative.

5.0 EQUIPMENT

- 5.1 Radiation and Contamination survey meters will be selected based on job specific requirements and be identified in the Site Work Plans.
- 5.2 Instruments used to perform routine surveys will be used in accordance with the applicable CABRERA administrative and operational procedures.
- 5.3 Authorized suppliers of properly calibrated and maintained equipment will supply/calibrate instruments; although equipment counting efficiencies may be determined by qualified CABRERA personnel.

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) - The PM is responsible for ensuring that personnel assigned the task of performing routine surveys are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.
- 6.2 Radiation Safety Officer (RSO) - The RSO is responsible for monitoring compliance with this procedure and training personnel in performing radiation and contamination surveys. The RSO can also assist in the interpretation of the results obtained during surveys.

- 6.3 Site Radiation Safety Lead (SRSL) - During field assignments, the SRSL is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the SRSL will act as the RSO's duly authorized representative for radiological issues.
- 6.4 Radiation Protection Technicians (RPT) - The RPT performing radiation and contamination surveys are responsible for understanding and complying with this procedure.

7.0 PROCEDURE

7.1 Safety Considerations

The safety requirements specified in the job specific Health and Safety Plans (HASPs) and work plans, the Radiation Safety Program (RSP), and other safety documentation must be adhered to when performing surveys.

7.2 Initial Preparations

Obtain and review any previous surveys performed in the area to determine radiation conditions that may be encountered.

7.2.1 Obtain appropriate survey instruments and assure daily quality control (QC) checks have been performed prior to instrument use.

7.2.2 Obtain necessary forms, smears, and protective clothing, which will be used during the survey.

7.2.3 Plan any strategy for performing the survey before entering the area to reduce exposure time within the area.

7.2.4 If smearable contamination is expected to be above allowable limits, set up an entry/exit area which will prevent the spread of contamination.

7.3 Radiation Surveys

7.3.1 If radiation levels are unknown or previous surveys remain in question, first measure general area radiation levels using a Micro-R Meter or equivalent dose rate meter to determine if elevated radiation levels exist in the survey area.

7.3.2 Small Areas/Items/Containers – This survey technique is used to establish exposure rates from small areas, items, or containers that contain radioactive materials.

- Scan the entire surface area of the area, item, or container with a Micro-R or equivalent meter and record locations and readings on the Survey Form, in Attachment B, or an equivalent form.

- Measure the exposure rate at 30 centimeters from all surfaces or sides of the area, item, or container and record the location and readings on the Survey Form, in Attachment B, or an equivalent.
- Large waste containers used for shipment of bulk quantities of soil debris etc., may have a single dose rate measurement per accessible side of the container for ALARA purposes. DOT regulations may require additional dose rate measurements prior to shipping which is not covered by this procedure. Note readings on the Survey Form or an equivalent.

7.3.3 Facility Surveys – This survey technique may be used to release facilities (buildings, etc.) to “unrestricted” status or to determine the status of facilities requiring decontamination and decommissioning. Final release of a facility will be established using the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance.

- Establish a 1 meter by 1 meter grid system [or another work plan-approved grid] for the facility surfaces and use a marking system that assigns a unique number/letter to the center of each grid section. Graphically illustrate the location of the grid system on the Survey Form, in Attachment B, or an equivalent.
- Using a Micro-R Meter or equivalent obtain radiation levels at 1 meter from the grid center point and at contact with the grid center point. Record the reading on the Survey Form, in Attachment B, or an equivalent. If elevated readings are noted, scan the surface of the grid and note the location of any elevated readings with a marker on the form.
- Obtain Micro-R or equivalent readings from locations surrounding the facility, or within the facility, which do not contain activity. This establishes a background level for comparison to the reading taken above.

7.3.4 Area Surveys – This survey technique may be used to release land masses to “unrestricted” status or determine status of areas requiring decontamination before release. Final release of a site area will be established using MARSSIM guidance

- Establish a 10 meter by 10 meter grid system of the area to be surveyed [or another approved grid as provided by the work plan] using surveyor stakes or equivalent, which are numbered with a unique number/letter to identify the center of each grid. List the locations of the “gridded” system on the Survey Form or an equivalent.
- Using a Micro-R meter or equivalent, obtain radiation levels at 1 meter above the ground surface in the center of the grid. Record all readings on the Survey Form or an equivalent.

- Survey the remainder of the grid at the surface using an “S” pattern for the instrument. If elevated readings are noted above or below the grid center point reading, subdivide the grid into additional sub-grids and obtain readings at 1 meter above the ground surface. Record all readings on the Survey Form or an equivalent.

7.4 Contamination Surveys

7.4.1 If removable contamination is suspected or previous surveys are in question, first scan likely contaminated areas with an alpha (α) and/or beta (β) probe and determine if elevated areas of contamination exists. Obtain smear samples from any elevated areas and count smears in sample counter. If smearable contamination above limits set for the job is found, use appropriate protective clothing and entry control techniques to prevent the spread of contamination.

7.4.2 Small Areas/Items/Containers – This survey technique is used to establish total and transferable contamination levels on small areas, items, or containers, which contain radioactive materials.

- If the area, item, or container contains alpha activity, scan the area with an alpha probe at $\frac{1}{4}$ inch above the surface. Note total (fixed plus transferable) contamination readings on the Survey Form or an equivalent.
- If the area, item, or container contains beta activity, scan the area with a beta probe at approximately $\frac{1}{2}$ inch above the surface to be surveyed and obtain reading following meter stabilization. Record meter reading on the Survey Form or an equivalent. The surface of a container can only be directly surveyed for beta activity if the radiation level from the container does not significantly elevate the beta probe background. Note total (fixed plus transferable) contamination readings on the Survey Form or an equivalent.
- Provide transferable smear contamination survey on the area, item or container by performing 100 cm² smears, at routine intervals, on the subject area, item, or container.
- Large waste containers used for shipment of bulk quantities of material will have one or more contact readings taken at routine intervals on the accessible sides of the container. Note total (fixed plus transferable) contamination readings on the Survey Form or an equivalent. **Note:** DOT regulations may require additional survey points.
- For large waste containers used for shipment of bulk quantities of material for disposal (or other large items such as soil moving equipment), determine the transferable surface contamination by taking LAS. Use Masslinn cloth or equivalent material to obtain a

LAS representative of the potentially contaminated area. Count the LAS, in a low background area, using alpha and beta detection equipment. If no transferable contamination above limits is found on the LAS, take several confirmatory 100 cm² smears at routine intervals on the object and count smears for alpha and beta activity. Record results on the Survey Form or an equivalent. **Note:** DOT regulations may require additional survey points.

Note: The presence of activity above transferable limits on a LAS signifies potential contamination. Determine actions to be taken with the RSO or SRSL.

7.4.3 Facility Surveys – This survey technique is used to aid in the release of facilities (buildings etc.) to “unrestricted” status or determine status of facilities requiring decontamination and decommissioning. Final release of a facility will be established using MARSSIM guidance.

- The grid system established in Section 7.3.3 will also be utilized for contamination surveys.
- Hold the beta probe at approximately ½ inch above the grid center point and obtain reading following meter stabilization. Record the meter reading on the Survey Form or an equivalent.
- If the readings are at background levels, randomly scan the remainder of the grid, concentrating on cracks, floor/wall joints, top of horizontal surfaces, ventilation ducts and grills, and other areas that might collect radioactive materials. Mark any locations above the release criteria on the Survey Form or an equivalent.
- If readings are at or near the release levels, scan grid surface and identify the portion of the grid that is above the release criteria. Note these areas on the survey form and mark the area of the grid with spray marker (or equivalent) on the Survey Form or an equivalent. Repeat steps 8.3.4 with an alpha probe at ¼ inch above the grid center point. If sufficient documentation of previous history is known about the facility and contamination is known not to be present, the alpha survey may not be required.
- One smear sample from a 100 cm² area will be taken in each grid. If the above survey found no elevated readings in the grid, the smear sample will be taken in the center of the grid. If elevated levels readings are identified the smear sample will be taken from the area where the highest reading was obtained.
- Each smear sample will be labeled with the grid location and counted for alpha and beta activity in the sample counter. The smear sample results will be recorded on the Survey Form or an equivalent.

7.4.4 Area Surveys – This survey technique is used to aid release of land masses to “unrestricted” status or determine status of area requiring decontamination before release. Final release of a facility will be established using MARSSIM guidance.

- The grid system established in Section 7.3.4 will be utilized for contamination surveys.
- Hold the beta probe at ½ inch above the grid center point and obtain reading following meter stabilization. Record the meter reading on the Survey Form or an equivalent.
- If readings are at background levels, randomly scan the remainder of the grid. Mark any locations above release criteria on the Survey Form or an equivalent.
- If readings are at or near the release levels scan the grid surface and identify portion of the grid that is above release criteria. Note these areas on the Survey Form or an equivalent.
- Areas contaminated with radioactive materials may require soil sample analysis to determine the activity concentration. The quantity and location of samples will be determined on a case-by-case basis.

7.5 Frequency and Requirements for Routine Surveys

Appropriate routine radiological surveys will be performed at the following frequencies as a minimum:

7.5.1 Radiation Surveys

- Upon initial entry after extended periods of closure,
- Daily, at contamination control points, where the potential exists for personnel to be exposed to dose rates greater than 2 mrem/hr,
- Daily, during continuous operation, and when levels are expected to change,
- Weekly, in routinely occupied areas adjacent to radiological control areas with dose rates greater than 2 mrem/hr,
- Weekly for operating High Efficiency Particulate Air (HEPA)-filtered ventilation units,
- Weekly, for any temporary Radiation Area boundaries to ensure that the Radiation Areas do not extend beyond posted boundaries, and
- Monthly, or upon entry if entries are less than monthly, for Radioactive Material Storage Areas.

7.5.2 Contamination Surveys

- Daily, at contamination control points from areas exhibiting contamination above surface contamination limits for the job site,
- Daily, in office spaces located in the radiological control areas,
- Weekly in lunchrooms or eating areas adjacent to radiological control areas,
- Weekly, in routinely occupied locker rooms or the shower areas adjacent to radiological control areas associated with site radiological work,
- Weekly, or upon entries, if entries are less frequent, in the areas where radioactive materials are handled or stored, and
- Weekly for all project offices on site.

7.5.3 Airborne Surveys

Airborne survey frequency, locations, and methods are determined by the RWPs and by the RSO/SRSL.

7.6 Identifying and Scheduling Routine Radiological Surveys

- 7.6.1 To assist in assuring surveys are scheduled, the RSO or duly authorized representative will identify and schedule routine surveys, as required by the radiological conditions and work activities.
- 7.6.2 Routine Survey Schedules or equivalent should be developed using a standard system for designating surveys such as:

Frequency of Survey

• Daily	D
• Weekly	W
• Monthly	M
• Quarterly	Q
• Semi-Annually	S
• Annually	A
• Upon Entry	U

Type of Survey

• Radiation	R
• Contamination	C
• Area TLD	T
• Air Sample	A

Example: DRC-1

Where:

- D: is the survey frequency (Daily in this example)
- R: is the type of survey (Radiation in this example)
- C: is a type of survey (Contamination)
- 1 corresponds to the numerical sequence of the survey

7.6.3 Routine survey schedules should be submitted to, and reviewed by, the RSO or duly authorized representative.

7.6.4 Routine Survey Schedules should be indicated on form in Attachment A or an equivalent. Task Leaders may elect alternate methods of determining the information contained on the Routine Survey Schedule.

7.7 Using ALARA Principles for Scheduling and Performing Surveys

7.7.1 Routine surveys should not be performed in High Radiation Areas unless other work necessitates entry. Boundary verification surveys would be appropriate if an entry is not required.

7.7.2 Routine surveys should be performed in conjunction with other work surveys as much as practicable.

7.8 Performance of Routine Surveys

7.8.1 RPTs and qualified individuals will perform routine surveys in accordance with the applicable operational procedure.

7.8.2 Upon completion of a routine survey, the RPT will initial and date the appropriate Survey Form.

7.9 Periodic Evaluation of Routine Surveys

7.9.1 Routine Survey Schedules should be reviewed and updated periodically to ensure that all areas within the project boundaries are receiving the appropriate routine survey coverage.

7.9.2 Changes of conditions within the project area will be reported to the RSO or duly authorized representative and may require a modification of the routine radiological survey schedule.

7.10 Management Notification

The RSO should be notified, by the PM or duly authorized representative, of failure to complete a routine survey, as scheduled. The missed survey will be completed within 24 hours (or next working day) of discovering the inconsistency.

8.0 REFERENCES

- Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation, Subpart E, *Radiological Criteria for License Termination*
- Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation, Subpart F, *Surveys and Monitoring*
- Title 10, Code of Federal Regulations, Part 20.2103, *Records of Surveys*
- Radiation Safety Program, Cabrera Services Inc., Manual
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure
- AP-010, *Personnel Protective Equipment Used Within Radiological Controlled Areas*, Cabrera Services Inc., Operating Procedure
- AP-012, *Radiation Work Permits*, Cabrera Services Inc., Operating Procedure
- OP-019, *Radiological Posting*, Cabrera Services Inc., Operating Procedure
- OP-020, *Operation of Contamination Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-021, *Alpha-Beta Counting Instrumentation*, Cabrera Services Inc., Operating Procedure
- OP-022, *Operation of Ionization Chambers*, Cabrera Services Inc., Operating Procedure
- OP-023, *Operation of Micro-R Meters*, Cabrera Services Inc., Operating Procedure

9.0 REQUIRED RECORDS

9.1 Survey records should include the following, at a minimum:

- A diagram of the area surveyed, if applicable.
- A list of items and equipment surveyed.
- Specific locations on the survey diagram where wipe test were taken.
- Background radiation levels with appropriate units.
- Contamination levels with appropriate units.
- Make, model number, and serial number of instruments used.
- Name of the person making the evaluation and recording the results and date.

9.2 Routine Survey Schedule

9.3 Survey Form

10.0 ATTACHMENTS

- Attachment A – Routine Survey Schedule
- Attachment B – Survey Form

Attachment A

Routine Survey Schedule

Routine Survey Schedule

Survey Designation	Location of Survey

Prepared By: _____

Date: _____

Reviewed By: _____

Date: _____

Attachment B

Survey Form

Survey Form

Location: Site:						RWP#				Survey #				Survey Type:				pg. 1 of	
Smear (CPM/100 cm ²)						circle one													
Direct Count (CPM/Direct Frisk)																			
No.	α	β	No.	α	β														
1			26																
2			27																
3			28																
4			29																
5			30																
6			31																
7			32																
8			33																
9			34																
10			35																
11			36																
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20			45																
21			46																
22			47																
23			48																
24			49																
25			50																
Comments						Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	γ Bkg	Cal. Due	Key			
																	■	A/S Location	
																	.	Boundary	
																	○	Smear	
																	□	Dose Rate /hr	
						Reviewed By:	Date:										*	Direct Reading CPM/direct frisk	
																	△	Grab Sample	



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

RADIOACTIVE AIR SAMPLING AND ANALYSIS

OP-002

REVISION 1.0

Reviewed by:

David Wunsch, Quality Assurance Manager

4/12/2013

Date

Approved by:



Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

This procedure provides the methods Cabrera Services Inc. (CABRERA) uses in the operation of air samplers and the calculation of radioactive particulate activity in air samples. This procedure describes the methods used to calculate Derived Air Concentration (DAC)-hour exposures to workers. Adherence to this procedure will provide a reasonable assurance that the surveys performed have accurate and reproducible results.

2.0 APPLICABILITY

This procedure will be used by CABRERA personnel to operate air samplers during surveys and work activities at customer facilities as well as calculate and record DAC-hour exposures to workers.

Air samples are considered when the alpha and beta contamination on facility surfaces, equipment and waste packages exceed the contamination limits specified in Table 1 of the Radiation Safety Program (RSP) and included as Attachment C of this procedure. Air monitoring will be performed in areas where there exists potential to exceed 10 percent (%) of any radionuclide DAC.

3.0 DEFINITIONS

- 3.1 Restricted Area – An area where access is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted areas do not include areas used as residential quarters, but separate rooms in a residential building may be set apart as restricted areas.
- 3.2 Smear Sample Survey – A survey technique using filter paper smears to determine quantities of alpha and beta emitting radioactive material which can be removed from facility surfaces and waste packages.
- 3.3 Air Sample Survey – A survey technique which collects particulates from a known volume of air and determines the concentrations of radioactive materials associate with airborne particles.
- 3.4 Annual Limit on Intake (ALI) – The ALI of radioactive materials is the smaller amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year (40 hours per work week for 50 weeks) that would result in a committed effective dose equivalent (CEDE) of 5 rem (0.05 Sievert [Sv]) or a committed dose equivalent (CDE) of 50 rem (0.5 Sv) to any individual organ or tissue.
- 3.5 Derived Air Concentration (DAC) – DAC is the concentration of a given radionuclide in air which, if breathed by “reference man” for a working year (40 hours per week for 50 weeks) under the conditions of light work (inhalation rate

of 1.2 cubic meters of air per hour), results in an air intake of one ALI.

3.6 DAC-hour – The product of the concentration of radioactive material in air, expressed as a multiple of the DAC for each nuclide, and the time of exposure to that nuclide in hours; 2,000 DAC-hours represents one ALI.

3.7 Airborne Radioactivity Area – A room, enclosure, or area in which the radioactive material is dispersed in the form of dusts, fumes, mists, particulates, or vapors, and the concentration of the dispersed radioactive material is in excess of:

- The DACs specified in Table 1 Column 3 of Appendix B, Title 10, Code of Federal Regulations, Part 20 (10 CFR 20), or
- Concentrations such that an individual present in the area without respiratory protective equipment could exceed, during the hours the individual is present in a week, an intake of 0.6% of the ALI, or 12 DAC-hours.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

4.1.1 Air samples run at altitudes in excess of 5,000 feet need to consider pressure adjustments for altitude and recorded flow-meter readings.

4.1.2 Air sample media will tear if the filter comes into contact with water. Outdoor sampling requires special consideration to ensure an effective sample is obtained.

4.2 Limitations

Air samplers should only be operated in temperatures between -4°F to 122°F .

4.3 Requirements

4.3.1 Air sampler inspections will be performed by qualified Health Physics personnel.

4.3.2 The alpha and beta counter used to count air samples will be calibrated daily with a known radioactive source with activity traceable to the National Institute of Standards and Technology (NIST).

4.3.3 Radiation Protection Technologists (RPTs) performing air sampling and analysis will review all applicable forms for accuracy and completeness. Entries on all pertinent forms must be dated and initialed, by the RPT performing the air sampling and analysis, to be valid.

4.3.4 The RSO or duly authorized representative will review any applicable completed forms for accuracy and completeness.

5.0 EQUIPMENT

- Low volume general area sampler: LV-1
- High volume air sampler: HI-Q
- Personal Breathing zone samplers: BZ

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – Ensuring that personnel assigned the task of air sampling and air analysis know and understand this procedure and are adequately trained with the specific instrument(s) being used to perform surveys.
- 6.2 Radiation Safety Officer (RSO) – Monitoring compliance with this procedure and training personnel in the use of the air sampling and air sampling analysis equipment. The RSO can also assist in the interpretation of the results obtained during surveys.
- 6.3 Site Radiation Safety Lead (SRSL) – During field assignments, the SRSL is the RSO's duly authorized representative for radiological issues when the RSO is not onsite, and is responsible for ensuring that this procedure is properly implemented.
- 6.4 Radiation Protection Technician(s) (RPT) – The RPT(s) performing air sampling and air sampling analysis are responsible for knowing, understanding and complying with this procedure.

7.0 PROCEDURE

7.1 Initial Preparation

- 7.1.1 Select the air sampler to be used, for the type of sample to be used, and verify that the instrument has a currently valid calibration. If the work area contains radioiodine or tritium, contact the RSO for special sampling procedures before proceeding.
 - Area air samples are collected with a low volume air sampler (LV-1) having airflow capability of 20 to 100 liters per minute (LPM) and are routinely set at 80 LPM.
 - Area air samples are collected with high volume air samplers (HI-Q) having airflow capability of 10 to 50 cubic feet per minute (CFM) and are routinely set at 15 to 40 CFM, depending upon the filter size used.
 - Breathing zone (BZ) air samples are normally collected using BZ, or lapel air samplers, which have an airflow capability of 1 to 5 LPM

and are calibrated and set at 4 LPM for radiological air sampling.

Note: Settings should not be changed.

- All air sampling devices will be calibrated to ensure accurate sample volumes are collected. The frequency of calibration will not exceed one (1) year.
- 7.1.2 Attach the air sampling head to the intake of the low volume sample pump or to the Tygon tubing of the lapel sampler.
- 7.1.3 Obtain the filter paper, to be used in the sample, and mark the back side of the filter with a unique number or mark, to represent the clean side of the filter. During the collection and handling of air sample filter papers, caution must be used to prevent the samples from being cross-contaminated by radioactive materials.
- 7.1.4 Place the filter paper in the holder and position the sampler, as indicated below.
- Area air samples are collected by placing the sample head at a distance of 3 to 6 feet above the floor and as close to the work area, as practical. If there is airflow in the work area, the sampler should be placed “downwind” of the area where there is the greatest potential for radioactive material to be suspended in air.
 - BZ/lapel air samples are collected from the workers breathing zone. The sample head is attached to the shoulder of the worker with the sample head facing forward. The sample head will be no further than 12” from the breathing zone. The Tygon tubing connecting the sample head to the pump is run down the back of the worker with the sample pump attached to the workers belt.

7.2 Collecting the sample

- 7.2.1 When the sample head with filter is in position, start the low volume or high volume sample pump and adjust the flow rate to the highest practical flow rate that can be maintained without flow rate fluctuations. BZ/lapel air samplers are not to be adjusted but rather be left at the calibration setting of 4 LPM following manufacturer maximum recommended flow rates.
- 7.2.2 Record the time the sample was started and the initial flow rate of the sample pump on Attachment A, Air Sample Data Sheet. Approved electronic templates may be used in place of this form as long as the equivalent information is provided, as described in this procedure.
- 7.2.3 If possible, identify the radionuclides, which will be encountered in the work area and record the radionuclides along with the DAC for each radionuclide in the space provided on the Air Sample Data Sheet. If a mixture of radionuclides is present, the DAC used in the calculations of

DAC-hours will be the most restrictive concentration.

7.2.4 Collect the sample for the maximum time possible, which represents the exposure encountered by the worker.

7.2.5 At the end of the collection period, note the flow rate of the sample pump and record this flow rate and the time, which the sampling stopped on the Air Sample Data Sheet. Collection times must be sufficient to achieve required MDA/MDCs for the radioisotope(s) of concern.

CAUTION: Be sure not to remove activity from the sample surface. Handle the filter with care (tweezers should be used if possible).

7.2.1 Remove the sample filter and place the filter in an individual envelope or poly bag to ensure no possibility of contamination by other sources of radioactivity.

7.2.2 Record the names of workers who were in the area and the time spent in the work area on the Daily Air Sample Record, in Attachment B. Approved electronic templates may be used in place of this form as long as the equivalent information is provided, as described in this procedure.

7.2.3 Determine the average sample flow rate by adding the initial sample flow rate and the final sample flow rate and dividing by 2. Record the average flow sample flow rate in the space provided on the Air Sample Data Sheet.

7.2.4 Calculate the total air volume sampled by multiplying the average flow rate in cubic centimeters per minute by the total minutes the sampler operated using the indicated spaces on the Air Sample Data Sheet.

7.3 Determining Minimum Detectable Activity (MDA) – During calculations or air concentrations in the following sections, the MDA for each analysis is calculated to determine the statistical significance of the calculated air concentrations.

7.3.1 For each air concentration calculation (alpha and beta) in the following sections, calculate the MDA using the following formula:

$$MDA \text{ in } \mu\text{Ci} / \text{cm}^3 = \frac{\frac{k_{\alpha}^2}{T_{s+b}} + 2[k_{\alpha}]\sqrt{\frac{R_b}{T_b} + \frac{R_b}{T_{s+b}}}}{(2.22 \times 10^6)(E)(V)}$$

Where:

E = Counter efficiency in CPM/DPM

- R_b = Background Count Rate in CPM
 T_b = Background Counting Time in Minutes
 T_{s+b} = Sample Counting Time in Minutes
 V = Sample Volume in cm^3
 2.22×10^6 = Disintegrations per minute per microCurie (DPM/ μCi)
 k_α = 1.645 for a confidence level of 95% and 1.96 for a confidence level of 99%

7.3.2 If the MDA is larger than 10% of the DAC, recount the background for a longer time and/or increase the sample count time to lower the MDA. (The maximum count time should not exceed 1 hour for background and 30 minutes for the sample). Enter the MDA for each air concentration calculated in the space provided on the Air Sample Data Sheet.

7.4 Initial Air Sample Analysis – The initial analysis of air samples provides the air concentrations for short-lived radionuclides and a first estimate of the long-lived air concentrations. In situations where there is a potential for worker intakes to exceed 40 DAC-hours in a week, or if the radionuclides of interest are short-lived, air sample results should be available before work resumes the following day.

7.4.1 Air particulate samples are to be analyzed, at a minimum, for gross alpha and gross beta activity using a Ludlum Model 2929 Dual Channel Scaler or equivalent.

7.4.2 Place the air sample collection media in the sample counter with the upstream collection side toward the detector. Count the air sample and calculate the sample activity and record results on appropriate form(s).

7.4.3 Record the alpha and beta sample DPM results in the Air Sample Data Sheet.

7.4.4 Calculate the alpha and beta air concentrations using the following formula. Adjustments due to alpha self-absorption are made, as appropriate.

$$\text{Air Concentration } (\mu\text{Ci} / \text{cc}) = \frac{\alpha \text{ or } \beta \text{ DPM}}{(2.22 \times 10^6 \text{ DPM} / \mu\text{Ci})(\text{Sample Volume}(\text{cm}^3))}$$

7.4.5 Enter the alpha and beta air concentrations on the Air Sample Data Sheet in the space provided for the initial air concentrations.

Note: If air sample concentration is greater than 10% of the DAC value, notify the RSO or duly authorized representative for further instructions.

- 7.4.6 If the air concentration is less than 10% of the most restrictive DAC, no further analysis of the air sample is required. If the air concentration exceeds 10% of the DAC concentration, proceed with the analysis in section 7.5.
- 7.5 Air sample analysis for long-lived radionuclides – This analysis allows for decay of naturally occurring radionuclides and provides for correcting air concentrations for naturally occurring radionuclides.
- 7.5.1 Particulate samples will be analyzed for gross alpha and gross beta following a 30-minute delay to account for radon decay, and again at 4 hours, if necessary, to allow for further decay using a Ludlum Model 2929 Dual Channel Scaler or equivalent.
- 7.5.2 Place the air sample in the sample counter with the collection side toward the detector. Count the air sample and calculate the sample activity and record results on appropriate form(s).
- 7.5.3 Record the alpha and beta sample DPM results in the Air Sample Data Sheet.
- 7.5.4 Calculate the alpha and beta air concentrations using the following formula. Adjustments due to self-absorption are made as appropriate.

$$\text{Air Concentration } (\mu\text{Ci} / \text{cc}) = \frac{\alpha \text{ or } \beta \text{ DPM}}{(2.22 \times 10^6 \text{ DPM} / \mu\text{Ci})(\text{Sample Volume}(\text{cm}^3))}$$

- 7.5.5 Enter the alpha and beta air concentrations, on the Air Sample Data Sheet, in the space provided. If the 30-minute decay air concentration is below 10% of the DAC, no further analysis is required.
- 7.5.6 If the 30-minute air concentration is above 10% of the DAC value, recount the air sample following 4 hours of decay from the time the sample was stopped. Calculate the air concentration using the formula in step 7.5.4 and record the air concentrations in the space provided for the 4-hour decay air concentration on the Air Sample Data Sheet.
- If the 4-hour air concentration is below 10% of the DAC value, no further analysis is required.
 - If the concentrations are above 10% of the DAC value, recount after 24 hours and document on the Air Sample Data Sheet.
 - If the air concentrations exceed 10% of the DAC values, notify the RSO or duly authorized representative for further instructions. Save the air sample for possible further analysis.
 - For air samples, which exceed 10% of the DAC values, an exposure is assigned to the workers residing in the area where the sample was taken.

7.6 Assignment of DAC-hour exposures to workers

7.6.1 For air samples which exceed 10% of the DAC values, calculate the workers DAC-hour exposure using the following formula:

$$\text{Exposure in DAC-hours} = \frac{A \times B}{C}$$

Where:

A = Area or Lapel air sample concentration in microCurie per cubic centimeter ($\mu\text{Ci}/\text{cm}^3$)

B = Hours worker was in the calculated air concentration

C = DAC air concentration in $\mu\text{Ci}/\text{cm}^3$ from regulatory reference.

7.6.2 Enter the DAC-hour exposure on the column provided on the Air Sample Data Sheet. If respiratory protection was used during the exposure period, contact the RSO or duly authorized representative for the protection factor used to adjust DAC-hour exposure.

8.0 REFERENCES

- Title 10, Code of Federal Regulations, Part 20, *Standards for Protection Against Radiation*.
- Radiation Safety Program, Cabrera Services Inc., Manual
- OP-021, *Alpha-Beta Sample Counting Instrumentation*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure
- U.S. Nuclear Regulatory Commission, *Air Sampling in the Workplace*, Regulatory Guide 8.25, (1992).
- U.S. Nuclear Regulatory Commission, Consolidated Guidance About Material Licenses, Vol. 11 - *Program-Specific Guidance About Licenses of Broad Scope*, NUREG-1556, (1999).
- CABRERA Effluent Monitoring Work Instruction, Pohakuloa Training Center, PTA-W1-001, 02 December 2010

9.0 REQUIRED RECORDS

- Air Sample Data Sheet (written or electronic)
- Daily Air Sample Record (written or electronic)

10.0 ATTACHMENTS

- Attachment A – Air Sample Data Sheet
- Attachment B – Daily Air Sample Record
- Attachment C – Contamination Limits

Attachment A

Air Sample Data Sheet

Air Sample Data Sheet

Sample # _____ Date _____

Description: _____

Radionuclides: _____ DAC value: _____

_____ DAC value: _____

_____ DAC value: _____

Initial sample flow rate: _____ Time sampler on: _____

Final sample flow rate: _____ Time sampler off: _____

Average sample flow rate: _____ Total sample time: _____ hours

Total sample volume: _____ cm³

30 min Air Concentration:

Alpha = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ Beta = _____ $\mu\text{Ci } \beta/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \beta/\text{cm}^3$

4 Hour Decay Air Concentration:

Alpha = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ Beta = _____ $\mu\text{Ci } \beta/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \beta/\text{cm}^3$

24 Hour Decay Concentration:

Alpha = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ Beta = _____ $\mu\text{Ci } \beta/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \alpha/\text{cm}^3$ MDA = _____ $\mu\text{Ci } \beta/\text{cm}^3$

Attachment B

Daily Air Sample Record

Daily Air Sample Record

Worker Name	Sample Date	Count Date	Time In	Time out	Total time (Hrs.)	Concentration ($\mu\text{Ci}/\text{cm}^3$)	DAC-Hour Exposure

Attachment C

Contamination Limits

Contamination Limits from Table 1 of RSP

RADIONUCLIDE	ALLOWABLE SURFACE CONTAMINATION (DPM/100 CM²)	
	REMOVABLE	FIXED + REMOVABLE
Transuranics, Ra-226, Ra-228, Th-230, Pa-231, Ac-227, I-125, I-129	20	100
Th-Natural, Th-232, Sr-90, Ra-223 Ra-224, U-232, I-126, I-131, I-133	200	1000
U-Natural, U-235, U-238, and associated Decay products	1000	5000
Beta-Gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	1000	5000



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

UNCONDITIONAL RELEASE OF MATERIALS FROM RADIOLOGICAL CONTROL AREA

OP-004

REVISION 2.0

Reviewed by:

David Wunsch, Quality Assurance Manager

4/12/13

Date

Approved by:

Henry Siegrist
Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

The purpose of this procedure is to specify requirements for releasing surface contaminated material and equipment from Radiological Controlled Areas (RCA) under Cabrera Services Inc (CABRERA) control. This procedure sets forth the requirements for release of these items from controlled areas at CABRERA project field sites.

2.0 APPLICABILITY

- 2.1 This procedure provides instructions for CABRERA field personnel for performing release surveys of items controlled as contaminated or potentially contaminated with radioactive materials.
- 2.2 Using these survey techniques, the procedure ensures that materials released from contaminated or potentially contaminated areas will meet the release criteria applicable to the license conditions, facility requirements, or in specified regulations/guidance required by regulatory agencies of the federal or state government.
- 2.3 Release of large items, such as waste containers used to ship bulk quantities of soil and waste for disposal, are further covered by the CABRERA procedure OP-001, *Radiological Surveys*.
- 2.4 Sealed check sources having activity less than listed in Schedule B, of 10 CFR 30.71 (Title 10 of the Code of Federal Regulations Part 30.71), are considered exempt quantities and are not covered by this procedure.

3.0 DEFINITIONS AND ABBREVIATIONS

- 3.1 Activity – The rate of disintegration (transformation) or decay of radioactive material. The units of activity for the purpose of this procedure are Becquerel (Bq) or microCuries (μ Ci).
- 3.2 Contamination – Deposition of radioactive material in any place where it is not desired. Contamination may be due to the presence of alpha particle, beta particle or gamma ray emitting radionuclides.
- 3.3 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.
- 3.4 Fixed Contamination – Radioactive contamination that is not readily removed from a surface, by applying light to moderate pressure, when wiping with a paper or cloth disk smear or Masslinn.
- 3.5 Minimum Detectable Activity (MDA) – For purposes of this procedure, MDA for removable radioactive contamination is defined as the smallest amount

of sample activity that will yield a net count, with a 95% confidence level, based upon the background count rate of the counting instrument used.

- 3.6 Release for Unconditional Use – A level of radioactive material below which an item/object is determined to be acceptable for use without restrictions. Under normal circumstances, authorized limits for residual radioactive material are set equal to, or below, the values specified in NRC Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors*.
- 3.7 Survey – An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation.
- 3.8 Survey Exempt Materials – Prior to leaving a RCA, all materials that exit must be surveyed. Items exempt from this rule are those that remain enclosed, in a sealed container, while in the RCA. Although its contents are exempt, the container must still be surveyed. For example, if a flashlight is used in a RCA, the exterior of the flashlight must be surveyed. However, the batteries are considered survey exempt materials if they were kept enclosed, in the sealed casing, and did not contact radiological material.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- 4.1.1 Ensure that all instruments used to perform release surveys are operated in accordance with their respective operating procedure or the manufacturer's operating manual.
- 4.1.2 Large area smears (LAS) may be used to augment (but not replace) the 100 square centimeters (cm²) smear survey. The LAS may be counted with the Ludlum Model-3 and 44-9 probe or Ludlum 2224-1 and 43-93 probe or equivalent. LAS are used to obtain immediate information concerning loose contamination for the purpose of radiological protection and to minimize time spent performing smears on an item easily identified as contaminated.
- 4.1.3 A document package, for equipment/items that are unconditionally released, should include the following:
 - Radiological Survey Form for radiation or contamination surveys.
 - Unconditional Release of Equipment and Items Log.
 - Daily instrument quality control (QC).
 - Any calculations or templates used to determine the total and transferable surface contamination levels.
- 4.1.4 The release documents should contain the following information:

- Completed Radiological Survey Forms with the date of the survey.
- Description or identification of the item(s).
- The release approval of the Radiation Safety Officer (RSO) or their duly authorized representative.

- 4.1.5 Ensure that radiation/contamination surveys are performed in accordance with OP-001, *Radiological Surveys*.
- 4.1.6 Ensure that items identified as radioactive, during the release survey, are controlled in accordance with OP-019, *Radiological Posting*.
- 4.1.7 Ensure that personnel performing release surveys are logged in on a Radiation Work Permit, in accordance with AP-012, *Radiation Work Permits* (if applicable).
- 4.1.8 Ensure that instruments used for release surveys are within current calibration and will have a response check performed daily, or before use, in accordance with the instrument's operating procedure or manufacturer's operating manual.
- 4.1.9 Ensure that items presented for release are direct scanned in an area of low background.

4.2 Limitations

- 4.2.1 The maximum probe speed, during direct scan surveys of surfaces, will be 3 centimeters per second (cm/sec).
- 4.2.2 The probe face will be held within: ¼ inch of the surface being surveyed for alpha radiation; and, ½ inch of the surface being surveyed for beta-gamma radiation.
- 4.2.3 During direct radiation scans, the meter probe will be held at the proper distance with allowance for the meter reading to stabilize.
- 4.2.4 If an instrument used to perform release surveys fails any operational checks, it will be removed from service. Data collected, during the period of instrument failure, must be evaluated by the RSO or duly authorized representative.

4.3 Requirements

- 4.3.1 Audible response instruments must be used during direct scan surveys.
- 4.3.2 Instrumentation used for surveys will be checked each day, prior to use, with standards and verified to have current valid calibration.
- 4.3.3 When releasing a large volume of materials, a program may be established, under the discretion of the RSO or their duly authorized

representative, to ensure by second check that no radioactive material has been released to the public or the environment.

- 4.3.4 Surveys performed for the release of material will be documented on a Radiation and Contamination Survey and/or on an Unconditional Release of Equipment or Items Survey (see Attachment A).
- 4.3.5 The Radiation Protection Technician (RPT) performing the survey will review the Unconditional Release of Equipment and Items Log and all other applicable forms for accuracy and completeness.
- 4.3.6 Entries on Unconditional Release of Equipment and Items Log and all other pertinent forms must be dated and initialed, by the RPT performing the survey, to be valid.

5.0 EQUIPMENT

There is no special equipment required for this procedure.

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – Responsible for ensuring that personnel assigned the task of surveying materials know this procedure, are adequately trained in its use, and have ready access to a copy.
- 6.2 Radiation Safety Officer (RSO) – Responsible for verifying that personnel are trained in the use of contamination survey meters, described in this procedure, and comply with procedure requirements. The RSO or their duly authorized representative (a) reviews all applicable forms for accuracy and completeness and (b) signs/dates the release approval documentation.
- 6.3 Site Radiation Safety Lead (SRSL) – During field assignments, the SRSL is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the SRSL will act as the RSO's duly authorized representative for radiological issues.
- 6.4 Radiation Protection Technician (RPT) – Responsible for performing the surveys described in this procedure. The RPT performing the survey will review the Unconditional Release of Equipment and Items Log, and all other applicable forms, for accuracy and completeness. The RPT ensures the use of the most current, approved version of these documents.

7.0 PROCEDURE

7.1 Release Limits for Gross Activity (Unknown Isotopes)

Exhibit 1: Release limits from NRC Regulatory Guide 1.86

EMISSION	REMOVABLE (dpm/100 cm ²) ¹	TOTAL ² (dpm/100 cm ²)
Alpha	20	100
Beta-Gamma	200	1000

¹ dpm/100 cm² = disintegrations per minute per 100 square centimeters

² fixed and removable

Note: If **all** of the constituents of the contamination are known **and** documented on the release documents, the applicable release limits are derived from Table 1 of the NRC Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors*.

7.2 Inaccessible Surfaces

7.2.1 Items with inaccessible internal surfaces should be disassembled, as completely as possible, to facilitate release surveys. Items with inaccessible surfaces will not be unconditionally released unless evaluated by the RSO, the duly authorized representative, or a designated evaluator who must authorize and document the release.

7.2.2 The following guidance will be used when performing evaluations for equipment/items with inaccessible surfaces:

- Review the history of the item and where it was used.
- Review the actual release survey.
- Review the determination of the radiological conditions in the area the item has been used or stored.
- Consider the use of gamma radiation sensitive detectors such as Sodium Iodide (Thallium activated) [NaI(Tl)] or its equivalent.
Note: These detectors may indicate internal contamination that a beta sensitive detector may not detect. This is due to the beta detector's lack of sensitivity to photon emissions, as well as the inability of beta emissions to penetrate through many surfaces.

7.2.3 Equipment, which has internal combustion engines, is not readily disassembled. Airborne data, equipment running time, and survey of motor air filters provide sufficient information to make a determination of potential internal contamination.

7.3 Materials considered dangerous, fragile, or not readily smearable – due to their physical or chemical nature – will not be unconditionally released unless evaluated, on a case-by-case basis, in a manner consistent with Section 7.2.2. Evaluation for release will be performed **only** by a designated evaluator who must authorize and document the release.

7.4 Survey Exempt Materials

Writing implements, flashlights and other small personal items brought into and used in contaminated areas will be surveyed by frisking, when leaving a controlled area, in the same manner as a personnel whole body frisk. Items defined as survey exempt materials (see Section 3.8) do not require frisking to be released.

7.5 Survey and Action Levels

7.5.1 Upon receipt of an item presented for release, attempt to determine the history:

- Its purpose,
- Current and past use,
- Location(s) the item was used or stored (contaminated or airborne area),
- Whether it was ever used for work with radioactive material or used in an area where radioactive material was used or stored.

Note: This knowledge of the item history should provide the surveyor with information helpful in performing the release survey.

7.5.2 Perform radiological surveys using protective clothing (e.g., gloves) if loose contamination is suspected, in accordance with OP-001.

- Perform a direct scan of all accessible areas of the item and determine the total and transferable (loose) radioactive material present, in accordance with OP-001.
- If the presence of radioactive contamination is indicated at levels exceeding Regulatory Guide 1.86 (or Section 7.1 above for unknown isotopes), the item or material is considered contaminated and will not be released until it is decontaminated. Control these materials in accordance with OP-019.

Note: Items presented for release will be direct scanned in an area of low background (≤ 100 counts per minute) when practical. The RPTs performing release surveys will determine if the background is acceptable for direct scan of the item.

7.5.3 If the direct radiation scan indicates radioactive material on the surface of the item is less than the limits of release for total activity, proceed to 7.5.5.

7.5.4 If the scan indicates radioactive material on the surface is greater than regulatory limits for total activity, the item cannot be unconditionally released until it is decontaminated.

7.5.5 Perform sufficient 100 cm^2 smears on the item to ensure that the contamination survey is representative of the item's surface area. OP-001 provides further guidance on large waste containers (also refer to Section 4.1.2).

7.5.6 Count and document the smear results in compliance with OP-001 and OP-021, *Alpha-Beta Counting Instrumentation*.

- Record smear(s) data on the radiological Survey Form.
- Determine transferable contamination levels.

- If the smear results indicate transferable activity below the release limits, proceed to step 7.5.7.
 - If the smear results indicate transferable activity above the release limits, the item cannot be released until it is decontaminated.
- 7.5.7 If the item has internal or inaccessible surfaces, CABRERA personnel will disassemble the item and either (a) repeat Steps 7.5.2 through 7.5.6 or (b) have the item evaluated for release by a designated evaluator who has sufficient knowledge to perform radiological surveys on items presenting difficult geometries.
- 7.5.8 If the item meets the release limits or is evaluated as meeting the unconditional release criteria, complete the Unconditional Release of Equipment and Items Log. The RSO or their duly authorized representative should review the release documents and approve release before allowing an item(s) to leave the controlled area.
- 7.5.9 If items are identified as radioactive during the release survey, contact the RSO or their duly authorized representative as soon as possible.
- 7.5.10 Any vehicle or container, with removable contamination exceeding the Department of Transportation limits, will be brought to the attention of the RSO or their duly authorized representative for release or acceptance approval, as appropriate.
- 7.5.11 Dose rate surveys, which exceed 0.2 micro-Roentgens per hour, will be brought to the attention of the RSO or their duly authorized representative for release or acceptance approval, as appropriate.
- 7.6 The results of either radiation or contamination surveys will be documented on a Radiological Survey Forms.

8.0 REFERENCES

- Title 10, Code of Federal Regulations, Part 20, *Standards for Protection Against Radiation*.
- AP-010, *Personnel Protective Equipment Used Within Radiological Control Areas*, Cabrera Services Inc., Operating Procedure
- AP-012, *Radiation Work Permits*, Cabrera Services Inc., Operating Procedure
- AP-016, *Radioactive Material Tracking*, Cabrera Services Inc., Operating Procedure
- OP-001, *Radiological Surveys*, Cabrera Services Inc., Operating Procedure
- OP-009, *Use and Control of Radioactive Check Sources*, Cabrera

Services Inc., Operating Procedure

- OP-019, *Radiological Posting*, Cabrera Services Inc., Operating Procedure
- OP-020, *Operation of Contamination Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-021, *Alpha-Beta Counting Instrumentation*, Cabrera Services Inc., Operating Procedure
- OP-023, *Operation of Micro-R Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure
- U.S. Nuclear Regulatory Commission, Consolidated Guidance About Material Licenses, *Vol.11 - Program-Specific Guidance About Licenses of Broad Scope*, NUREG-1556, (1999).
- U.S. Nuclear Regulatory Commission, *Termination of Operating Licenses for Nuclear Reactors*. Regulatory Guide 1.86, (1974).

9.0 REQUIRED RECORDS

- Unconditional Release of Equipment and Items Log
- Radiation and contamination surveys on Radiological Survey Forms
- Daily instrument QC documentation (e.g., logs/forms)
- Any calculations or templates used to determine the total and transferable surface contamination levels.

10.0 ATTACHMENTS

Attachment A - Unconditional Release of Equipment and Items Log

Attachment A

Unconditional Release of Equipment and Items Log

UNCONDITIONAL RELEASE OF EQUIPMENT AND ITEMS LOG

Project Name _____ Project Number _____

Item/ Equipment Released	Comments	Survey #	Surveyor Initials	Date

Reviewed By: _____

Date: _____



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

USE AND CONTROL OF RADIOACTIVE SOURCES

OP-009

REVISION 1.0

Prepared/Reviewed by:

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4/12/2013

Date

Approved by:

Henry Siegrist

Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

This procedure describes methods for control of instrument check sources and the methods used by Cabrera Services Inc. (CABRERA) to evaluate sources for the potential of leaking radioactive material. These sources are used to ensure proper radiation detection instrument operation.

2.0 APPLICABILITY

- 2.1 This procedure will be used by Cabrera personnel for use and control of radioactive sources used for portable radiation detectors and will also be used when leak testing licensed radioactive sources, as defined in the Cabrera NRC License, and other RSO requested source leak testing.
- 2.2 Adherence to this procedure will provide reasonable assurance that: personnel exposures will be below specified limits; sources will not be lost or misplaced; personnel will remain free of contamination; and, contamination will not be spread beyond any designated contaminated areas. In addition, it will provide a reasonable assurance that leak testing, of radioactive sources, meets the requirements of Title 10, Code of Federal Regulations, Part 20 (10 CFR 20) and Cabrera's NRC license.

3.0 DEFINITIONS

- 3.1 Restricted Area – An area, to which access is limited by the licensee, for protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted areas do not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.
- 3.2 Leak Test – A survey technique used to determine the presence of removable activity from the surface of a sealed source.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

- 4.1 Precautions
 - 4.1.1 When performing a leak test on licensed-quantity sources, use specific license procedures.
 - 4.1.2 If licensed-quantity sources are being inspected, the RSO or duly authorized representative will determine any additional precautions (e.g., finger rings, etc.).
 - 4.1.3 Sealed sources of activity may exhibit high dose rates. Ensure that a thorough dose rate survey has been performed documented prior to beginning any leak test evaluation.

- 4.1.4 The window area of an alpha-beta detector may be covered with a thin window and may be easily punctured. Avoid surveying areas which have protruding fragments that may puncture the detector face. Remove the protruding fragments, if possible, before surveying. Upon removal of the leak test sample, analyze the sample away from the source. If the sample yields a high-count rate compared to background, assume the source to be leaking and provide appropriate controls to limit contamination spread.

4.2 Limitations

- 4.2.1 Storage location(s) of radioactive sources will be approved by the RSO, or duly authorized representative, for protection against loss, leakage, or dispersion by the effect of fire or water.
- 4.2.2 This procedure does not apply to pure gamma emitters not emitting alpha or beta particles – contact the RSO for guidance.
- 4.2.3 A Radiation Work Permit (RWP) must be generated for leak testing of non-exempt sources or sources exceeding contact dose rates of 100 mrem/hr gamma or 1,000 millirad/hr beta. For instructions on how to generate an RWP refer to AP-012.

4.3 Requirements

- 4.3.1 Individual source quantities shall not result in exceeding license limits.
- 4.3.2 The methods specified in this procedure will be reviewed annually to ensure compliance with the requirements of the CABRERA NRC License to measure leakage from sealed radioactive sources.
- 4.3.3 The leak test shall be capable of detecting the presence of 0.005 microcuries of removable activity to comply with the NRC requirements of the CABRERA Radioactive Material License.
- 4.3.4 Ensure accountability and direct control of sources at all times when unlocked and in use. Minimize the number of people in the area of the source during the leak test to reduce exposure and maintain work areas as low as is reasonably achievable (ALARA). If high radiation area controls are necessary, the source must either be locked or guarded.
- 4.3.5 Only qualified CABRERA Radiation Worker personnel may use or have possession of CABRERA radioactive sources.
- 4.3.6 Only CABRERA NRC Material License Authorized Users or CABRERA Designees as provided for by written authorization may provide leak tests on licensed radioactive sources.
- 4.3.7 The quality of leak test analyses is dependent upon the quality of the wipe and the quality of analysis. Periodic evaluation of the process and

analysis methods shall be conducted to ensure appropriate methods are used and this procedure is followed.

- 4.3.8 The RSO or duly authorized representative shall review completed forms for accuracy and completeness.

5.0 EQUIPMENT

- Ludlum 2929 or equivalent
- Remote smear handling assembly
- Liquid cleaner (if recommended by source manufacturer)
- Smears
- Portable radiation detection equipment
- Calibration sources

6.0 RESPONSIBILITIES

- 6.1 Radiation Safety Officer (RSO) – Responsible for verifying that personnel comply with this procedure and are trained with respect to radioactive source use, as described in this procedure. The RSO ensures that CABRERA personnel performing this procedure are qualified by training and experience to perform its requirements.
- 6.2 Site Radiation Safety Lead (SRSL) – During field assignments, the SRSL is responsible for ensuring that this procedure is properly implemented. When the RSO is not on site, the SRSL will act as the RSO's duly authorized representative for radiological issues. The CABRERA NRC Material License Authorized User or Designee conducting leak tests of licensed radioactive sealed sources is responsible to comply with the provisions of this procedure
- 6.3 Radiation Protection Technician (RPT) – Responsible for the control and use of exempt radioactive check sources.

7.0 PROCEDURE

7.1 Action Levels

7.1.1 Source Inventory

- A physical source inventory is conducted at intervals not exceeding six months. The RSO or duly authorized representative shall be notified immediately if it has been determined that a source is missing and an immediate search shall be conducted. Loss of licensed radioactive sources may require NRC notification by the RSO.

- The RSO shall be immediately notified of any new radioactive sources controlled or purchased by CABRERA projects. Such sources include both exempt and non-exempt sources.

7.1.2 Source Leak Tests

- Sealed sources shall be tested for leakage at intervals not to exceed that specified on the certificate of registration issued by the NRC under 10 CFR 32.210 or equivalent regulations of an Agreement State.
- Sealed sources designed to primarily emit alpha particles shall be tested for leakage at intervals not to exceed 3 months.
- In the absence of a certificate from a transferor indicating that a leak test has been made within the interval specified by the NRC, a leak test will be performed by CABRERA personnel prior to putting a non-exempt source into use.
- Sealed sources need not be tested if they contain only tritium; only a radioactive gas; have a half-life of less than 30 days; or contain no more than 100 microcuries of beta-gamma or 10 microcuries of alpha emitting material. Sealed sources not being used and that are in storage do not need a leak test. However a leak test must be performed prior to transferring the source to another person. No source shall go untested for a period of more than 10 years.

7.1.3 Source Leakage

If a source is suspected to have lost its integrity, the RSO or duly authorized representative shall be notified immediately and a leak test shall be performed.

7.1.4 Storage Area Radiation Levels

Radiation levels shall be maintained at less than 2 millirem per hour (mrem/hr) on any accessible surface where the radioactive sources are stored. Notify the RSO or duly authorized representative if radiation levels exceed 2 mrem/hr.

7.2 Inventory List

The inventory list will be reviewed/updated at least once every six months, or whenever a new source is received or a source is disposed of to ensure inventory records are updated. Prior to disposing of a source, approval should be obtained from CABRERA's Corporate RSO. The results shall be recorded on the Source Inventory form (Attachment A), or equivalent, and shall be retained in the project files as well within the corporate source file for a period of not less than five years.

7.3 Storage

Radioactive sources and licensed radioactive sources will be stored in fire resistant containers when not in use. Such containers will be used at the worksite and for routine storage of the sources at CABRERA offices.

7.4 Leak Test Initial Preparations

7.4.1 Select a work area free of radioactive contamination to conduct the leak test.

7.4.2 Select instruments that have a Minimum Detectable Activity (MDA) capable of detecting at least 0.005 microcuries (μCi) of the radionuclide of concern.

7.4.3 If a wet wipe test is anticipated, prepare distilled water in a container, as appropriate, for the source being tested. Specific solutions may be mentioned in vendor documentation. If they are, use the solutions required by the vendor.

Caution: Do not directly smear unsealed sources, such as depleted uranium plates or fragile mylar windows covering sources. Rather, smear the areas around such sources, such as the holder and container or box holding such sources.

7.4.4 Inform the RSO or duly authorized representative of the source to be leak tested. The RSO or duly authorized representative will evaluate the test and may provide additional precautionary measures to ensure protection of people and equipment in the work area.

Caution: Do not touch or get extremely close to an exposed source of high specific activity. Sealed sources of high specific activity may cause high contact dose rates, resulting in high shallow dose equivalents to the extremities.

7.4.5 Use remote means to smear the outside surface of the source, using cloth or paper, for any high activity sources as described by the cautionary note. This smear will be the leak test sample that is analyzed for activity associated with a potentially leaking source. Wipe the outside surfaces of the source, up to and including, a total area of 100 cm^2 .

7.4.6 Be cautious when handling leak test samples in order to prevent the spread of contamination, should the sample have loose radioactivity on it from a leaking source.

7.4.7 Minimize the time period conducting the leak test. In a well-planned test, the exposure time will be short.

7.4.8 If the source emits particle radiation, a very thin window will typically cover the radioactive material. Take special precautions to prevent damage to the window during leak testing.

7.4.9 Wear rubber or latex gloves when handling the leak test samples or equipment associated with the test.

7.5 Smear Analysis Using a Portable Instrumentation Probe

To maintain the calibrated detection efficiency, the detector probe must be held at the appropriate height, determined using calibration, when counting a leak test smear. This generally means ½ inches or less for alpha and low energy beta particles.

7.6 Smear Analysis Using Alpha-Beta Sample Counting Equipment

The leak test sample shall be analyzed by a method, which will ensure detection of at least 0.005 μCi of the radionuclide of interest. Existing CABRERA procedures and templates shall be used as practical to ensure appropriate analysis and documentation of results.

Note: If the activity estimation determines the leak test sample to be in excess of the leak test limit of 0.005 microcuries, then label the source as unusable to prevent further spread of activity. Conduct a detailed survey of the leak test work area to ensure that activity from the source has not spread beyond the capsule of the source and immediately contact the RSO.

7.7 Performing Leak Tests

7.7.1 Leak tests are performed on licensed radioactive sources received in the field prior to use. A leak test may also be performed on exempt quantity sealed sources, in the event a source is suspected of having a loss of encapsulation or other possible leakage.

7.7.2 A visual inspection of the source shall be made for physical damage. If an area of the source is noticeably damaged, perform the leak test in that area.

7.7.3 Determine the extent of source leakage by one of the following methods:

- Dry Wipe Test – This test will be performed on encapsulated sources or adjacent surfaces of plated or foil sources. The sources shall be wiped with a dry disc smear applying moderate pressure. (**Note:** Never wipe the surface of a plated or foil source.) Removal of any radioactive materials from the source or adjacent surfaces (i.e., source leakage) will be determined by counting the filter paper with appropriate instrumentation.
- Wet Wipe Test – This test will be performed on encapsulated sources only. The entire surface of the source shall be wiped with a disc smear moistened with distilled water, applying moderate pressure. Removal of any radioactive material from the source will be determined by counting the filter paper with appropriate instrumentation after the filter paper has dried out.

7.7.4 When any contamination or leak test reveals the presence of 0.005 μCi or greater of removable contamination, the source shall be retested.

The source will be either repaired, if possible, or disposed of as radioactive waste if the second test is unsatisfactory. The results of leak tests for the sources are recorded on the Source Leak Test Data Sheet (Attachment B) and shall be retained for a minimum of five years.

7.8 Source Storage Area Survey

The on-contact radiation level exterior to the location where the sources are stored shall be maintained at less than 2 mrem/hr on any accessible surface. A radiation survey of the storage location shall be performed at least quarterly and after the receipt of any additional sources.

8.0 REFERENCES

- AP-012, *Radiation Work Permits*, Cabrera Services Inc., Operating Procedure
- OP-001, *Radiological Surveys*, Cabrera Services Inc., Operating Procedure
- OP-020, *Operation of Contamination Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-021, *Alpha-Beta Sample Counting Instrumentation*, Cabrera Services Inc., Operating Procedure
- OP-022, *Operation of Ionization Chambers*, Cabrera Services Inc., Operating Procedure
- OP-023, *Operation of Micro-R Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure
- U.S. Nuclear Regulatory Commission, *Consolidated Guidance About Material Licenses, Vol. 11 - Program-Specific Guidance About Licenses of Broad Scope*, NUREG-1556, (1999).

9.0 REQUIRED RECORDS

9.1 The RSO or duly authorized representative prepares and maintains a source file which shall, at a minimum, consist of the following:

- Procurement history of each source, including copies of seller certification;
- Status change (damage, sale or transfer, disposal, or recalibration);
- Completed "Source Inventory" Form; and,
- Any other correspondence related to the sources.

9.2 Records of leak tests shall be kept in units of microCuries (uCi) and shall be maintained for five years.

10.0 ATTACHMENTS

Attachment A – Source Inventory

Attachment B – Sealed Source Leak Test Data Sheet

Attachment A
Source Inventory

SOURCE INVENTORY

Radionuclide	Undecayed Activity, μCi)	Serial Number/Bar Code	Date of Inventory	Location of Source	Performed by (initials) Date of inventory

Comments _____

Date Performed: _____ Reviewed by: _____

Attachment B
Source Leak Test Data Sheet

Source Leak Test Data Sheet**Source Information**

Source ID Number _____

Source Manufacturer: _____ Date of Assay: _____

Source Model Number: _____ Source Serial # _____

Activity of Source at Assay Date: _____ microcuries Source Today: _____ microcuries

Radionuclide name: _____ Half-life of radionuclide _____

Leak Test Sample Information

Location of Leak Test Work Area _____

Describe the method of leak testing: _____

Instrument/Serial Number: _____

Detector/Serial Number: _____ Calibration Due Date: _____

Alpha Detection Efficiency: _____ c/d Beta Detection Efficiency _____ c/d

Background count time: _____ min.

Background alpha counts _____ Background beta counts _____

Alpha MDA: _____ microcuries Beta MDA: _____ microcuries
(MUST BE LESS THAN 0.005 microcuries)

Sample total alpha counts _____ Sample Total beta counts: _____

Sample count time: _____ min.

Leak test sample activity: _____ microcuries alpha _____ microcuries beta

Leak Test Result – Check all boxes that apply

- ☐ The leak test sample is in excess of the 0.005 microcuries alpha or beta limit
- ☐ The leak test sample is below the 0.005 microcuries limit
- ☐ The source has been controlled to prevent the spread of activity.

Source Leak Test Performed by: _____ Date: _____

Leak Test Analysis Conducted by: _____ Date: _____

Radiation Safety Officer: _____ Date: _____



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

DECONTAMINATION OF RADIOACTIVITY FROM EQUIPMENT AND TOOLS

OP-018

REVISION 1.0

Reviewed by:

David Wunsch, Quality Assurance Manager

4/12/13

Date

Approved by:

Henry Siegrist
Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

This procedure establishes the requirements for decontamination of equipment, material, and tools used at Cabrera Services Inc., (CABRERA) field projects that become contaminated with radioactive material.

2.0 APPLICABILITY

This document applies to all CABRERA personnel involved in the decontamination. Each decontamination operation is unique; thus, this procedure provides general, effective decontamination techniques and guidelines to be used by CABRERA field personnel.

3.0 DEFINITIONS

- 3.1 Decontamination – The processes whereby contamination can be safely and effectively removed from equipment tools and materials.
- 3.2 Herculite – Herculite is a brand name plastic or polyethylene floor covering and containment material used for decontamination operations.
- 3.3 Material Safety Data Sheet (MSDS) – Sheets providing information and limitations about chemicals and products that is issued by the manufacturer.
- 3.4 Radiation Work Permit (RWP) – A document generated by Health Physics to provide:
 - A description and scope of the work to be performed;
 - Existing radiological conditions in the work area;
 - Limitations placed upon the scope of work;
 - Maximum radiological limits allowed;
 - Measures to be employed to protect the worker(s); and
 - Special instructions to workers and RPT personnel for the work to be performed.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- 4.1.1 Decontamination of contaminated tools or equipment will be performed under the direction of an RPT. The RPT will provide direction in accordance with this procedure, and the RWP.
- 4.1.2 Decontamination activities will be performed within a controlled area.
- 4.1.3 Controls to contain the spread of loose contamination, during the decontamination activity, will be planned and established prior to the decontamination of equipment, material, and tools.

4.2 Limitations

- 4.2.1 This procedure may not be applicable or readily applied to decontaminating surfaces composed of porous materials such as wood or concrete. It is therefore not the preferred operating procedure for decontaminating building surfaces.
- 4.2.2 Protective clothing worn, by the personnel involved in decontamination activities, will be determined in accordance with the RWP.
- 4.2.3 Decontamination cleaning solvent/solutions will only be used in accordance with the directions and limitations listed on the manufacturer supplied MSDS.
- 4.2.4 Respiratory protection devices, required by the RWP for decontamination operations, will be selected and used in accordance with the provisions of CABRERA procedure AP-006.

4.3 Requirements

- 4.3.1 Instrumentation used in the surveys will be checked with standards daily and verified to have current calibration records.
- 4.3.2 A pre-job briefing will be held to instruct RPTs and other personnel of the conditions of the RWP. All personnel performing work in the decontamination work area will sign the RWP prior to work.
- 4.3.3 Radiation and contamination surveys will be performed in accordance with the provisions of CABRERA procedure OP-001.
- 4.3.4 Release of equipment, materials, and tools from the decontamination work area will be performed in accordance with the provision of CABRERA procedure OP-004.
- 4.3.5 Operations conducted using this procedure will be reviewed for compliance at least annually.

5.0 EQUIPMENT

Appropriate Personal Protective Equipment (PPE) and decontamination equipment includes, but is not limited to:

- Herculite
- Decontamination rags
- Cleaning solutions

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – Ensures that personnel assigned the task of decontamination know and understand this procedure, are adequately trained in its use, and have access to a copy.

- 6.2 Radiation Safety Officer (RSO) – Training of personnel in the decontamination techniques and performing radiation surveys described in this procedure; and ensures that technicians are qualified by training and experience to perform the requirements of this procedure.
- 6.3 Site Radiation Safety Lead (SRSL) – During field assignments, ensures that this procedure is properly implemented. When the RSO is not on site, the SRSL will act as the RSO's duly authorized representative for radiological issues.
- 6.4 Radiation Protection Technologist(s) (RPT) – Performing the surveys of decontaminated items, and ensuring that radioactive material is not released to the public or the environment.

7.0 PROCEDURE

7.1 Pre-Decontamination Preparation

- 7.1.1 The SRSL will initiate decontamination work instructions.
- 7.1.2 A radiological survey will be performed by an RPT on any item or object that is to be removed from a controlled area.
- 7.1.3 If radiological survey results indicate that an RWP is required for decontamination, the RSO or duly authorized representative will write the RWP in accordance with CABRERA procedure AP-012.
- 7.1.4 If a survey indicates that decontamination is required, the item should be bagged, wrapped, or contained under the direction of health physics staff. The RPT will label the item with all pertinent information.
- 7.1.5 The SRSL will approve or disapprove the decontamination operation based on conditions of the RWP and the cost effectiveness of the operation versus disposal costs.

7.2 Establishment of the Decontamination Work Area

- 7.2.1 The RSO or duly authorized representative and the SRSL will determine a location for the decontamination area.
- 7.2.2 Once a location has been established, the decontamination area will be set-up, by the RPT, under the direction of the SRSL.
- 7.2.3 The decontamination area should consist of the following:
- Covered (or equivalent) floor surfaces. A double layer of Herculite (or equivalent) may be laid on the floor at the direction of Health Physics staff.
 - Covered (Herculite or equivalent) wall surfaces, if applicable.
 - Engineering controls (HEPA ventilation, vacuum cleaners,

containment tent walls glove bags, etc.), if applicable.

- Engineering controls will be determined on the basis of the ALARA consideration section of the RWP.

Note: All possible engineering controls will be utilized when feasible to minimize the need for respiratory protection equipment.

- Use of safe, sturdy workstations with contamination resistant surfaces and tables that will support decontamination attempts on heavy pieces of equipment.
- Adequate supply of overhead light, adequate electrical/compressed air supply for the operation of electrical/pneumatic driven decontamination equipment.
- Adequate supply of CABRERA approved cleaning solutions and solvents along with an adequate supply of decontamination equipment, such as:
 - Light duty decontamination equipment such as paper wipes, paper towels, masselin towels, etc.
 - Medium to heavy-duty decontamination equipment such as scrub pads, wire brushes steel wool, files, sandpaper, etc.
 - Fully stocked hand tool kit for disassembly of contaminated equipment.
 - Radioactive material storage bags, stickers, etc.
 - Buckets, barrels or drums for the storage of contaminated liquids, sludges, or slurries, if applicable.
 - Blotter paper or sorbent, if applicable.
 - Approved absorbent material such as oil dry, if applicable.
- Storage drums/bags for the storage of contaminated protective clothing under direction of Health Physics staff.
- Proper surveillance instruments (air monitor/sampler, contamination monitor, friskers, dose rate meter, etc.) in accordance with the RWP.
- Adequate supply of personal protective clothing gloves respiratory equipment, etc.
- Step-Off or Double Step-Off Pad, in accordance with the provision of the RWP.
- A designated area, within the decontamination area, for the segregation of radioactive waste.

7.2.4 Once the decontamination area has been established and stocked for operation, the bagged and/or wrapped contaminated or controlled

equipment should be placed in the decontamination work area by the technician, under the direction of the SRS and RPT. Contaminated or controlled items should always be escorted, under the direction of a RPT, to the decontamination area.

7.3 Decontamination

7.3.1 After the decontamination area has been posted, and area access controls established, all requirements of the RWP will be observed.

7.3.2 The preparation for decontamination of a particular tool, material, or piece of equipment will be performed, as follows:

- Position the wrapped item so that the written information on the label/wrapping is visible.

Note: Junior RPTs may operate survey instruments for decontamination monitoring purpose. RPTs will oversee Junior RPTs when survey instruments are in use.

CAUTION: Survey instruments to be used in a known or suspected contaminated area should be protected (wrapped in plastic, poly, etc.) against possible contamination before use.

- The RPTs will direct the removal of the item from the wrapping in such a manner (rolling plastic, poly, etc.) to control the spread of contamination.
- An item that is highly contaminated with loose contamination should be misted with an approved liquid such as demineralized water. The water vapor will wet down the particulate contamination and help prevent the possibility of generating airborne contamination.
- Once the item has been removed from the wrapping and has been properly positioned, discard the wrapping as radioactive waste.

7.3.3 The following decontamination techniques should be considered for the decontamination of equipment, materials, and tools:

- Any equipment with inaccessible areas will be dismantled so that all surfaces are accessible for decontamination and survey.
- Decontamination will be performed in a safe, effective manner.
- The RPT will be notified immediately if the job conditions change (e.g. suspected asbestos found, presence of mercury in a switch or a light bulb, a fluid leak, or any other special circumstances).
- An RPT (or qualified individual) will be assigned as a fire watch if any spark creating decontamination techniques (grinding, etc.) are used and there are combustible materials in the area. There will be

a dedicated fire extinguisher located within the decontamination work area.

- The decontamination area will remain organized and free of debris with the RPT enforcing the "clean-as-you-go" policy, whenever necessary.
- A HEPA vacuum cleaner may be used during the decontamination operation.

7.3.4 Smearable Contamination Removal

When the item is properly positioned for decontamination and the pre-survey has been completed, perform the following:

- Moisten the surface of the item with an approved liquid (e.g. demineralized water).
- Fold a paper or cloth wipe into sections, using one surface of the wipe gently wipe contamination off in one direction away from the user's body. This should reduce the possibility of personnel contamination.
- Re-fold the paper or cloth wipe so that a clean surface is available (this should prevent cross-contamination) and continue until item is ready for survey.
- For some materials, duct tape will effectively remove smearable contamination. Wrap the duct tape loosely around the gloved hand with the adhesive side out. Roll the tape over the contaminated area and re-survey.

7.3.5 Fixed Contamination Removal

There are many techniques that can be used to remove fixed contamination. The general idea is to remove the material, which is fixing the activity to the surface, or remove a very thin layer of the surface material. The techniques selected for a particular decontamination operation is at the discretion of the SRSL and the RPT. The techniques can be divided into the following categories:

- Light hand decontamination
- Abrasive hand decontamination
- Power tool decontamination
- Machine decontamination (use of abrasive bead blasters, grit blasters, high pressure water wash systems, etc.). The specific implementation of these techniques is not included within the scope of this procedure.
- Cleaning solutions/solvents (use of ultrasonic cleaners, acid baths,

electropolishing, etc.). The specific implementation of these techniques is not included within the scope of this procedure.

7.3.6 Light hand decontamination consists of using many of the same techniques as 7.3.4 of this procedure.

7.3.7 Abrasive hand decontamination will be performed in the following manner:

- Remove as much smearable contamination as possible.
- Moisten the surface of the item(s) to contain contamination.

CAUTION: Abrasive measure should only be applied to surfaces that are not critical for operation of devices, which must be restored to working condition. Abrasion of machined surfaces should be minimized if the device is intended to provide its designed operation.

- Use an abrasive cleaning tool (e.g. sandpaper, steel wool, steel brush, hand grinder, etc.) to loosen fixed contamination. Clean in one direction only and clean away from the body to prevent personnel contamination.
- Continue to moisten the surface of the item(s) to contain contamination.
- Remove as much smearable contamination as possible.
- Re-survey.

7.3.8 Power tool decontamination will be performed in the following manner only as a last resort decontamination effort. The use of engineering controls must be used and must be under the guidance of the SRSL/RPT.

Note: When using power tools, always consider the potential of injury due to the hazards involved. Power tools will be used cautiously and in accordance with the manufacturer's recommendations.

Some of the electric power tools that can be used in decontamination operations are:

- Drills to drill out contaminated areas, to disassemble contaminated components and when used with grinding wheels or disks, may be used as an abrasive tool.
- Saws to separate contaminated pieces from clean pieces.
- Grinders to grind fixed contamination from surfaces.
- Electric screwdrivers used in the disassembly of component parts.

7.3.9 Power tool decontamination will be performed in the following manner:

- Using a spray bottle, moisten the surface of the item lightly to contain contamination.

CAUTION: Do not use electric power tools on a wet working surface. Keep liquids away from electric power tools.

- Whenever feasible a containment device (e.g. glove box or bag etc.) should be used to contain the spread of contamination when using power tools for decontamination operations.
- Use the power tool to remove fixed contamination. Clean in one direction only and clean away from the body to prevent personnel contamination.
- Re-survey.

7.4 Post-Decontamination

7.4.1 If the decontamination was successful, the technician will notify the RPT, who will perform a release survey in accordance with CABRERA procedure OP-004.

- If the item satisfies the criteria for release, as stated in OP-004, remove the item to a holding area for disposal and document results. When prepared for disposal, ensure compliance with the provisions of CABRERA procedures AP-014 and AP-013.
- If the item remains contaminated, attempt a second decontamination.
- If the item continues to be contaminated, attempt a third decontamination only at the direction of the RSO or duly authorized representative.

7.4.2 If an item cannot be effectively or economically decontaminated, the SRSL may direct the CABRERA work crew to volume-reduce (reduce to component parts) the equipment, material, or tools as much as possible. If the item is expendable, the individual parts may be surveyed and released in accordance with step 7.4.1.

7.4.3 If an item is volume-reduced to its component parts and decontamination is not feasible, and the item is not needed, the item parts will be considered radioactive waste. Radioactive waste is to be segregated into similar material for shipment purposes by the direction of the PM. The SRSL will direct the segregation of radioactive waste into the following categories:

- Steels, hard metals
- Wood

- Fiber products
- Paper
- Rubber
- Cloth (duct tape is considered a cloth)
- Aluminum, soft metals (brass)
- Glass
- Questionable items (e.g. light bulbs pipe with lead solder, electronic component parts) which could be considered mixed or hazardous waste.
- Other categories, if applicable.

7.4.4 After all decontamination operations have been completed, an RPT will perform a release survey of the decontamination area and de-post the area in accordance with CABRERA procedures OP-001 and OP-019.

8.0 REFERENCES

- Radiation Safety Program, Cabrera Services Inc., Manual
- AP-006, *Respiratory Protection Program*, Cabrera Services Inc., Operating Procedure
- AP-012, *Radiation Work Permits*, Cabrera Services Inc., Operating Procedure
- AP-013, *Packaging Radioactive Material*, Cabrera Services Inc., Operating Procedure
- AP-014, *Classifying Radioactive Waste*, Cabrera Services Inc., Operating Procedure
- OP-001, *Radiological Surveys*, Cabrera Services Inc., Operating Procedure
- OP-004, *Unconditional Release of Material from Radiological Control Areas*, Cabrera Services Inc., Operating Procedure
- OP-019, *Radiological Posting*, Cabrera Services Inc., Operating Procedure
- OP-020, *Operation of Contamination Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-021, *Operation of Alpha-Beta Sample Counting Instrumentation*, Cabrera Services Inc., Operating Procedure
- OP-023, *Operation of Micro-R Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure

9.0 REQUIRED RECORDS

The records generated by the use of this procedure are documented in accordance with the provisions of referenced CABRERA procedures. No new records are created.

10.0 ATTACHMENTS

None



CABRERA SERVICES

RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

OPERATION OF CONTAMINATION SURVEY METERS

OP-020

REVISION 1.0

Reviewed by:

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4/11/13

Date

Approved by:

Henry Siegrist

Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

This procedure provides the methods for Cabrera Services Inc. (CABRERA) to use when operating alpha/beta survey meters in performing contamination surveys. Adherence to this procedure will provide a reasonable assurance that the surveys performed have reproducible results.

2.0 APPLICABILITY

This procedure will be used by CABRERA personnel to measure fixed and removable alpha and/or beta/gamma emitting radioactive material on facility surfaces, equipment, waste packages, personnel, personnel protective clothing, etc.

3.0 DEFINITIONS

- 3.1 Restricted Area – An area containing radioactive material(s) to which access is controlled, by the licensee, to protect individuals from exposure to ionizing radiation.
- 3.2 Alpha/Beta Contamination Survey – A survey technique used to determine fixed and removable alpha/beta contamination.
- 3.3 Acceptance Range – A range of values that describe an acceptable daily instrument source check result.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- 4.1.1 Ensure that thin Mylar or mica windows on the probe face are protected from punctures, during survey operations.
- 4.1.2 In the case of the 44-110 tritium windowless meter, very fragile anode wires are behind the screen. **Note:** Do not allow objects to pass beyond the protective wire screen as damage to the detector can occur.
- 4.1.3 If any instrument inconsistencies are observed (e.g., unusually high or low background readings, source checks outside the acceptable range, etc.), remove the instrument from use, label it "OUT OF SERVICE" and report the condition to the Radiation Safety Officer (RSO), Site Radiation Safety Lead (SRS�), or a duly authorized representative.

4.2 Limitations

Typical operating temperature ranges for detectors are -20 to 50 degrees Celsius (°C) [-4 to 122 degrees Fahrenheit (°F)].

4.3 Requirements

- 4.3.1 Calibration sources must be traceable to the National Institutes of Science and Technology.
- 4.3.2 A battery check, general observation of instrument condition, high voltage check, and source response check will be performed each day before instrument use. An end of daily work activities final verification of instrument operability may also be provided, as required by site work plans.
- 4.3.3 Survey instrument calibrations will be performed by a calibration facility licensed by the Nuclear Regulatory Commission or an Agreement State.
- 4.3.4 Instruments used to perform routine surveys will be used in accordance with the applicable CABRERA administrative and operational procedures. Authorized suppliers of properly calibrated and maintained equipment will supply/calibrate instruments.
- 4.3.5 Prior to field mobilization, project SRSL and identified radiological leads will review approved work plans to ensure identified survey equipment is appropriate. Where practical, equipment familiarization with expected ranges to be used, typical efficiency of detection, and templates to be used in the field with the particular instrument are desired.
- 4.3.6 Personnel performing the survey will ensure that this procedure is the most current and approved revision.
- 4.3.7 Personnel performing the survey will review QC records to ensure that the instrument passed the source-check prior to use.
- 4.3.8 The RSO or their duly authorized representative will review any applicable completed forms and templates for accuracy and completeness.
- 4.3.9 All entries documented on pertinent forms must be dated and initialed by personnel performing the survey to be valid.

5.0 EQUIPMENT

- 5.1 Equipment counting efficiencies should be determined by qualified CABRERA personnel to verify efficiencies of calibrated instruments prior to use. Routine survey equipment includes, but is not limited to:

- 5.1.1 Alpha Surveys – Ludlum Model 43-5 probe and Ludlum Model 3 survey meter or equivalent meter/probe combination.
- 5.1.2 Beta/Gamma Surveys – Ludlum Model 44-9 probe and Ludlum Model 3 survey meter or equivalent meter/probe combination.
- 5.2 Proportional meters may be advantageous for use in situations where the suspected contamination type is unknown or the contamination contains mixed alpha and beta/gamma components. Alpha and beta/gamma contamination can be detected simultaneously with proportional meters. Proportional meters that may be used for a contamination survey include, but are not limited to:
 - 5.2.1 Hand-held meters – Ludlum Model 43-93 probe coupled with a Ludlum Model 2360 meter or an equivalent meter/probe combination.
 - 5.2.2 Gas proportional floor meters – Ludlum Model 43-37 probe coupled with a Ludlum Model 2360 meter or an equivalent meter/probe combination.
 - 5.2.3 Radionuclide-specific meters – Includes meters such as a tritium contamination meter: Ludlum Model 44-110 probe coupled with a Ludlum Model 2221 meter or equivalent meter/probe combination.
- 5.3 Contamination survey meters will be selected based on job-specific requirements identified in site work plans.

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – Ensuring that personnel assigned the task of operating contamination survey meters know and understand this procedure, are adequately trained, and have access to a current copy.
- 6.2 Radiation Safety Officer (RSO) – Verifying that personnel comply with this procedure and are trained in the use of the contamination survey meters described in this procedure.
- 6.3 Site Radiation Safety Lead (SRSL) – During field assignments, the SRSL is responsible for ensuring that this procedure is properly implemented and will review approved work plans to ensure identified survey equipment is appropriate. When the RSO is not on site, the SRSL will act as the RSO's duly authorized representative for radiological issues.
- 6.4 Radiation Protection Technician (RPT) – The RPT operating contamination survey meters is responsible for knowing, understanding, and complying with this procedure and may be required to review approved work plans to ensure identified survey equipment is appropriate.

7.0 PROCEDURE

7.1 Instrument Inspection

7.1.1 Select the contamination survey meter and probe to be used in the survey.

7.1.2 Before each use, perform the following checks:

- Verify the probe/meter has a current calibration label.
- Visually inspect the probe/meter for physical damage or defects.
- Position the meter switch to “BAT” and check to see that the needle falls within the “Bat Test” checkband.
 - If the needle falls below the “Bat Test” checkband, install new battery(ies).
 - If the needle still falls outside the “Bat Test” checkband after the installation of new batteries, tag the instrument “OUT OF SERVICE” and notify the RSO or their duly authorized representative.
- Check alpha detectors for light leaks by pointing the Mylar window of the detector towards a light source (preferably sunlight) and observing for a change in the meter indication.

7.1.3 Remove and tag the instrument “OUT OF SERVICE” if it fails any of the criteria in steps 7.1.1 and 7.1.2 and notify the RSO or their duly authorized representative.

Note: Any defects, damages, or other physical abnormalities require that the instrument be removed from service and the RSO or their duly authorized representative be notified.

7.2 Initial Preparations

7.2.1 Assure that the necessary daily quality control (QC) checks have been performed prior to instrument use.

7.2.2 Obtain the necessary forms, smears, and protective clothing that will be used during the survey. This information can be obtained from the Radiation Work Permit (RWP) or the SRSL.

7.2.3 Position the meter fast/slow (“F/S”) switch to “S” as appropriate.

7.2.4 Position the meter switch to the appropriate range scale.

7.2.5 Ensure that the QC acceptance range has been calculated utilizing CABRERA count rate templates. Current templates can be obtained from the RSO and may be found in the CCDR.

7.3 Daily QC Check

- 7.3.1 Ensure both the source and detector are in documented, reproducible positions which will be used each time this check is performed.
- 7.3.2 Allow the instrument reading to stabilize (approximately 30 seconds) and place the QC source on its designated position, near the detector, and record the value on the QC template.
- 7.3.3 Compare the reading to the acceptance range and response check criteria on the count rate QC template. If the response reading falls outside of the acceptance range, tag the instrument "OUT OF SERVICE" and notify the RSO or their duly authorized representative.

7.4 Contamination Survey Techniques

CAUTION: The window area of the detectors is covered with either a very thin layer of aluminized Mylar or mica. In the case of the tritium windowless detector, small anode wires are present behind the protective screen. Windows and fragile anode wires can be easily punctured or broken when surveying areas that have protruding fragments. Ensure that care is used and that such potentially damaging fragments are removed, prior to performing surveys, or avoided.

Note: To maintain the calibrated detection efficiency, the detector must be held at the appropriate height when surveying, which is determined during calibration. For example, if a beta probe's efficiency was calculated at $\frac{1}{2}$ inch from the calibration source, the detector must be held at $\frac{1}{2}$ inch from the surface being surveyed to maintain calibrated detection efficiency.

Avoid contacting the detector probe to the area being surveyed. This potentially could contaminate the probe.

- 7.4.1 Initially, verify the instrument selector switch is in the x0.1 position or on the lowest scale. Scale settings may change during surveys.
- 7.4.2 For a stationary reading, place the detector over the area to be measured and allow the meter to stabilize. Record the average meter indication in either counts per minute (cpm) or total counts recorded on the ratemeter, in a set time interval, on the radiological survey form/template.
- 7.4.3 For a scan survey, move the detector slowly over the surface, at the rate described in the site work plan and record data, as described by the plan.

7.5 Final Verification

If required by the site work plan, upon completion of work activities, repeat steps 7.1.1 and 7.1.2 as a final verification that the instrument is working properly.

8.0 REFERENCES

- Radiation Safety Program, Cabrera Services Inc., Manual
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure
- OP-001, *Radiological Surveys*, Cabrera Services Inc., Operating Procedure
- OP-009, *Use and Control of Radioactive Sources*, Cabrera Services Inc., Operating Procedure

9.0 REQUIRED RECORDS

Results will be documented electronically in the “Alpha Beta Counting and Smear Worksheet” and Smear and/or Static worksheets should be printed out and filed along with the radiological Survey Form in Attachment B of OP-001. All records, including electronic records, must be managed in accordance with OP-187.

10.0 ATTACHMENTS

None



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

ALPHA-BETA COUNTING INSTRUMENTATION

OP-021

REVISION 1.0

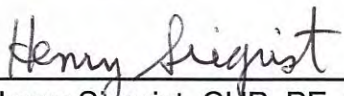
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4/12/13

Date

Approved by:



Henry Siegrist, CHP, PE, Radiation Safety Officer

4/12/2013

Date

1.0 PURPOSE

This procedure provides instruction on the operation and setup of an alpha/beta sample counter. Adherence to this procedure will provide a reasonable assurance that the surveys performed have reproducible results.

2.0 APPLICABILITY

This procedure will be used by Cabrera Services Inc., (CABRERA) personnel operating an alpha/beta sample counter during surveys. Types of surveys that may use an alpha/beta sample counter are:

- Smear surveys performed to determine the removal of alpha and beta contamination on facility surfaces, equipment, waste, source packages, etc.
- Air sample surveys performed in a worker's breathing zone, a work area, or around the perimeter of a work site to determine alpha and beta air concentrations.

3.0 DEFINITIONS

- 3.1 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.
- 3.2 Smear Sample Survey – A technique using a two-inch diameter filter paper to determine removable contamination of alpha and/or beta emitting radioactive material over a 100 cm² area.
- 3.3 Air Sample Survey – A technique where particulates are collected, from a known volume of air drawn through a filter paper, and the concentrations of airborne alpha and beta activity, associated with the particulates, are determined by sample counting.
- 3.4 Chi-Square Test – A statistical test used to evaluate the operation of a sample counter by determining how data fit a series of counts to a Poisson distribution.
- 3.5 Daily Calibration Check – A determination of alpha and beta sample counting efficiency by counting radioactive standards that are traceable to the National Institutes of Science and Technology.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

If any instrument inconsistencies are observed (e.g., unusually high or low background counts, source checks outside the tolerance range), remove the instrument from use and report the condition to the Site Radiation Safety Lead (SRSL) or other duly authorized representative.

4.2 Limitations

This instrumentation should be set up for use in a low background area, as determined by the SRSL or other duly authorized representative.

4.3 Requirements

- 4.3.1 Calibration sources will be traceable to the National Institutes of Science and Technology (NIST).
- 4.3.2 Survey instrument calibrations will be performed by a calibration facility licensed by the Nuclear Regulatory Commission or Agreement State.
- 4.3.3 A battery or power source check, general observation of instrument condition, background check, and source check will be performed each day before instrument use. A second daily quality check that includes all of the above can be performed at the end of daily work activities, if determined to be necessary on a project site.
- 4.3.4 The alpha/beta sample counter will be checked for proper calibration daily with a NIST-traceable source, when in use.
- 4.3.5 Chi-Square tests will be verified and noted as currently valid, when performed.
- 4.3.6 The Radiation Protection Technician (RPT) will ensure that the attachment forms are the most current and approved revisions.
- 4.3.7 The RPT will review completed forms for accuracy and completeness; all entries must be dated and initialed, by the RPT, to be valid.
- 4.3.8 The RSO or their duly authorized representative will review any applicable, completed forms for accuracy and completeness.

5.0 EQUIPMENT

Ludlum Model 2929 sample counter, or equivalent, coupled to a Ludlum Model 43-10-1 alpha/beta scintillation detector with sample tray. Equivalent instruments, based on project need, can be utilized (i.e. Ludlum Model 3030, Canberra Tennelec).

6.0 RESPONSIBILITIES

- 6.1 Project Manager (PM) – Ensuring that personnel assigned the task of operating alpha/beta sample counters know and understand this procedure, are adequately trained in its use, and have easy access to a copy.
- 6.2 Radiation Safety Officer (RSO) – Verifying that personnel comply with this procedure and are trained in the use of alpha/beta sample counters described in this procedure.

- 6.3 Site Radiation Safety Lead (SRSL) – During field assignments, the SRSL is responsible for ensuring that this procedure is properly implemented. When the RSO is not on site, the SRSL will act as the RSO's duly authorized representative for radiological issues.
- 6.4 Radiation Protection Technician (RPT) – The RPTs, using alpha/beta sample counters, are responsible for knowing and complying with this procedure.
- 6.5 CABRERA personnel – Individuals performing work with an alpha/beta counter will know and understand the requirements set forth in the current and approved version of this procedure.

7.0 PROCEDURE

7.1 Instrument Inspection

7.1.1 Before each use, perform the following checks:

- Verify that the instrument has a current calibration label.
- Visually inspect the instrument for physical damage and defects.
- Verify that the high voltage and high voltage potentiometer settings agree with the calibration sheet.

7.1.2 Remove and tag the instrument "OUT OF SERVICE" if it fails any of the above criteria and notify the SRSL or the duly authorized representative.

Note: Any defects, damages or other physical abnormalities require that the instrument be removed from service and the SRSL, or other duly authorized representative, be notified.

7.2 Chi-Square Test

Note: The Chi-Square Test is not always required, but is a good verification check on the instrument operability and count setup routines, at the beginning of a project. A Chi-Square Test is only required whenever significant changes have been made to the equipment, such as a detector tube (Model 43-10-1) change out and subsequent recalibration or decontamination of the equipment. Contact the SRSL for guidance.

7.2.1 Set up the instrument in a low background area.

7.2.2 Ensure the high voltage potentiometer is positioned according to the posted instrument label. Adjust if necessary.

7.2.3 Set the time multiplier switch to "x1".

7.2.4 Set the instrument-preset timer to one (1) minute.

7.2.5 Insert the alpha calibration standard into center of the sample tray, slide

the sample tray under the detector and depress the "COUNT" button to obtain a one minute count.

- 7.2.6 Upon completion of the count, record digital counts appearing in the alpha display in the "Xi" column on the Chi-Square Data Sheet (Attachment A).

Note: Approved electronic templates may be used in place of this form as long as the equivalent information is provided as described in this procedure.

- 7.2.7 Repeat counting sequence, ensuring that the count source is removed and repositioned within the count holder, thus ensuring count position variability consistent with actual use counting. No instrument settings can be changed during this count sequence. Continue until a total of 20 counts have been taken and recorded in the "Xi" column on the Chi-Square Data Sheet (Attachment A).
- 7.2.8 Add the 20 counts recorded in the "Xi" column and record in the "Sum" column. Then divide by 20 to obtain the mean number of counts (X_m) and record on the line " X_m ."
- 7.2.9 Calculate the individual count "Xi" difference from the mean (X_m) value and record in the " $(X_i - X_m)$ " column the Chi-Square Data Sheet for all 20 values.
- 7.2.10 Calculate $(X_i - X_m)^2$, sum the " $(X_i - X_m)^2$ " column, and record on the Chi-Square Data Sheet.
- 7.2.11 Calculate the value of Chi-Square using the following formula:

$$\chi^2 = \frac{\sum (X_i - X_m)^2}{X_m}$$

- 7.2.12 The value of Chi-Square should be between 8.91 and 32.8 (represents a probability between 0.025 and 0.975). Record this value at " χ^2 ." If the Chi-Square value falls outside this range, contact the SRSL or other duly authorized representative for further instructions.
- 7.2.13 Sign and date the Daily Calibration Check form (Attachment B) and forward the results to the SRSL or other duly authorized representative for review. Keep an electronic copy in the project files.
- 7.3 Initial Quality Control Check
- 7.3.1 Ensure the high voltage potentiometer is positioned according to the posted instrument label. Adjust slowly, if necessary.
- 7.3.2 Set time multiplier switch to "x1."
- 7.3.3 Set the instrument-preset timer to the pre-determined background count

time set by the SRSL. Counter MDAs need to be setup for 50% of the release limit for the given isotope.

- 7.3.4 Record the source type to be used and corresponding serial number on the proper line indicated on the Daily Calibration Check form. Use separate rows of the form for each source efficiency to be calculated.

Note: Approved electronic templates may be used in place of this form as long as the equivalent information is provided, as described in this procedure.

- 7.3.5 Insert a blank sample into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a background count.
- 7.3.6 Record the background count rate in the cell labeled "Bkg Count Time" on the Daily Calibration Check form.
- 7.3.7 Repeat the counting sequence until a total of 10 counts have been taken and recorded in the "Bkgd" row on the Daily Calibration Check form. Calculate the average of the 10 counts and the standard deviation (σ) for the average count.
- 7.3.8 Reset the instrument-preset timer to the pre-determined source count time set by the SRSL.
- 7.3.9 Remove the blank sample and insert the alpha or beta calibration standard into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a source count.

Note: Be sure to turn the source approximately 90 degrees with every count as this will give a wider range since not all sources are uniform in nature.

- 7.3.10 Record the source count rate in the columns labeled "Source #1 Count Time" and "Source #2 Count Time," respectively, on the Daily Calibration Check form
- 7.3.11 Repeat the counting sequence until a total of 10 counts have been taken and recorded for both alpha and beta check sources in the "Source #1" and "Source #2" rows on the Daily Calibration Check form. Calculate the average of the 10 counts for each source and (σ) for the average counts.
- 7.3.12 Remove calibration standards and place in source holders.
- 7.3.13 Initial and date the Daily Calibration Check form and forward the results to the SRSL, or other duly authorized representative, for review.

- 7.3.14 Record all data electronically in an alpha/beta counting spreadsheet and keep in project files. All records, including electronic records, must be managed in accordance with OP-187.

7.4 Daily Calibration Check

- 7.4.1 Ensure the high voltage potentiometer is positioned according to the posted instrument label. Adjust slowly, if necessary.
- 7.4.2 Set time multiplier switch to “x1”.
- 7.4.3 Set the instrument-preset timer to the pre-determined background count time, set by the SRSL.
- 7.4.4 Record the source type to be used and corresponding serial number on the proper line indicated on the Daily Calibration Check form. Use separate rows of the form, for each source efficiency, to be calculated.
- 7.4.5 Insert a blank sample into the center of the sample tray, slide the sample tray under the detector and depress the “COUNT” button to obtain a background count.
- 7.4.6 Calculate and record the background total counts and count rate in the columns labeled “Bkgd” and “Bkg Count Time” respectively on the Daily Calibration Check form. The background count rate in CPM (counts per minute) can be calculated as follows:

$$CPM = \frac{Total\ Counts}{Total\ Time}$$

- 7.4.7 Remove the blank sample and insert the alpha or beta calibration standard into the center of the sample tray, slide the sample tray under the detector and depress the “COUNT” button to obtain a source count.
- 7.4.8 Upon completion of the measurement, calculate and record the total counts and count rate in the columns labeled “Total Counts” and “CPM” respectively, under ‘Source’ information on the Daily Calibration Check form. The count rate (CPM) can be calculated as listed in Step 7.4.6.
- 7.4.9 Calculate Net Source CPM, as below, and record on the Daily Calibration Check form under “Net CPM.”

$$Net\ Source\ CPM = CPM - BKG\ CPM$$

Note: Obtain activity (DPM) value from the source certification paperwork. Decay correct activity, if needed.

- 7.4.10 Use the source disintegration per minute (DPM) to calculate the 4 pi efficiency, as shown below, and check against calibrated efficiency. This data can be recorded in the electronic template.

$$\% \text{ Efficiency} = \frac{\text{Net Source CPM}}{\text{DPM}} * 100$$

- 7.4.11 To calculate the efficiency, for the next source, remove the current source standard and insert a new source standard, then repeat steps 7.4.1 through 7.4.10, as necessary.
- 7.4.12 Remove calibration standards and place in source holders.
- 7.4.13 Generate an excel control chart tracking the daily efficiencies and notify the SRS or duly authorized representative if any point falls outside of 2σ variance.

Note: For the first day on the control chart, use five data points to begin the trend line.

8.0 REFERENCES

- Radiation Safety Program, Cabrera Services Inc., Manual
- AP-005, ALARA, Cabrera Services Inc., Operating Procedure
- OP-001, *Radiological Surveys*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure
- U.S. Nuclear Regulatory Commission, Consolidated Guidance About Material Licenses, Vol. 11 - *Program-Specific Guidance About Licenses of Broad Scope*, NUREG-1556, (1999).

9.0 REQUIRED RECORDS

The following records must be maintained whether paper or electronic:

- Chi-Square Data Sheet (when applicable)
- Daily Calibration Check
- Excel calibration records

10.0 ATTACHMENTS

Attachment A – Chi-Square Data Sheet

Attachment B – Daily Calibration Check

Attachment A

Chi-Square Data Sheet

Chi-Square Data SheetDate: _____ Instrument: _____ Serial Number: _____ χ^2 _____

Alpha Source No./Activity: _____ Beta Source No./Activity: _____

Count Number	X_i	$(X_i - X_m)$	$(X_i - X_m)^2$
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
Sum		////////////////////////////////////	
X_m		////////////////////////////////////	////////////////////////////////////

Prepared By: _____ Date: _____
Print/SignReviewed By: _____ Date: _____
Print/Sign

Attachment B

Daily Calibration Check

Daily Calibration Check

[illegible]



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

OPERATING PROCEDURE

FOR

PERSONNEL FRISKING AND DECONTAMINATION

OP-243

Revision 2.0

Reviewed by:

David Wunsch

David Wunsch, Quality Assurance Manager

4/12/13

Date

Approved by:

Scott Hay

Scott Hay, Principal Health Physicist

4/11/2013

Date

1.0 PURPOSE

The purpose of this procedure is to provide the steps necessary to properly perform personnel frisking and decontamination, and to provide Cabrera Services Inc. (CABRERA) personnel with requirements for contamination control and decontamination implements.

2.0 APPLICABILITY

The protocols presented here apply to personnel frisking and decontamination. This procedure provides the requirements and proper techniques to be adhered to while performing personnel frisking and decontamination from clothing, skin and/or wounds. Adherence to this procedure will provide adequate contamination controls while maintaining CABRERA'S goals for control of radiation exposure As Low As Reasonably Achievable.

3.0 DEFINITIONS

- 3.1 Radiological Survey – An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal or presence of radioactive material or other sources of radiation.
- 3.2 Contamination Survey – A survey used to determine fixed and removable radioactive contamination on personnel, components and structures.
- 3.3 As Low As Reasonably Achievable (ALARA) – An approach to maintaining exposures to radiation as far below the federal limit as technical, economical and practical considerations permit.
- 3.4 Bioassay – A direct measurement of radioactive material in the body using In-vitro and In-vivo techniques.
- 3.5 In-vitro – An examination of discrete samples of tissue or fluids outside the body (i.e., urine and hair samples).
- 3.6 In-vivo – An examination of the individuals body tissues as a whole without taking discrete samples (i.e., whole body counter).
- 3.7 Internal Dose Assessment – An evaluation process involving the dose, at which human tissues are subjected to radiations from radionuclides, that has entered the body via inhalation, ingestion, injection or other routes. This can be measured via air sampler data or bioassay.
- 3.8 Frisking – A process of monitoring for radioactive contamination using handheld instrumentation on personnel or their clothing performed before exiting a known or potentially contaminated area.
- 3.9 Decontamination – The removal of unwanted radioactive material from personnel, clothing, equipment, or other materials.
- 3.10 Low level radioactive waste – A broad category of material that has become

contaminated with radioactive material, but does not belong in the categories of: "high-level" waste; uranium mill residues or tailings; transuranic material; naturally-occurring radioactive material; or, material produced in an accelerator.

4.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

4.1 Precautions

- 4.1.1 Ensure that all necessary steps are taken to limit the further spread of contamination to work areas, personnel, equipment, and materials.
- 4.1.2 Ensure that instruments are used and maintained in accordance with operating procedures or manufacturer's recommendations, and are in current calibration.
- 4.1.3 Ensure that all survey instruments are inspected for serviceability and checked against check sources each day they are in use, to verify they are in proper working condition.
- 4.1.4 Ensure that all radiation surveys and reports are to be reviewed by the Site Radiation Safety Lead (SRSL), or duly authorized representative, for accuracy and completeness.

4.2 Limitations

- 4.2.1 Only Health Physicists, Radiation Protection Technicians, or authorized personnel and qualified medical personnel are permitted to decontaminate personnel with skin contamination.
- 4.2.2 Contaminated wounds of any kind must be decontaminated under the supervision of the SRSL or duly authorized representative.

4.3 Requirements

- 4.3.1 Emergency medical care must be administered immediately for injuries affected by radioactive materials. Medical treatment of injuries will take precedence over radiological considerations.
- 4.3.2 Personnel skin contamination events must be reported to the Corporate Health Physicist (Corporate HP) and a duly authorized representative (e.g. SRSL) to determine whether a skin dose assessment must be performed. An evaluation is required to accurately assess the need for medical action when personnel contamination exceeds background by 1,000 disintegrations/minute (dpm) alpha or 5000 dpm beta-gamma.
- 4.3.3 Internal dose assessment may be required by the Corporate HP under the following circumstances:
 - Nasal or mouth smears exceeding 20 dpm alpha, or 1,000 dpm beta-gamma, above background.

- Any detectable radioactivity above background on nasal or mouth smears, and if the skin or clothing contamination exceeds 1,000 dpm alpha or 5,000 dpm beta-gamma.
 - Facial contamination exceeds 1,000 dpm alpha or 5,000 dpm beta-gamma, above background.
- 4.3.4 An in-vivo and/or in-vitro examination may be required, at the discretion of the Corporate HP, if the internal dosimetry evaluation exceeds 100 millirem (mrem) Committed Effective Dose Equivalent (CEDE).
- 4.3.5 When in-vitro examinations are required as a result of an incident, the Corporate HP will be immediately be notified and the affected personnel will be given a bioassay kit and continue supplying samples until directed to stop by the Corporate HP or duly authorized representative.
- 4.3.6 If in-vivo bioassay (via whole body counter) is required, the affected personnel will be transported directly to the nearest whole body counter facility, as soon as possible, after the incident. Results of this evaluation will be forwarded to the Corporate HP immediately for review and analysis.

5.0 EQUIPMENT

- Latex or equivalent gloves.
- Tape with strong adhesive for decontamination (e.g., duct tape).
- Ratemeter with alpha/beta sensitive detector (Ludlum model 43-89/93 or equivalent).
- Ratemeter with beta/gamma sensitive detector (Ludlum model 44-9 Geiger-Mueller [GM] or equivalent).
- Smears and/or large area wipes (Masslinn).
- Nasal smears or Q-tips for facial contamination.
- Mild detergent (e.g., baby shampoo or equivalent).

6.0 RESPONSIBILITIES

- 6.1 Corporate Health Physicist (Corporate HP) – Responsible for identifying radiation control areas and frisking station locations for a project, evaluating frisking results when contamination has been identified, performing an internal dose assessment and calculating the CEDE, determining the need for in vivo and in vitro bioassay, determining when medical attention for radiation exposure is required, assigning the total dose associated with exposure to contamination, determining the source of contamination, and ensuring similar exposures are reduced or eliminated.

- 6.2 Project Manager (PM) – Responsible for ensuring that the assigned personnel know and understand this procedure and have access to a current copy.
- 6.3 Radiation Safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the use of personnel frisking and decontamination.
- 6.4 Site Radiation Safety Lead (SRSL) – Responsible for training personnel on this procedure, establishing frisking stations and radiation control area boundaries designated by the Corporate HP, monitoring compliance ensuring its proper implementation, reviewing instrument logs to ensure proper operation of equipment, performing or overseeing decontamination of personnel, investigating potential sources of contamination and preventing additional exposures or spread of contamination..
- 6.5 Field Supervisor – Responsible for ensuring daily implementation of this procedure. When the SRSL is not on-site the Field Supervisor will act as the authorized representative for radiological issues.
- 6.6 Radiation Protection Technician (RPT) – Responsible for knowing, understanding, and complying with this procedure.

7.0 PROCEDURE

- 7.1 The Corporate HP will identify radiation control area boundaries and locations of frisking stations at all access points based on the project requirements.
- 7.2 The Corporate HP will identify frisking requirements based on the radionuclides of concern, expected activity levels, expected chemical and physical form of contamination, and activities to be performed. The default frisking requirements are total body frisk for alpha/beta and beta/gamma contamination. Alternative frisking requirements may include less than total body frisk (e.g., hands and feet only) or nuclide-specific screening (e.g., alpha/beta only or beta/gamma only).
- 7.3 All personnel exiting a radiation control area are required to frisk for contamination. CABRERA-trained radiation workers are allowed to self-perform frisking. All other personnel will be frisked by a CABRERA-trained RCT.
- 7.4 In case of a medical emergency the SRSL will issue a stop work order and have all non-emergency personnel exit the area. If the injured person can be safely moved, move them out of the contaminated area. If the injured person cannot be moved, the SRSL will escort emergency personnel to the injured person and assist with contamination control during the emergency.
- 7.5 Frisking is performed by positioning the detector approximately one centimeter (1 cm) above the skin surface and slowly moving the detector until the entire area to be frisked has been covered. The detector should move at a rate of approximately one detector width per second. Listen to the audio output of the detector during frisking. If an increase in the count rate is detected, hold the detector stationary for at least 30 seconds to determine if there is an area of

contamination at that location. A total body frisk should take at least 3 minutes.

- 7.6 Areas of concern during frisking include areas that are most likely to come into contact with radiation during work activities such as hands, feet, knees, elbows, and the seat of the pants. Areas with the highest potential for exposure are also of interest, such as the mouth, nose, and face.
- 7.7 Contamination may be removed from personnel clothing by patting the **affected area with tape and resurveying to determine if additional decontamination is necessary**. If contamination cannot be reduced to levels below the applicable levels and ALARA, the clothing will be removed from service for disposal as low-level radioactive waste.
- 7.8 If personnel require skin decontamination, they will be decontaminated by health physics personnel and/or qualified medical personnel. The following are protocols for performing skin decontamination.
 - 7.8.1 Medical treatment of severe injuries will take precedence over radiological considerations.
 - 7.8.2 Emergency medical care should be administered immediately for injuries affected by radioactive materials.
 - 7.8.3 Personnel skin contamination must be reported to the Corporate HP if levels exceed those stated in Section 4.3. The Corporate HP will determine if a skin dose assessment must be performed.
 - 7.8.4 The SRSL and Corporate HP will provide medical personnel with any necessary radiological support regarding radiological contamination control and monitoring of the patient, medical staff, and medical facilities.
 - 7.8.5 The treatment of radiologically contaminated injuries should include the following:
 - Treatment of contaminated wounds by medically qualified individuals,
 - Monitoring of wounds, bandages, and medical instruments and equipment for contamination, and
 - Radionuclide identification.
 - 7.8.6 Contaminated wounds, of any kind, will be decontaminated under the guidance of the SRSL or Corporate HP. Severe wounds will be decontaminated by medical personnel with health physics personnel providing guidance and support.
 - 7.8.7 Survey the affected area and record the types and initial levels of contamination on the Personnel and Clothing Contamination Report (Attachment A). If possible, remove particles of contamination with tape and save the particles for evaluation. The SRSL will prepare a

- report documenting the number, type, and locations of measurements and the results of the measurements. This report will be maintained in the employee's radiation exposure file.
- 7.8.8 Attempt localized washing with warm water and soap while ensuring that contamination is not spread to uncontaminated parts of the body.
 - 7.8.9 Resurvey the affected area to determine if the contamination has been reduced to levels below the applicable levels and ALARA.
 - 7.8.10 If contamination persists, decontamination attempts and resurveys may be repeated multiple times but should stop if these methods are ineffective or skin irritation occurs.
 - 7.8.11 If the area cannot be decontaminated sufficiently with soap and water, the area may be covered (e.g. with plastic or by wearing latex gloves) to allow contamination to be removed through perspiration.
 - 7.8.12 Depending on the levels of contamination encountered, an internal dosimetry evaluation (AP-008, *Dosimetry Program*) and/or bioassay (AP-007, *Bioassay Program*) may be required. See Section 4.3 for specific details.
- 7.9 The SRSL will interview all personnel with contamination on skin or clothes exceeding the limits listed in Section 4.3.3 and attempt to identify the source of the contamination. Common sources of contamination on personnel include unexpected radiological conditions in the work area, damaged or non-functioning personal protective equipment (PPE, such as ripped gloves), and improper work technique.
- 7.9.1 If unexpected radiological conditions are encountered the SRSL will suspend work in that area or on that task. The Corporate HP will review the available information and make recommendations to adjust PPE requirements or modify the tasks being performed to minimize the chance for contamination of personnel and equipment, and control the potential spread of contamination.
 - 7.9.2 If PPE is damaged the SRSL and Corporate HP will review the current PPE requirements and make necessary changes to the PPE requirement. If PPE is non-functioning the damaged equipment will be replaced. All similar PPE will be inspected and replaced if necessary.
 - 7.9.3 If personnel are performing a task improperly the SRSL will restrict that person from access to radiological control areas and tasks involving radioactivity. The person will be instructed in the proper method for performing tasks in a radiological control area to minimize exposure to radiation and control the spread of contamination. The SRSL will observe the person performing the necessary tasks in an uncontaminated area to evaluate the effectiveness of the training. The person will not be re-instated for work in radiation control areas without written approval from the Corporate HP.

- 7.9.4 If the source of contamination is not identified the SRS� will notify all personnel working in the area that contamination was observed and initiate additional radiological monitoring (e.g., static measurements, smears, air monitoring as required) during the next shift to identify the source of contamination.
- 7.10 The Corporate HP will document the results of the contamination investigation in a letter report describing the levels of contamination observed, the sources of contamination identified including measurements performed, and documenting any corrective actions implemented to prevent additional contamination of personnel and control the spread of contamination.

8.0 REFERENCES

- AP-005, *ALARA*, Cabrera Services Inc., Operating Procedure
- AP-007, *Bioassay Program*, Cabrera Services Inc., Operating Procedure
- AP-008, *Dosimetry Program*, Cabrera Services Inc., Operating Procedure
- AP-011, *Emergency Response*, Cabrera Services Inc., Operating Procedure
- OP-001, *Radiological Surveys*, Cabrera Services Inc., Operating Procedure
- OP-020, *Operation of Contamination Survey Meters*, Cabrera Services Inc., Operating Procedure
- OP-187, *Records Management*, Cabrera Services Inc., Operating Procedure

9.0 REQUIRED RECORDS

- Personnel and Clothing Contamination Report (Attachment A).
- All instrument logs containing inspections for serviceability, checks against check sources and calibration data as specified in OP-020.
- Letter report describing any observed contamination and documenting all investigations and corrective actions implemented to prevent additional contamination of personnel and control the spread of contamination.

10.0 ATTACHMENTS

Attachment A – Personnel and Clothing Contamination Report

Attachment A

Personnel and Clothing Contamination Report

PERSONNEL AND CLOTHING CONTAMINATION REPORT
(Page 1 of 2)

Contaminated Individuals Name:	Date:	Time:	RWP/Task #:
Project Name & Number:	Approx. surface area of contamination (cm ²):		Technician/Supervisor:
Approximate length of time that individual remained contaminated, including decontamination attempts:		Type of Contamination: <input type="checkbox"/> Localized <input type="checkbox"/> Discrete Particle <input type="checkbox"/> Distributed	

Individual was wearing:

☐ Street Clothes ☐ Full Protective Clothing ☐ Lab Coat ☐ Scrubs

Probable Reason for Contamination (see attachment 1):

☐ Poor Work Practices ☐ Inadequate HP Controls ☐ Inadequate Protective Clothing

☐ Failure of Protective Clothing ☐ Contaminated PCs ☐ Perspiration Through PCs

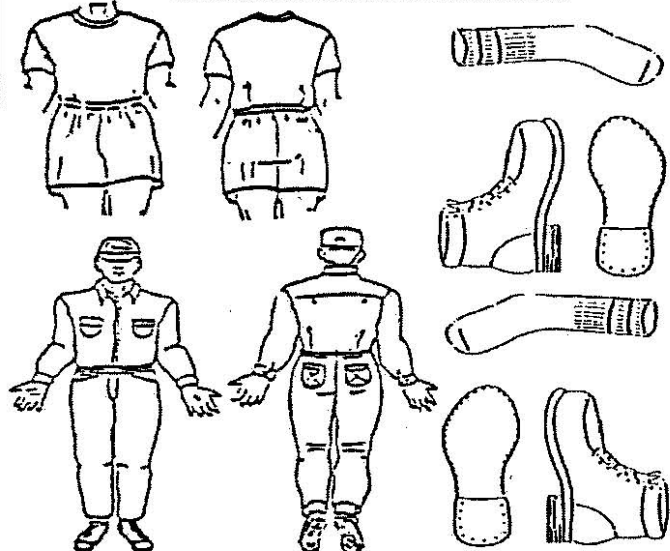
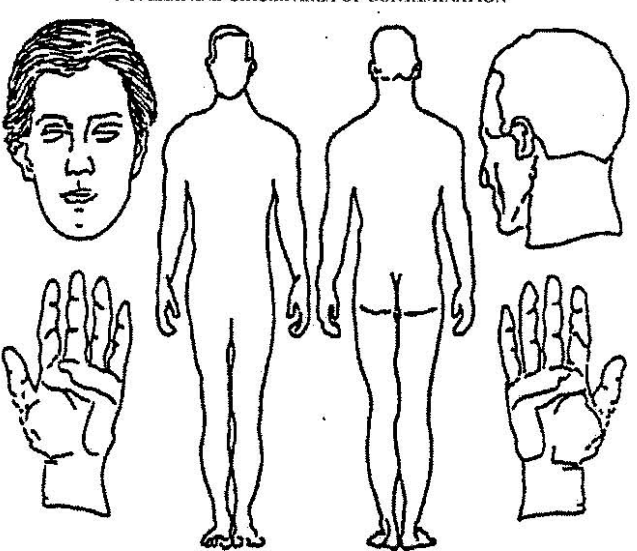
☐ Planned Contamination ☐ Accidental ☐ Spread From Adjacent Work Area

Contamination

Comments:

Action Taken:

PERSONNEL AND CLOTHING CONTAMINATION REPORT**(Page 2 of 2)****CLOTHING CONTAMINATION
CONTAMINATION****SKIN**

NUMBER AND CIRCLE AREA OF CONTAMINATION	NUMBER AND CIRCLE AREA OF CONTAMINATION
	
If a discrete particle is on clothing, provide survey through clothing, if possible.	

Location No (mark on diagram)	Counts per Minute (cpm)	1 st Decontamination		2 nd Decontamination		3 rd Decontamination	
		Method	Results (cpm)	Method	Results (cpm)	Method	Results (cpm)

Instrument Type:	Serial No:	Cal Due Date:	Efficiency:	Background (cpm):
Instrument Type:	Serial No:	Cal Due Date:	Efficiency:	Background (cpm):

Disposition of clothing: _____

Surveyed by: _____

Print

Sign

Date Released

Reviewed by: _____

Print

Sign

Date

Appendix D

Waste Management Plan

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Hill Air Force Base Performance-Based Remediation

WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Waste Management Plan

Hill Air Force Base
Contract No: FA8903-09-D-8560
Task Order 0006

Prepared for:
Air Force Civil Engineer Center
2261 Hughes Avenue, Suite 155
JBSA Lackland Air Force Base, Texas 78236-9853

Prepared by:
EA Engineering, Science, and Technology, Inc.
2363 N. Hill Field Road, Suite 104
Layton, Utah 84041

and



CABRERA SERVICES
RADIOLOGICAL • ENGINEERING • REMEDIATION

1106 North Charles Street, Suite 300
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AUGUST 2014

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Attachments

- A US Ecology/EnergySolutions Waste Acceptance Criteria
- B Sample Waste Documentation
- C Disposal Facility Directions/Travel Route

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Acronyms and Abbreviations

AFB	Air Force Base
Cabrera	Cabrera Services, Inc.
CFR	Code of Federal Regulations
DOT	U.S. Department of Transportation
EA	EA Engineering, Science, and Technology, Inc.
LMTA	Little Mountain Test Annex
NRC	Nuclear Regulatory Commission
OP	Operating procedure
RD/RAWP	Remedial Design/Remedial Action Work Plan
RCA	Radiological Control Area
WAC	Waste Acceptance Criteria
WMP	Waste Management Plan

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1.0 Introduction

This Waste Management Plan (WMP) was developed by EA Engineering, Science, and Technology, Inc. (EA) and Cabrera Services, Inc. (Cabrera) to support investigation, remediation, decommissioning, and site closeout at the Little Mountain Test Annex (LMTA) Magnesium-Thorium Disposal Trench Site, Hill Air Force Base (AFB), in Ogden, Utah, under the Hill AFB Performance-Based Remediation Contract No. FA8903-09-D-8560, Task Order 0006. Investigations have confirmed radiological impact to surface and subsurface soil at the Magnesium-Thorium Disposal Site, which will be referred to herein as Site WR111. This WMP addresses the work to be performed in support of waste characterization, transportation, and disposal at the site during remedial action activities and is an appendix to the Remedial Design/Remedial Action Work Plan (RD/RAWP) for the site.

1.1 Plan Objectives

Site WR111 is located within the LMTA, which is approximately 15 miles northwest of Hill AFB and adjacent to the Great Salt Lake (Figure 1-1 of the RD/RAWP). The disposal trench is approximately 200 × 150 feet in area and is enclosed by a chain-link fence in the southeastern corner of the LMTA (Figure 1-2 of the RD/RAWP).

Historical information indicates that magnesium-thorium scrap and waste materials associated with the manufacture of controls, accessories, and engine parts were burned/buried in the disposal trench from 1959 through 1961. Results of a recent investigation at the site (2007-2009) indicate that site soils within the fenced area have been impacted with thorium-232 and decay progeny above background levels (AECOM 2009). A supplemental characterization survey performed in 2013 (EA/Cabrera 2014) confirmed that radiological contamination extended to the east of the WR111 fenceline, and identified two additional radionuclides (radium-226 and thorium-230) of concern for the site. Results of groundwater sampling that was conducted in 2006 indicate that there are no radiological impacts to groundwater from the thorium alloy scrap metal or potential cutting oil (Parsons Infrastructure and Technology Group, Inc. 2007). A detailed discussion of the radionuclides of concern for Site WR111 is provided in Section 2.3 of the RD/RAWP.

Sampling for chemical constituents has also been conducted at Site WR111. Results from the 2007-2009 investigation showed that no volatile organic compounds or semivolatile organic compounds were detected above reportable limits in soil (AECOM 2009). In addition, during the 2013 supplemental survey by EA/Cabrera, soil sampling was conducted to assess hazardous waste characteristics and support selection of an appropriate offsite disposal facility.

During remedial action activities, radiologically-impacted soil at Site WR111 will be excavated and processed, packaged and transported to an offsite disposal facility in accordance with the selected remedial alternative as defined in the Decommissioning Plan (EA/Cabrera 2014).

The purpose of this WMP is to establish requirements for the following:

- Excavating and handling radioactive waste, including soils, at the Site
- Preparing this waste to meet the waste acceptance criteria (WAC) of the selected offsite disposal facility
- Packaging and shipping this waste for offsite disposal at the selected facility.

Waste will be appropriately characterized to identify radiological contaminants and contaminant concentrations as well as non-radiological hazardous waste characteristics as required by the U.S. Environmental Protection Agency in Title 40 Code of Federal Regulations (CFR), Parts 262 and 265. Characterization of waste for radiological and non-radiological hazardous constituents will ensure waste is acceptable for disposal offsite. Waste will either be shipped to U.S Ecology Idaho, Inc. located in Grand View, Idaho or EnergySolutions, located in Clive, Utah. Both of these offsite disposal facilities are licensed to accept the radiological waste generated at the site.

Waste will be prepared, packaged, and transported in accordance with applicable U.S. Department of Transportation (DOT) requirements in 49 CFR, Subchapter C, and the WAC for the offsite disposal facility. The US Ecology, Inc. WAC is provided in Attachment A-1, and the EnergySolutions WAC is provided in Attachment A-2.

2.0 Organizational Structure

Site project organization and responsibilities are presented in the Site-Specific Supplemental Quality Assurance Project Plan (Appendix A of the RD/RAWP) and the Decommissioning Plan (EA/Cabrera 2014).

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3.0 Waste Management

The process for initial identification of radiological wastes, waste removal and initial segregation, and preparation of waste for disposal are discussed in the following sections.

3.1 Waste Characterization

Sample results of soils collected during the characterization survey in 2013 are documented in the Decommissioning Plan (EA/Cabrera 2014) and were provided to US Ecology, Inc. and EnergySolutions. Radiological results included thorium-230, thorium-232, and radium-226 concentrations for each sample. Three samples were also collected and analyzed via a full suite Toxicity Characteristic Leaching Procedure analysis (consisting of Resource Conservation Recovery Act metals, volatile organic compounds, semivolatile organic compounds, polychlorinated biphenyls, pesticides and herbicides, and cyanide) and ignitability, corrosivity, and reactivity. Sample results were utilized to assess if any chemical or radiological constituents in WR111 soils exceed WAC limits for the proposed offsite disposal facilities. Based on the results, it has been concluded that radiological and non-radiological results meet the WAC for both US Ecology, Inc. and EnergySolutions. Visual and radiological screening will be used throughout the excavation of trench soils to identify any changes in these assumptions. Additional sampling will be conducted, if necessary, to confirm continued compliance with WAC criteria.

3.2 Waste Handling

Contaminated soils will be excavated from the WR111 trench and staged in the western end of the RCA as described in Section 4.2.3.1 of the RD/RAWP. The Radiological Staging Area is shown in Figure 4-1 of the RD/RAWP. As excavation continues, stockpiled soils will be loaded into end-dump trucks or dump trucks that back up to the western edge of the RCA (Figure 4-1). Waste packaging and transportation are described in the following sections.

3.3 Waste Packaging

Radiological wastes will be transported in tarped end-dump trucks or dump trucks. End-dump trucks have a maximum load capacity of approximately 22 tons, and dump trucks have a maximum load capacity of approximately 15 tons.

Transport vehicles will be radiologically surveyed for release from the site in accordance with Cabrera Radiation Safety Program Operating Procedure OP-004, Unconditional Release of Materials from Radiological Control Area (Cabrera 2000), which incorporates U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.86 criteria (NRC 1974). These criteria include contamination (less than 20 and 200 disintegrations per minute per 100 square centimeters for removable alpha and beta activity, respectively) limits. Radiation level will also be measured in accordance with the DOT criteria in 49 CFR 173, Subpart I, Class 7 (Radioactive) Materials. Transport vehicles must be less than 0.5 millirem per hour dose rate at any point on the external surface of the package. These are the most restrictive DOT regulations for a radioactive material shipment, which apply to shipping excepted packages for limited quantity of radioactive material. Each package must be designed and prepared such that, under conditions normally incident to transportation, the specified radiation levels are not exceeded. The levels of removable contamination on the external surfaces of the packages and vehicles will be determined by

smearing an area of 300 square centimeters of the surface and converting the measured results to the limits listed above, and must also be kept as low as reasonably achievable.

The following will be performed for each truck in preparation for waste loading, loading, and shipment.

Dump Truck Preparation for Loading

- Upon arrival of an empty truck and prior to loading, perform radiological dose rate and removable activity surveys of exterior surfaces by Cabrera Health Physics personnel
- Verify the physical integrity of the truck bed and tarp to ensure there are no holes or damage, that the tarping system is operational, and the general appearance is satisfactory
- Verify the truck is empty with no residual soil, material or other debris
- Verify permanent markings, if applicable, are readily readable
- Remove or obscure any non-permanent markings or unnecessary placards
- Ensure water is removed, when present.

Dump Truck Loading

- Soil will be loaded carefully to avoid spilling soils outside of the truck bed.
- The laborer attending to the loading of the truck will ensure that any excess soils are brushed off of the tailgate or top of the bed.
- Soils will be loaded in a way to minimize void spaces and conserve space in each load.
- After the truck is filled, the tarp will be lifted over the truck bed before the truck moves to avoid any potential wind-blown dust from the load.
- The front-end loader operator will record the total weight of the load from the bucket scale and will notify the waste broker, or designee, of the weight so the bill of lading can be filled out.

Dump Truck Preparation for Shipment

- Radiological surveys will be completed and documented to verify DOT limits (listed above) are met.
- DOT required markings, labels, and placards will be applied as necessary.
- Shipping papers will be completed (non-hazardous waste manifest for trench soils).
- The open top of load will be covered completely by a tarp and checked to ensure that the tarp is free of holes or penetrations.

3.4 Waste Transportation

Low activity radiological wastes will be transported via end-dump truck or dump truck by utilizing US Ecology, Inc. or EnergySolutions as the waste transportation subcontractor. The Cabrera waste broker will ensure that each waste shipment is accompanied by properly completed shipping documents and use appropriate documents as required by federal, state, and local laws and regulations. If US Ecology, Inc. is selected for waste disposal, then the only form that is anticipated being used is a non-hazardous waste manifest/bill of lading. An example of the non-hazardous manifest is provided in Attachment B. If EnergySolutions is selected for waste disposal, then NRC Forms 540 and 541 will be completed for the shipment in accordance with the EnergySolutions WAC. Examples of these forms are provided in Attachment B.

All completed documents for non-hazardous radiological wastes requiring shipper's and waste certifications will be signed by the Cabrera waste broker prior to release of each shipment. Prior to shipment, the Site Manager and waste broker shall:

- Verify all waste packaging records are complete
- Conduct and document a visual inspection of the conveyance and ensure any discrepancies are corrected
- Verify the transport is properly marked, labeled, and placarded, as applicable
- Review all paperwork to ensure legibility
- Verify that the transporter's representative understands all special instructions such as maintenance and prior notification requirements
- Ensure that the drivers are endorsed to transport hazardous waste (if hazardous waste is generated)
- Verify the transporter's representative and Cabrera have signed all required forms.

Following shipment, the Site Manager and waste broker shall ensure the following requirements are met:

- Verify all records are complete for the shipment and copies filed at the Site
- Verify receipt notification is obtained once the shipment arrives at the disposal facility and shipment records updated, as necessary
- Resolve any shipment discrepancies that may be identified as a result of inspections of the conveyance and/or package waste at the disposal facility
- Receive the Disposal Certification Form from the disposal facility, compare to the shipment records for accuracy, and attach to the shipment file for inclusion into the project Remedial Action Closure Report.

The planned transport routes to US Ecology, Inc. in Grandview, Idaho and EnergySolutions in Clive, Utah are provided in Attachment C.

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4.0 Health and Safety

The Health and Safety Plan (EA 2013), the Site-Specific Addendum to the Health and Safety Plan (Appendix B of the RD/RAWP), and the Radiation Protection Plan (Appendix C of the RD/RAWP) describe the health and safety and radiological guidelines and controls that will be used at the Site during waste loading and shipping activities. These guidelines were developed to protect onsite personnel, visitors, and the public from physical harm and exposure to hazardous materials during these activities.

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5.0 Quality Assurance/Quality Control

Activities associated with this WMP shall be performed in accordance with written procedures and/or protocols in order to ensure consistent, repeatable results. Topics covered in project procedures and protocols may include proper use of instrumentation, sampling methods and procedures, and reporting requirements. Implementations of quality assurance and quality control measures for this project are described in the Quality Assurance Project Plan (Appendix A of the RD/RAWP) and the Construction Quality Plan (Section 6.0 of the RD/RAWP).

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6.0 References

- AECOM. 2009. *Radiological Disposal Site Characterization for Little Mountain Training Annex*. November.
- Cabrera Services, Inc. (Cabrera). 2010. Cabrera Radiation Safety Program, Rev1; Cabrera Services, Inc.; May 2010; including all current revisions of the standard radiological operating procedures.
- EA Engineering, Science, and Technology, Inc. (EA). 2013. *Health and Safety Plan – Hill Air Force Base Performance-Based Remediation*. June.
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- Parsons Infrastructure and Technology Group, Inc. 2007. *Final North Disposal Area, Thorium Site and Oil Emulsion Disposal Area Data Summary Report Little Mountain Test Annex Operable Unit A Remedial Investigation 2006 Program*. December.
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Attachment A
U.S. Ecology/EnergySolutions
Waste Acceptance Criteria

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C.3 WASTE ACCEPTANCE CRITERIA

C.3.1 Pre-acceptance Review

The preacceptance protocol has been designed to ensure that only hazardous and radioactive material that can be properly and safely stored, treated and/or disposed of by USEI are approved for receipt at the facility. A two-step approach is taken by USEI. The first step is the chemical and/or radiological and physical characterization of the candidate waste stream by the generator. The second step is the preacceptance evaluation performed by USEI to determine the acceptability of the waste for receipt at the facility. Figure C-2 presents a logic diagram of the preacceptance protocol that is utilized at the facility.

C.3.2 Radioactive Material Waste Acceptance Criteria

The following waste acceptance criteria are established for accepting radiological contaminated waste material that is generally or specifically exempted from regulation by the Nuclear Regulatory Commission (NRC) or an Agreement State under the Atomic Energy Act of 1954 ("AEA"), as amended. Material may also be accepted if it is not regulated or licensed by the NRC or has been authorized for disposal by the IDEQ and is within the numeric waste acceptance criteria. Waste acceptance criteria are consistent with these restrictions.

The following five tables establish types and concentrations of radioactive materials that may be accepted. These tables are based on categories and types of radioactive material not regulated by the NRC based on statute or regulation or specifically approved by the NRC or an Agreement State for alternate disposal. The criteria are consistent with these restrictions and detailed analyses set forth in *Waste Acceptance Criteria and Justification for FUSRAP Material*, prepared by Radiation Safety Associates, Inc. (RSA) as subsequently refined, expanded and updated in *Waste Acceptance Criteria and Justification for Radioactive Material*, prepared by USEI.

Material may be accepted if the material has been specifically exempted from regulation by rule, order, license, license condition, letter of interpretation, or specific authorization under the following conditions: Thirty (30) days prior to intended shipment of such materials to the facility, USEI shall notify IDEQ of its intent to accept such material and submit information describing the material's physical, radiological, and/or chemical properties, impact on the facility radioactive materials performance assessment, and the basis for determining that the material does not require disposal at a facility licensed under the AEA. The IDEQ will have 30 days from receipt of this notification to reject USEI's determination or require further information and review. No response by IDEQ within thirty (30) days following receipt of such notice shall constitute concurrence. IDEQ concurrence is not required for generally exempted material as set forth in Table C.4a.

Based on categories of waste described in the waste acceptance criteria, the concentration of the various radionuclides in the conveyance (e.g., rail car gondola, other container etc.) shall not exceed the concentration limits established in the WAC without the specific written approval of the IDEQ unless generally exempted as set forth in Table C.4a. Radiological surveys will be performed as outlined in ERMP-01 to verify compliance with the WAC. If individual "pockets" of activity are detected indicating the limits may be exceeded, the RSO or RPS shall investigate the discrepancy and estimate the extent or volume of the material with the potentially elevated

radiation levels. The RPS or RSO shall then make a determination on the compliance of the entire conveyance load with the appropriate WAC limits. If the conveyance is determined not to meet the limits, USEI will notify IDEQ's RCRA Program Manager within 24 hours of a concentration based exceedance of the facility WAC to evaluate and discuss management options. The findings and resolution actions shall then be documented and submitted to the IDEQ.

The radioactive material waste acceptance criteria, when used in conjunction with an effective radiation monitoring and protection program as defined in the USEI *Radioactive Material Health and Safety Plan* and *Exempt Radioactive Materials Procedures* provides adequate protection of human health and the environment. Included within this manual are requirements for USEI to submit a written summary report of Table C.1 through C.2 radioactive material waste receipts showing volumes and radionuclide concentrations disposed at the USEI site on a quarterly basis. USEI will also submit a Table C.3 through C.4b annual report of exempted products devices, materials or items within 60 (sixty) days of year end (December 31st). The annual report will provide total volumes or mass of isotopes and total activity by isotope listing the activity of each radionuclide disposed during the preceding year, and the cumulative total of activity for each radionuclide disposed at the facility. The report will include an updated analysis of the impact on the facility performance assessment.

These criteria and procedures are designed to assure that the highest potential dose to a worker handling radioactive material at USEI shall not exceed 400 mrem/year TEDE dose, and that no member of the public is calculated to receive a potential post closure dose exceeding 15 mrem/year TEDE dose, from the USEI program. TEDE is defined as the "Total Effective Dose Equivalent", which equals the sum of external and internal exposures. The public dose limit during operation activities is limited to 100 mrem/yr TEDE dose. An annual summary report of environmental monitoring results will be submitted to IDEQ by June 1st for the preceding year.

Materials that have a radioactive component that meets the criteria described in Tables C.1 through C.4b and are RCRA regulated material will be managed as described within this WAP for the RCRA regulated constituents.

Table C.1: Unimportant Quantities of Source Material Uniformly Dispersed* in Soil or Other Media**

	Status of Equilibrium	Maximum Concentration of Source Material	Sum of Concentrations Parent(s) and all progeny present
a	Natural uranium in equilibrium with progeny	<500 ppm / 167 pCi/g (^{238}U activity)	≤ 3000 pCi/g
	Refined natural uranium (^{238}U , ^{235}U , ^{234}U , $^{234\text{m}}\text{Pa}$, ^{231}Th)	<500 ppm / 333 pCi/g	≤ 2000 pCi/g
	Depleted Uranium ($^{234\text{m}}\text{Pa}$, $^{234\text{m}}\text{Th}$)	<500 ppm / 169 pCi/g	≤ 2000 pCi/g
b	Natural thorium (^{232}Th + ^{230}Th)	<500 ppm / 110 pCi/g	≤ 2000 pCi/g
	^{230}Th in equilibrium with progeny	<0.01 ppm / 200 pCi/g	≤ 2000 pCi/g
	^{230}Th (with no progeny)	0.1 ppm / ≤ 2000 pCi/g	
	Any mixture of Thorium and Uranium	Sum of ratios ≤ 1 ****	≤ 2000 pCi/g

Table C.2: Naturally Occurring Radioactive Material Other Than Uranium and Thorium Uniformly Dispersed* in Soil or Other Media**

	Status of Equilibrium	Maximum Concentration of Parent Nuclide	Sum of Concentrations of Parent and All Progeny Present
a	^{226}Ra or ^{228}Ra with progeny in bulk form ¹	500 pCi/g	≤ 4500 pCi/g
b	^{226}Ra or ^{228}Ra with progeny in reinforced IP-1 containers ¹	1500 pCi/g	13,500 pCi/g
c	^{210}Pb with progeny (Bi & ^{210}Po)	1500 pCi/g	4500 pCi/g
	^{40}K	818 pCi/g	N/A
	Any other NORM		≤ 3000 pCi/g

¹ Any material containing ^{226}Ra greater than 222 pCi/g shall be disposed at least 6 meters from the external point on the completed cell.

Table C.3: Particle Accelerator Produced Radioactive Material

Acceptable Material	Activity or Concentration
Any particle accelerator produced radionuclide.	All materials shall be packaged in accordance with USDOT packaging requirements. Any packages containing iodine or volatile radionuclides will have lids or covers sealed to the container with gaskets. Contamination levels on the surface of the packages shall not exceed those allowed at point of receipt by USDOT rules. Gamma or x-ray radiation levels may not exceed 10 millirem per hour anywhere on the surface of the package. All packages received shall be directly disposed in the active cell. All containers shall be certified to be 90% full.

*Average over conveyance or container. The use of the phrase "over the conveyance or container" is meant to reflect the variability on the generator side. The concentration limit is the primary acceptance criteria.

**Unless otherwise authorized by IDEQ, other Media does not include radioactively contaminated liquid (except for incidental liquids in materials). See radioactive contaminated liquid definition (definition section of Part B permit).

$$*** \frac{\text{Conc. of U in sample}}{\text{Allowable conc. of U}} + \frac{\text{Conc. of Th in Sample}}{\text{Allowable conc. of Th}} \leq 1$$

Table C.4a: NRC Exempted Products, Devices or Items

Exemption 10 CFR Part*	Product, Device or Item	Isotope, Activity or Concentration
30.15	As listed in the regulation	Various isotopes and activities as set forth in 30.15
30.14, 30.18	Other materials, products or devices specifically exempted from regulation by rule, order, license, license condition, concurrence, or letter of interpretation	Radionuclides in concentrations consistent with the exemption
30.19	Self-luminous products containing tritium, ⁸⁵ Kr, ³ H or ¹⁴⁷ Pm	Activity by Manufacturing license
30.20	Gas and aerosol detectors for protection of life and property from fire	Isotope and activity by Manufacturing license
30.21	Capsules containing ¹⁴ C urea for <i>in vivo</i> diagnosis of humans	¹⁴ C, one μ Ci per capsule
40.13(a)	Unimportant quantity of source material: see table above	$\leq 0.05\%$ by weight source material
40.13(b)	Unrefined and unprocessed ore containing source material	As set forth in rule
40.13(c)(1)	Source material in incandescent gas mantles, vacuum tubes, welding rods, electric lamps for illumination	Thorium and uranium, various amounts or concentrations, see rules
40.13(c)(2)	(i) Source material in glazed ceramic tableware (ii) Piezoelectric ceramic (iii) Glassware not including glass brick, pane glass, ceramic tile, or other glass or ceramic used in construction	$\leq 20\%$ by weight $\leq 2\%$ by weight $\leq 10\%$ by weight
40.13(c)(3)	Photographic film, negatives or prints	Uranium or Thorium
40.13(c)(4)	Finished product or part fabricated of or containing tungsten or magnesium-thorium alloys. Cannot treat or process chemically, metallurgically, or physically.	$\leq 4\%$ by weight thorium content.
40.13(c)(5)	Uranium contained in counterweights installed in aircraft, rockets, projectiles and missiles or stored or handled in connection with installation or removal of such counterweights.	Per stated conditions in rule.
40.13(c)(6)	Uranium used as shielding in shipping containers if conspicuously and legibly impressed with legend "CAUTION RADIOACTIVE SHIELDING – URANIUM" and uranium incased in at least 1/8 inch thick steel or fire resistant metal.	Depleted Uranium
40.13(c)(7)	Thorium contained in finished optical lenses	$\leq 30\%$ by weight thorium, per conditions in rule.
40.13(c)(8)	Thorium contained in any finished aircraft engine part containing nickel-thoria alloy.	$\leq 4\%$ by weight thorium, per conditions in rule.

Table C.4b: Materials Specifically Exempted by the NRC or NRC Agreement State

Exemption	Materials	Isotope, Activity or Concentration*
10 CFR 30.11**	Byproduct material including production particle accelerator material exempted from NRC or Agreement State regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.***	Byproduct material at concentrations consistent with the exemption
10 CFR 40.14**	Source material exempted from NRC or Agreement State regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.***	Source material at concentrations consistent with the exemption.
10 CFR 70.17	Special Nuclear Material (SNM) exempted from NRC regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.***	SNM at concentrations consistent with the exemption.

*Sum of all isotopes up to a maximum concentration of 3,000 pCi/gm.

**Also includes equivalent Agreement State regulation where applicable.

*** Similar material not regulated or licensed by the NRC may also be accepted. Sum of all isotopes up to a maximum concentration of 3,000 pCi/gm. IDEQ shall be notified prior to the receipt of Special Nuclear Material not regulated or licensed by the NRC.

Additional Information for USEI's Waste Analysis Plan

1. US Ecology Idaho, Inc. (USEI) may receive contaminated materials or other materials as described in Tables C.1 - C.4b above. USEI may not accept for disposal any material that by its possession would require USEI to have a radioactive material license from the Nuclear Regulatory Commission (NRC).
2. Unless approved in advance by USEI and IDEQ, average activity concentrations may not exceed those concentrations enumerated in Tables C.1 and C.2. Additionally, for Tables C.1 and C.2, individual pockets of material may exceed the WAC for the radionuclides present as long as the average concentration of all radionuclides within the package or conveyance remains at or below the WAC and the highest dose rate measured on the outside of the unshielded package or conveyance does not exceed those action levels enumerated in ERMP-01.
3. Other items, devices or materials listed in Table C.4a, which are exempted in accordance with 10 CFR Parts 30, 40 or equivalent Agreement State regulations or 10 CFR Part 70 may be accepted at or below the activities (per device or item) or concentrations specified in those exemptions.
4. 10CFR20.2008 authorizes disposal of certain byproduct material as defined in Section 11.e(3) and 11.e(4) of the Atomic Energy Act, as amended, at disposal facilities authorized to dispose of such material in accordance with any Federal or State solid or hazardous waste law, as authorized under the Energy Policy Act of 2005.
5. The generator of particle accelerator produced waste must specify that the waste meets applicable acceptance criteria.
6. In accordance with permit requirements, notification of any exceedance of the WAC will be provided to the RCRA Program Manager within 24 hours, in accordance with the permit.

EnergySolutions Clive, Utah
Bulk Waste Disposal and Treatment Facilities
Waste Acceptance Criteria
Revision 9

(Includes Class A LLRW, Mixed Waste, and 11e.(2) Disposal Embankments)

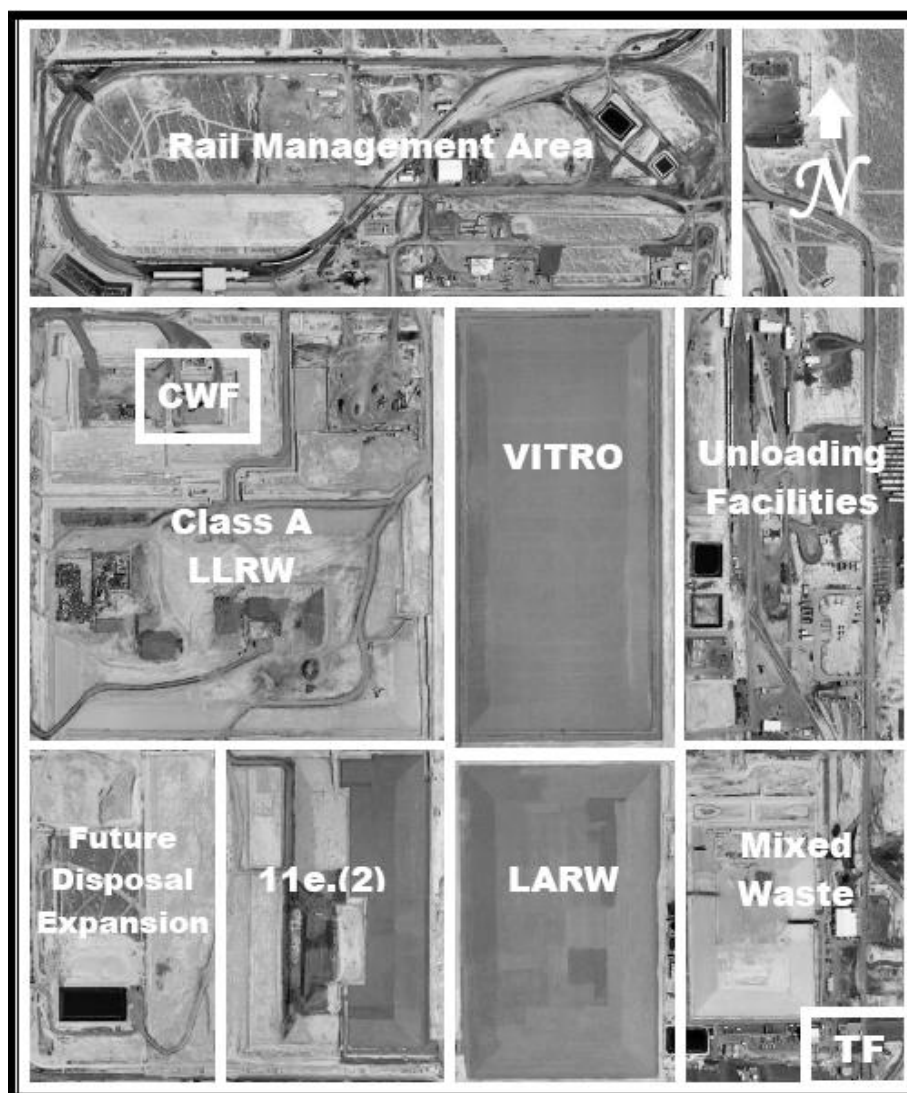


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SECTION 1

INTRODUCTION

1.1 PURPOSE

EnergySolutions has developed this Bulk Waste Disposal and Treatment Facilities – Waste Acceptance Criteria (BWF WAC) document to assist waste generators and their contractors by providing information about the capabilities and requirements of EnergySolutions’ Clive, UT disposal and treatment facilities. EnergySolutions is authorized to receive:

- Class A Low-Level Radioactive Waste (LLRW)
- NORM/NARM
- Class A Mixed LLRW (i.e., radioactive and hazardous)
- 11e.(2) Byproduct Material
- PCB Radioactive, and
- Other various forms and types of radioactive wastes

The BWF WAC provides information on EnergySolutions’ waste acceptance processes including:

- Waste characterization and profiling,
- Pre-shipment sampling and analysis,
- Waste packaging, transportation and delivery,
- Waste receipt, verification sampling and acceptance, and
- Waste treatment and disposal

1.2 SCOPE

These waste acceptance criteria collectively pertain to the Bulk Waste and Treatment Facilities which are described in detail below. The BWF WAC does not apply to EnergySolutions’ Containerized Waste Facility (CWF). Please refer to the CWF WAC which can be downloaded from EnergySolutions’ website at www.energysolutions.com.

Numerous state and federal agencies regulate the management, transportation, treatment and disposal of radioactive and hazardous materials. This document provides guidance on EnergySolutions’ waste acceptance process and should be used in conjunction with current copies of EnergySolutions’ licenses, permits and applicable state and federal regulations. These licenses, permits, and regulations take precedence over any information contained in this document. Generators may request variances from the BWF WAC on a case-by-case basis. EnergySolutions will evaluate such requests and provide written notification to the generator if the variance is approved. In some cases, a variance may require state or federal regulatory approval.

Links to EnergySolutions’ governing licenses and permits may be found at the Customer Portal tab on the EnergySolutions’ website at www.energysolutions.com. In addition, Appendix A of this document contains a list of contact information for both EnergySolutions and the State of Utah. For additional information, representatives of EnergySolutions’ Technical staff are available to answer any questions and can be contacted at (801) 649-2000.

1.3 RESPONSIBILITIES

The generator is responsible to characterize, classify, schedule, manifest, package and transport waste shipments to EnergySolutions' disposal facility in accordance with the BWF WAC, licenses, permits, and applicable state and federal regulations. The generator is also responsible for identifying any hazards (chemical, industrial, radiological) that may compromise worker safety and health. For waste classification, generators must have in place a quality control program to ensure compliance with the waste classification requirements. The generator or authorized representative must complete and submit a Radioactive Waste Profile Record to EnergySolutions for review and approval prior to shipment. Additional forms and certifications may also be required such as the Special Nuclear Material Exemption Certification, the PCB Waste Certification, and the Land Disposal Restriction Notification and/or Certification. Section 4 details the waste profiling process. The generator or authorized representative should be available to resolve issues that arise associated with waste shipments.

EnergySolutions is responsible to safely and compliantly receive, treat (if applicable), and dispose of waste shipments in accordance with all applicable permits, licenses, and regulations. EnergySolutions will provide disposal and/or treatment certificates upon request from the generator. In addition, EnergySolutions will contact the generator to resolve non-conforming waste shipments or discrepancies with the contractual terms and conditions associated with the receipt and management of waste shipments.

SECTION 2

SITE AND FACILITY DESCRIPTION

2.1 SELECTION OF THE CLIVE DISPOSAL SITE LOCATION

The initial selection of the *EnergySolutions* disposal site location dates back to the late 1970s when the Department of Energy (DOE) and the State of Utah began the cleanup of an abandoned uranium mill site. The Vitro mill site, located in central Salt Lake City, was one of the first sites cleaned up under the DOE Uranium Mill Tailings Remediation Action (UMTRA) Program.

The DOE investigated 29 sites to identify the safest permanent disposal site for these materials. After eight years of characterization and evaluation of several sites, the DOE selected the Clive site located in Utah's West Desert approximately 75 miles west of Salt Lake City. The site's remote location, low precipitation, naturally poor groundwater, and low-permeability clay soils were some of the attractive qualities of the area. From 1984 to 1988, the Vitro tailings were relocated to Clive and placed in an above-ground disposal cell.

Since acquiring land adjacent to the Vitro disposal embankment and obtaining a disposal license, the vision of *EnergySolutions'* Clive facility has been to provide a private disposal option for material from cleanups and generators of radioactive waste in separate disposal embankments similar to those used for DOE's Vitro project. The Clive site has received waste from cleanups carried out across the country including projects by the Environmental Protection Agency (EPA), Department of Energy (DOE), Department of Defense (DOD), utilities and other commercial entities. The initial disposal license was for Naturally Occurring Radioactive Material (NORM). Since 1988, *EnergySolutions'* Radioactive Material License (RML) has been amended several times, expanding the types of radioactive materials to include Class A low-level radioactive waste (LLRW), in addition to NORM.

2.2 LICENSES, PERMITS, AND AUTHORIZATIONS

EnergySolutions is permitted, licensed, and authorized to receive, treat, and dispose Class A LLRW, NORM/NARM, Class A Mixed LLRW, 11e.(2) Byproduct Material, Special Nuclear Material based on concentration limits, Polychlorinated Biphenyl (PCB) Radioactive Waste, and PCB Mixed Waste in accordance with the following documents:

- Radioactive Material License (RML) Number UT 2300249, as amended
 - Class A LLRW as defined in Utah Administrative Code R313-15-1009
 - Class A Mixed LLRW (radioactive and hazardous)
 - NORM/NARM
 - Special Nuclear Material (concentration-based limits)
- 11e.(2) Byproduct Material License Number UT 2300478, as amended
 - 11e.(2) Byproduct Material as defined by the Atomic Energy Act, as amended
- State-Issued Part B Permit Number UTD982598898, as amended
 - Storage, treatment, and disposal of Mixed Waste
 - Authorizes disposal of specific types of PCB regulated waste in the LLRW and Mixed Waste disposal facility, depending upon the type and concentration of PCBs present in the waste [note that this authority has been transferred from the Groundwater Discharge Permit to the RCRA Part B Permit]

- Special Nuclear Material (SNM) Exemption Order issued by the NRC, as amended
 - Authorizes receipt, storage, treatment, and disposal of waste containing SNM based on concentration limits rather than mass limits
- TSCA Coordinated Approval and TSCA Shredding Approval issued by the EPA Region 8, as amended
 - Authorizes the receipt, management, and disposal of PCB Radioactive and PCB Mixed Waste (40 CFR Part 761)

Section 3 details the various waste types and waste forms that are acceptable at *EnergySolutions*. Waste streams that are subject to multiple regulations must meet the requirements for each applicable regulation.

2.3 SITE LOCATION AND ACCESS

EnergySolutions operations are conducted on and adjacent to Section 32, Township 1 South, Range 11 West, SLM, Tooele County, Utah. The facility is about 75 miles west of Salt Lake City and about three miles south of Interstate 80, Exit 49. The site is conveniently accessed by both highway and rail transportation. The disposal site mailing address is:

EnergySolutions LLC
 Clive Disposal Site
 Interstate 80, Exit 49
 Clive, UT 84029 (84083 if using Fed Ex)
 Phone: (435) 884-0155

EnergySolutions receives waste shipped via bulk truck, containerized truck, enclosed truck, bulk railcars, rail boxcars, and rail intermodals. The transportation access allows *EnergySolutions* to operate throughout the entire year. The disposal site is accessed by the Union Pacific Railroad at *EnergySolutions* private siding. *EnergySolutions* uses more than ten miles of track and three locomotives for railcar management. The covered railcar thaw shed, rotary dumper, and railcar decontamination facilities allow for the efficient unloading, decontamination and return of rail shipments.

2.4 DISPOSAL AND TREATMENT FACILITIES

The design and operation of the *EnergySolutions* disposal site provides a long-term disposal solution with a minimal need for active maintenance after closure. *EnergySolutions* uses an above-ground engineered disposal cell. The design of these cells is patterned after DOE and EPA specifications for the VITRO disposal embankment. Each licensed disposal embankment meets or exceeds the applicable regulatory requirements.

Figure 2-1 shows the locations of *EnergySolutions* waste treatment, disposal, and operations areas at the Clive facility. Clive waste operations are managed as three facilities:

- “Bulk Waste Facility” (BWF) – including Mixed Waste, LARW, 11e.(2) and Class A LLRW
- “Containerized Waste Facility” (CWF) – located within the Class A LLRW area
- “Treatment Facility” (TF) – located in the southeast corner of the Mixed Waste area

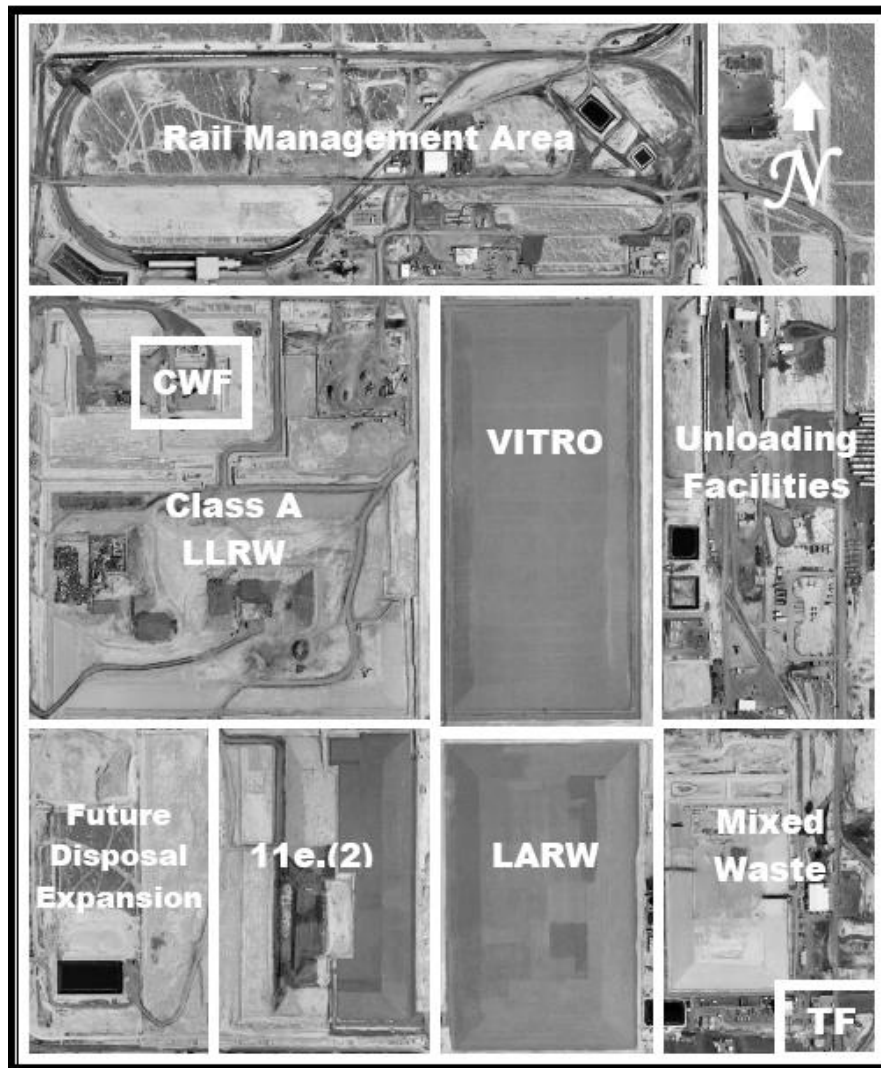


Figure 2-1. EnergySolutions' Disposal and Treatment Facilities

Bulk Waste Facility

Waste shipped for direct disposal that is compliant with the ALARA Criteria described below is managed at EnergySolutions' Bulk Waste Facility (BWF). Such waste is either removed from the container or filled with a grout-like mixture to minimize void spaces. Waste that is removed from the shipping container is typically compacted into soil lifts. For disposal in a bulk soil lift, debris must be less than 10 inches in at least one dimension and no longer than 12 feet in any dimension. Debris items that exceed this size limit are disposed of using grout in a different disposal area within the BWF. Waste is directly disposed at the Class A LLRW, Mixed Waste, or 11e.(2) disposal embankments. Bulk containers (e.g., intermodals, gondolas, etc.) and non-bulk containers (e.g., drums, boxes, etc.) are acceptable for receipt at the BWF.

The Bulk Waste Facility (BWF) includes the following disposal embankments and structures:

- Class A LLRW and NORM disposal embankment
- 11e.(2) Byproduct Material disposal embankment
- Mixed Waste disposal embankment for LDR compliant solid waste
- Intermodal unloading facility for unloading and staging bulk waste shipments for disposal
- Railcar Rotary Dump facility for unloading and staging bulk waste shipments for disposal
- Rail Wash Facility for decontamination, surveying, and releasing of railcars
- Container Wash Facility for decontamination, surveying and releasing of bulk containers

Containerized Waste Facility

Waste shipped for direct disposal exceeding EnergySolutions' ALARA Criteria is managed at the Containerized Waste Facility (CWF). Waste must be packaged in disposal containers (e.g., drums, boxes, liners, etc.) instead of bulk containers (e.g., intermodals, gondolas, etc.) for shipments to the CWF since EnergySolutions will not remove such waste from its container due to the elevated dose rates. Please refer to EnergySolutions' CWF WAC for information on shipping waste to the CWF.

Shipments to the CWF typically are shipped in a shielded transportation package such as a cask as illustrated in Figure 2-2.



Figure 2-2. Cask Shipment to the CWF

Treatment Facility

Waste shipped to EnergySolutions for treatment or liquid solidification prior to disposal is managed at EnergySolutions' Treatment Facility. The Treatment Facility is shown in Figure 2-1 as "TF". The Treatment Facility is designed for radioactive waste that requires treatment for RCRA constituents and for liquid radioactive wastes requiring solidification prior to disposal. EnergySolutions' Mixed Waste treatment and solidification capabilities include:

- Chemical Stabilization – Including oxidation, reduction, neutralization and deactivation.
- Amalgamation – For the treatment of elemental mercury.
- Macroencapsulation – For the treatment of radioactive lead solids, RCRA metal-containing batteries and hazardous debris.
- Microencapsulation – To reduce the leachability of hazardous constituents in mixed wastes that are generally dry, fine-grained materials such as ash, powders or salts.
- Liquid Solidification – For the solidification of radioactively contaminated liquids such as aqueous solutions, oils, antifreeze, etc. to facilitate land disposal. Mixed waste liquids can also be treated and solidified at the Treatment Facility.
- Vacuum Thermal Desorption of Organic Constituents - For the thermal segregation of organic constituents from wastes including wastes with PCBs. Waste containing PCB liquids is also acceptable for VTD treatment. Liquids will require solidification prior to processing through the system. The organic liquid condensate generated in the VTD process must be treated prior to final disposal. The non-liquid waste residue will be further treated for metal contaminants (if required) and disposed at the Mixed Waste embankment.
- Debris Spray Washing – To remove contaminants from applicable hazardous debris.

Each of these treatment technologies are discussed in further detail in Section 3.1.3.

The Treatment Facility includes open and covered waste storage areas for storing, sampling, and staging Mixed Waste shipments, including the following buildings and areas:

- Mixed Waste Operations Building
- Mixed Waste Treatment Building
- Liquids Storage Building
- Mixed Waste storage, staging and sampling areas

2.5 ALARA CRITERIA FOR THE BULK WASTE AND TREATMENT FACILITIES

EnergySolutions has implemented an "As Low As Reasonably Achievable" (ALARA) Criteria to minimize worker exposures. The ALARA Criteria is not a license condition but is used as the primary distinction between waste that is acceptable for direct disposal at the BWF and CWF. Wastes with higher

dose rates exceeding the ALARA Criteria are disposed at the CWF where waste packages are directly disposed without sampling and actual waste handling. Conversely, wastes with dose rates less than the ALARA Criteria may be disposed at the BWF since the waste is sampled and, in most cases, removed from the shipping container.

As shown in the table below, these ALARA Criteria define allowable external contact dose rates and loose surface contamination limits for waste managed at the BWF.

External Contact Dose Rate	Removable Surface Contamination On Exterior Surfaces of Debris
< 200 mR/hr on manifested container	< 500 dpm α /100 cm ²
< 500 mR/hr on external, accessible surfaces of waste in container	< 50,000 dpm β, γ /100 cm ²
< 80 mR/hr on contact of unshielded bulk containers with resin	

External Contact Dose Rate Limits

The external contact dose rate limit of 200 mR/hr applies to the manifested container (e.g., drums/boxes on a flatbed truck or enclosed van, bulk containers such as intermodals, sealands, cargo containers, etc.). For example, if drums or boxes are shipped in a bulk container, such as an intermodal, and the intermodal is manifested as the strong, tight container, then the external contact dose rate of 200 mR/hr applies to the intermodal and not to the drums or boxes inside the intermodal. The drums and boxes in this case would be considered waste and must not contain any item with dose rates exceeding 500 mR/hr on the external, accessible surfaces of the item.

The dose rate for debris items such as pipes should only be measured on the exterior surfaces and on the plane surface of the opening of the pipe to demonstrate compliance with the ALARA Criteria. For example, the internal pipe surfaces may exceed the 500 mR/hr dose limit only if the surface plane to the opening of the pipe is less than 500 mR/hr. Shield plates used to cover the opening of the pipe should not be used solely to lower the dose rates below the criteria since EnergySolutions is required to remove or penetrate into the debris items to fill internal voids with grout material.

Another example is DAW placed into 55 gallon drums and compacted into pucks. The dose rate criteria apply to the external surfaces of the puck itself and not to the DAW inside the puck.

Resin External Contact Dose Rate Limits

Resins shipped in bulk containers must comply with the ALARA Criteria. This is due to the required resin blending process that necessitates worker proximity to the waste. Resins shipped in disposal containers such as drums, boxes, liners, etc. may be acceptable at the BWF for grouting if the container is compliant with the ALARA Criteria for non-bulk packages. Resins shipped to the BWF must be shipped under a Waste Profile specific for resins unless specifically approved in writing by EnergySolutions. Resins with dose rates that exceed these limits must be disposed at the CWF.

Removable Surface Contamination Limits

The same ALARA principles apply to the removable surface contamination limits. The main concern is controlling loose contamination on the exterior surfaces of debris items removed from the container. Fixatives may be applied to the debris items to reduce the removable contamination levels below the specified limits.

Requests for Exceptions

Requested exceptions to the ALARA Criteria are evaluated on a case-by-case basis. For example, Mixed Waste exceeding the ALARA Criteria will be evaluated since the CWF cannot accept Mixed Waste for disposal. Generators must provide radiation and contamination surveys of the container and/or waste item when requesting approval to exceed the ALARA Criteria. Dose rate measurements at one foot from the waste should be provided on the radiation survey. The transportation mode and manifested package information should also be included with the request. The generator must receive written approval for exemptions to the ALARA Criteria prior to shipment of the waste.

SECTION 3

WASTE CRITERIA

3.1 ACCEPTABLE RADIOACTIVE WASTES

The type, form, and quantity of LLRW, NORM, 11e.(2) byproduct material, and mixed waste that EnergySolutions can receive for treatment and disposal is governed by the various licenses and permits under which EnergySolutions operates. EnergySolutions has been issued an Agreement State Radioactive Material License (License #UT 2300249, as amended) by the Utah Division of Radiation Control (DRC). This license authorizes EnergySolutions to receive Class A LLRW, NORM, and NARM waste. EnergySolutions has been issued a separate license (License number UT 2300478, as amended) to receive and dispose of uranium and thorium mill tailings byproduct material as defined by section 11e.(2) of the Atomic Energy Act of 1954, as amended.

The Utah Division of Solid and Hazardous Waste (DSHW) issued EnergySolutions a State-Issued Part B Permit (EPA ID Number UTD982598898, as amended) to treat and dispose of hazardous waste which is also contaminated with LLRW, NORM, or NARM wastes (mixed waste). Early in 1999, EnergySolutions received a Permit modification which authorized the receipt and disposal of PCB Radioactive and PCB Mixed wastes. In 2002, EnergySolutions received a TSCA Coordinated Approval from the EPA to expand PCB receipt and disposal options. The TSCA Coordinated Approval has been subsequently expanded to include additional types of PCB radioactive and PCB mixed wastes.

3.1.1 Class A Low-Level Radioactive Waste

EnergySolutions Clive facility is authorized to receive Class A Low-Level and Mixed Low-Level Radioactive Waste. These wastes must be classified in accordance with the requirements of the Utah Administrative Code (UAC) R313-15-1009, Classification and Characteristics of Low-Level Radioactive Waste. Utah rule R313-15-1009 is similar to the NRC Waste Classification requirements in 10 CFR 61.55 with the addition of Radium-226. Generators must have in place a quality control program to ensure compliance with the waste classification requirements and prepare and retain with manifest documentation a record documenting the generator's waste classification analysis. Shippers and generators should also review NRC IE Bulletin No. 79-19 to ensure compliance with applicable training requirements in managing LLRW.

The information provided below is a summary of the waste classification regulations and how generators must classify their LLRW prior to shipment to the Clive facility. Further guidance is provided in NRC's "Branch Technical Position on Concentration Averaging and Encapsulation", as amended (BTP). All generators shipping LLRW to the Clive facility must comply with the NRC's BTP as specified in Condition 16 of the Radioactive Material License. **Utilization of the BTP for purposes of waste classification concentration averaging requires written approval from EnergySolutions Technical staff. Please contact EnergySolutions to assist and support the evaluation of these determinations.**

Determination of waste class involves two considerations. First, consideration must be given to specific long-lived radionuclides listed in Table I of UAC R313-15-1009. Second, consideration must be given to specific short-lived radionuclides listed in Table II of UAC R313-15-1009. The waste is Class A if the radionuclides listed in either Table I or Table II are not present in the waste. Both tables are provided below.

The concentration limits for determining waste class are given in curies per cubic meter with the exception of the following Table I radionuclides which are given in nanocuries per gram: alpha-emitting transuranic radionuclides with a half-life greater than five years, Pu-241, Cm-242, and Ra-226. The following bullets outline the steps for determining waste class per R313-15-1009.

Classification Tables from UAC R313-15-1009

Table I

Radionuclide	Ci/m ³	nCi/g
C-14	8	
C-14 (act)	80	
Ni-59 (act)	220	
Nb-94 (act)	0.2	
Tc-99	3	
I-129	0.08	
Alpha-emitting transuranics > 5 year half-life		100
Pu-241		3,500
Cm-242		20,000
Ra-226		100

- When the waste does not contain any radionuclides listed in either Table I or II, it is Class A.
- When the concentration does not exceed 0.1 times the value in Table I, the waste is Class A.
- When the concentration exceeds 0.1 times the value in Table I, but does not exceed the value in Table I, the waste is Class C. EnergySolutions is not authorized to receive Class B and Class C waste.
- For wastes containing mixtures of radionuclides listed in Table I, the total concentration shall be determined by the sum of fractions rule as illustrated in the example below.
- When the waste does not contain any of the radionuclides listed in Table I, classification shall be determined based on the concentrations shown in Table II.

Table II

Radionuclide	Column 1 Ci/m ³	Column 2 Ci/m ³	Column 3 Ci/m ³
Total of all radionuclides < 5 year half-life	700	*	*
H-3	40	*	*
Co-60	700	*	*
Ni-63	3.5	70	700
Ni-63 (act)	35	700	7,000
Sr-90	0.04	150	7,000
Cs-137	1	44	4,600

* There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the

concentrations for these wastes. These wastes shall be Class B unless the concentrations of other radionuclides in Table II determine the waste to be Class C independent of these radionuclides.

- When the concentration does not exceed the value in Column 1 of Table II, the waste is Class A.
- When the concentration exceeds the value in Column 1 but does not exceed the value in Column 2 of Table II, the waste is Class B.
- When the concentration exceeds the value in Column 2 but does not exceed the value in Column 3 of Table II, the waste is Class C.
- For wastes containing mixtures of the radionuclides listed in Table II, the total concentration shall be determined by the sum of fractions rule.

For waste material that contains more than one radionuclide, the waste must be classified by applying the sum of fractions rule described in UAC R313-15-1009(1)(g). This rule states:

“For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each radionuclide’s concentration by the appropriate limit and adding the resulting values. The appropriate limits shall all be taken from the same column of the same table. The sum of fractions for the column shall be less than 1.0 if the waste class is to be determined by that column.”

The following examples demonstrate the application of the sum of fractions rule in determining waste class.

EXAMPLE #1: A generator has one 55 gallon container of soil contaminated with plutonium-238, radium-226, uranium-234, uranium-235, uranium-238, cesium-137, and strontium-90. The density of the soil is 1.6 g/cm³ and is used to convert concentration units from pCi/g to Ci/m³. The radionuclide concentration in the container is as follows:

Radionuclide	Container Concentration (pCi/g)	Container Concentration (Ci/m ³)*	Table I Class A Concentration Limit (pCi/g)	Table II Class A Concentration Limit (Ci/m ³)
Pu-238	3,000	4.8 E-03	10,000	--
Ra-226	6,000	9.6 E-03	10,000	--
U-238	5,000	8.0 E-03	--	--
U-235	1,100	1.8 E-03	--	--
U-234	5,000	8.0 E-03	--	--
Sr-90	5,000	8.0 E-03	--	0.04
Cs-137	8,000	1.3 E-02	--	1

* The soil density (1.6 g/cm³) is used to convert from pCi/g to Ci/m³.

The sum of fractions rule is applied to the container according to the radionuclides listed in Table I and II as follows:

$$\text{Table I: } \frac{3.0E+03}{1.0E+04} + \frac{6.0E+03}{1.0E+04} = 9.0E-01$$

$$\text{Table II: } \frac{8.0E-03}{4.0E-02} + \frac{1.3E-02}{1.0E+00} = 2.1E-01$$

Based on the sum of fractions rule, the waste in this container is determined to be Class A waste (i.e., 90 percent of the Class A limit for Table I radionuclides). This container is acceptable for disposal at EnergySolutions since it meets the sum of fractions rule. The uranium radionuclides are not included in the sum of fractions calculation since these radionuclides are not included in Table I or II of R313-15-1009.

EXAMPLE #2: A generator has one 55 gallon container of Dry Active Waste (DAW) contaminated with americium-241, technetium-99, europium-155, cobalt-58, and cesium-135. The density of the DAW is 0.25 g/cm³ and is used to convert Table II units from pCi/g to Ci/m³. The radionuclide concentration in the container is as follows:

Radionuclide	Container Concentration (pCi/g)	Container Concentration (Ci/m ³)*	Table I Class A Concentration Limit (pCi/g)	Table II Class A Concentration Limit (Ci/m ³)
Am-241	6,000	1.5 E-03	10,000	--
Tc-99	900,000	2.3 E-01	0.3 Ci/m ³	--
Eu-155	150,000	3.8 E-02	--	700
Co-60	100,000	2.5 E-02	--	700
Cs-135	500,000	1.3 E-01	--	--

* The DAW density (0.25 g/cm³) is used to convert from pCi/g to Ci/m³.

The sum of fractions rule is applied to the container according to the radionuclides listed in Table I and II as follows:

$$\text{Table I: } \frac{6.0E+03}{1.0E+04} + \frac{2.3E-01}{3.0E-01} = 1.4E+00$$

$$\text{Table II: } \frac{3.8E-02}{7.0E+02} + \frac{2.5E-02}{7.0E+02} = 9.0E-05$$

Based on the sum of fractions rule, the waste in the DAW container exceeds the Table I Class A concentration limit and would not be acceptable at EnergySolutions. Note that Cs-135 is not included in the sum of fractions calculation since this radionuclide is excluded in Table I or II of R313-15-1009. **Waste Classification Labels on Packages**

All waste packages containing LLRW, including Mixed LLRW, must be labeled either “Class A Unstable” or “Class AU” and appropriately marked in Block 16 of the Uniform Low-Level Radioactive Waste Manifest Form 541. There are no State or Federal regulations that prescribe the size or color of the classification labels. The Utah DRC, however, requires that each package be labeled with a minimum of 0.5-inch lettering in contrasting color (refer to the “Generator Site Access Permit Enforcement Policy - Utah Division of Radiation Control”, as amended). This requirement also applies to bulk packaging (e.g., intermodals, gondolas, etc.).

LLRW Compact Export Approval

EnergySolutions' Clive disposal site is not classified as a LLRW compact site under the Federal Low-Level Radioactive Waste Policy Act, as amended. Condition 9A of the Radioactive Material License requires generators to demonstrate that the LLRW has been approved for export to EnergySolutions prior to the initial shipment of waste. Conditions to consider when exporting waste from a compact:

- In cases where an initial export authorization comes with an expiration date, generators are responsible to ensure continuing export authorization prior to shipment.
- In cases where specific authorization is required, generators are responsible for including a copy of the approval letter with the shipping documentation.
- Processors and collectors must ensure approval from the LLRW compact of origin, or for states unaffiliated, the state of origin.
- Compact rules are subject to change, generators are responsible to comply with current compact requirements.

This license condition does not apply to DOE generators. Please contact EnergySolutions for assistance in complying with this license condition.

3.1.2 NORM/NARM Waste

EnergySolutions' Radioactive Material License allows receipt and disposal of Naturally Occurring or Accelerator-Produced Radioactive Material (NORM/NARM). NORM/NARM does not include Byproduct, Source, or Special Nuclear Material and generally contains radionuclides in the uranium and thorium decay series. Since NORM/NARM waste is not considered LLRW, the waste classification regulations do not apply. In addition, LLRW Compact approval is required for NORM/NARM waste exported from the Rocky Mountain Compact.

3.1.3 Class A Mixed Low-Level Radioactive Waste

EnergySolutions' Clive facility is authorized to receive Class A Mixed Low-Level Radioactive Waste (Mixed Waste) for (1) disposal, or (2) treatment and disposal. Mixed Waste is defined by EnergySolutions' State-Issued Part B Permit (# UTD982598898) as:

Waste defined by the Low Level Radioactive Waste Policy Act, Public Law 96-573; this is radioactive waste not classified as high-level radioactive waste, transuranics waste, spent nuclear fuel, or byproduct material as defined by section 11e.(2) of the Atomic Energy Act, and contains hazardous waste that is either listed as a hazardous waste in Subpart D of 40 CFR 261 and/or exhibits any of the hazardous waste characteristics identified in Subpart C of 40 CFR 261, or hazardous waste which also contains naturally occurring radioactive materials.

In accordance with 40 CFR 268.7, and by requirement of the State-issued Part B Permit, a Land Disposal Restriction Notification and/or Certification must accompany each shipment of Mixed Waste. This includes former hazardous wastes that have been treated to remove the Hazardous Waste Codes.

3.1.3.1 Acceptable Hazardous Waste Codes

The specific EPA Hazardous Waste Codes that may be received by *EnergySolutions* are identified in its Statute-Issued Part B Permit. A copy of this permit may be found at the Customer Portal tab on the *EnergySolutions*' web site: www.energysolutions.com. The following Utah Hazardous Waste Codes are not acceptable at *EnergySolutions*: F999 and P999.

3.1.3.2 LDR Compliant Mixed Waste

Mixed Waste must be analyzed to determine if treatment is required prior to disposal. Mixed Waste that is determined to be compliant with the Land Disposal Restriction (LDR) treatment standards specified in 40 CFR 268 may be directly disposed in *EnergySolutions*' Mixed Waste disposal embankment, or under certain circumstances, may be transferred to the LLRW embankment for disposal. *EnergySolutions* is required to verify LDR compliance for all Mixed Waste streams prior to disposal.

3.1.3.3 Mixed Waste Requiring Treatment

EnergySolutions' Clive facility may also receive Mixed Waste that requires treatment in order to comply with LDR treatment standards. *EnergySolutions* is approved under the State-Issued Part B Permit to operate a mixed waste treatment facility. Mixed Waste that is not LDR compliant may be treated by *EnergySolutions* using one of the following treatment technologies or methods:

- Chemical Stabilization, Oxidation, Reduction, Neutralization, and Deactivation
- Macroencapsulation of hazardous debris or radioactive lead solids
- Debris Spray Washing
- Microencapsulation
- Thermal Treatment of Organics including PCBs
- Mercury Treatment (Amalgamation)

Chemical Stabilization

Chemical stabilization involves the addition of approved chemical reagents in accordance with a waste-specific treatment formula and is performed in mixers at *EnergySolutions*' Treatment Facility. Formula additions of waste, reagents, and water involve the following chemical processes to chemically bind contaminants to reduce their ability to leach from the waste.

- Stabilization (STABL)
- Deactivation (DEACT)
- Neutralization (NEUTR)
- Oxidation (CHOXD)
- Reduction (CHRED)

Formula development may also be applied to Mixed Waste with very low levels of organic contaminants that require chemical destruction in order to meet total concentration based standards versus a leach standard as determined by the Toxicity Characteristic Leaching Procedure (TCLP) test. Mixed Waste requiring chemical stabilization may be sized and homogenized using various equipment including shredders, vibrating screens, and mixers. In order to evaluate chemical compatibility with the stabilization treatment process, generators shipping waste with Hazardous Waste Codes D001, D002, or D003 must provide a list of specific chemicals in each container with the shipping paperwork.

Macroencapsulation of Hazardous Debris and Radioactive Lead Solids

Mixed Waste consisting of hazardous debris may be macroencapsulated in accordance with the “Alternative Treatment Standards for Hazardous Debris” as specified in 40 CFR 268.45. Figure 3-1 illustrates macroencapsulation of hazardous debris performed in-cell using pozzolanic material. Treatment of hazardous debris via macroencapsulation must meet the following criteria:

“Macroencapsulation of hazardous debris requires application of surface coating materials such as polymeric organics (e.g., resins and plastics) or use of a jacket of inert inorganic materials to substantially reduce surface exposure to potential leaching media” (40 CFR 268.45).

In order for hazardous debris to qualify for this alternative treatment, the waste must comply with the debris definition in 40 CFR 268.2(g).

“Debris means solid material exceeding a 60 mm particle size that is intended for disposal and that is: A manufactured object; or plant or animal matter; or natural geologic material. However, the following materials are not debris: Any material for which a specific treatment standard is provided in Subpart D, Part 268, namely lead acid batteries, cadmium batteries, and radioactive lead solids; Process residuals such as smelter slag and residues from the treatment of waste, wastewater, sludges, or air emission residues; and intact containers of hazardous waste that are not ruptured and that retain at least 75% of their original volume. A mixture of debris that has not been treated to the standards provided by § 268.45 and other material is subject to regulation as debris if the mixture is comprised primarily of debris, by volume, based on visual inspection” (emphasis added).



Figure 3-1. In-Cell Macroencapsulation of RCRA Hazardous Debris

Therefore, packaged waste subject to macroencapsulation (MACRO) may contain other material that does not meet the debris definition (e.g., paint chips, scale, etc.) to the extent that the mixture is “comprised primarily of debris”. Consistent with the ALARA principle, this definition provides generators with flexibility in managing waste streams requiring treatment without having to sort and segregate non-debris items prior to treatment. However, as noted in 40 CFR 268.2(h), “deliberate mixing of other hazardous

material with debris to change its treatment classification (i.e., from waste to hazardous debris) is not allowed under the dilution prohibition in § 268.3.”

Radioactive Lead Solids (RLS) are another type of hazardous waste that requires treatment via macroencapsulation. Radioactive Lead Solids include, but are not limited to, all forms of lead shielding and other elemental forms of lead. There are no size criteria for RLS unlike the 60 mm particle size requirement for hazardous debris. As such, smaller forms of RLS such as lead shot or fines require macroencapsulation prior to disposal.

EnergySolutions’ MACRO treatment capability accommodates any size or weight of hazardous debris, thus enabling the generator to reduce the amount of time and cost associated with preparing waste packages for shipment. Generators with large debris over 20,000 pounds requiring macroencapsulation will provide the following information to EnergySolutions for review during the waste acceptance process: drawings, photographs, dimensions, weight, description of access ports to internal voids, radiological dose rate and contamination levels, and loading plans.

Debris Spray Washing

Debris Spray Washing is another alternative treatment option utilized by EnergySolutions to treat hazardous debris. High pressure water is sprayed at the debris surface to remove hazardous constituents to a “clean debris surface”. This treatment technology is best if used on non-porous debris such as metal. „Clean debris surface” criteria are specified in 40 CFR 268.45:

“Clean debris surface means the surface, when viewed without magnification, shall be free of all visible contaminated soil and hazardous waste except that residual staining from soil and waste consisting of light shadows, slight streaks, or minor discolorations, and soil and waste in cracks, crevices, and pits may be present provided that such staining and waste and soil in cracks, crevices, and pits shall be limited to no more than 5% of each square inch of surface area.”

Microencapsulation

Microencapsulation (MICRO) is a technology used on Mixed Waste to reduce the leachability of the hazardous constituent. The types of Mixed Waste most suitable for MICRO include, but are not limited to, ash, powders, and salts. MICRO involves the combining of waste with molten polyethylene to form a material that does not leach hazardous constituents in excess of established TCLP treatment standards. Mixed Waste is placed into the mixer with polyethylene. These are mixed at a high frequency with shear and frictional forces until the polyethylene melts and mixes with the waste to create a microencapsulated waste form. The treatment system includes size separation, size reduction, and a waste dryer for waste preparation prior to treatment.

Thermal Treatment of Organics (including PCBs)

Mixed Waste streams contaminated with organic hazardous constituents are among the most difficult waste streams to treat. The LDR treatment standards are expressed in terms of total organic concentrations (i.e., mg/kg) versus TCLP concentration based standards. As such, treatment of organic contaminated waste streams requires either destruction or removal of the organic constituent from the waste. Several organic contaminants carry the CMBST (combustion) technology-based treatment standard; the EnergySolutions’ Vacuum-assisted Thermal Desorption (VTD) unit has been demonstrated and approved by the EPA to meet this standard.

EnergySolutions utilizes the VTD system to process organic-contaminated waste streams including those containing PCBs. Waste containing PCB liquids is also acceptable for VTD treatment. PCB capacitors (leaking small PCB capacitors and light ballasts as well as large PCB capacitors) may also be processed through VTD. These wastes require size reduction prior to treatment and EnergySolutions has regulatory authority (through the EPA-administered TSCA Coordinated Approval) to shred PCB capacitors prior to treatment.

To meet permit requirements, generators are requested to identify the presence of asphalt or crude oil in profiled VTD waste streams.

Mixed Waste streams are heated in the VTD system at sufficient temperatures to volatilize the organic constituents which are then condensed and collected as a liquid. The thermally treated residue is then sampled to verify LDR compliance. In some cases, the treatment residue will require additional treatment to stabilize hazardous metals prior to disposal. The organic liquid condensate will require further treatment to comply with LDR treatment standards.

Mercury Treatment

Elemental mercury contaminated with radioactive materials must be treated via amalgamation per 40 CFR 268.40. Amalgamation of elemental mercury involves the mixing of reagents with the mercury to produce a non-liquid, semi-solid amalgam that reduces the potential emissions of elemental mercury vapors to the air. The Utah DSHW also requires the amalgamation treatment to reduce the leachability of elemental mercury to below the characteristic concentration limit of 0.2 mg/L TCLP. This requirement applies to amalgamated mercury treated at either EnergySolutions' Treatment Facility or treated at another facility and shipped to EnergySolutions for disposal. Generators may ship elemental mercury contaminated with radioactive materials to EnergySolutions for treatment and disposal.

EnergySolutions is also capable of treating both Low (< 260 ppm Hg) and High Mercury Subcategory waste streams (\geq 260 ppm Hg). Waste streams containing Low Subcategory Mercury must be treated to less than 0.025 mg/L TCLP mercury. The EPA requires High Mercury Subcategory waste streams be treated thermally by incinerating (IMERC) or retorting (RMERC). EnergySolutions has received a site-specific treatment variance from the Utah Solid and Hazardous Waste Control Board to treat High Mercury Subcategory waste streams via stabilization instead of IMERC or RMERC. Consequently, waste streams containing High Subcategory Mercury are treated via stabilization and analyzed post-treatment to ensure the TCLP mercury results are less than 0.2 mg/L.

Hazardous debris that is contaminated with mercury may be macroencapsulated in accordance with the "Alternative Treatment Standards for Hazardous Debris" as specified in 40 CFR 268.45. Elemental mercury must be removed from hazardous debris to the maximum extent practical including, but not limited to, draining pumps, hoses, pipes, etc. and wiping excessive mercury from external surfaces.

3.1.4 11e.(2) Byproduct Material

EnergySolutions is licensed by the Utah DRC to receive and dispose of 11e.(2) byproduct material as defined by the Atomic Energy Act, as amended. 11e.(2) byproduct material is defined as the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Shipments of 11e.(2) waste will be managed and disposed of in a separate disposal embankment specifically licensed and designed for this material.

3.1.4.1 Radionuclide Concentration Limits

EnergySolutions may accept 11e.(2) byproduct material with an average concentration in any transport vehicle (truck or railcar) not to exceed 4,000 pCi/g for natural uranium or for any radionuclide in the Radium-226 series, 60,000 pCi/g for Thorium-230, or 6,000 pCi/g for any radionuclide in the thorium decay series. EnergySolutions' 11e.(2) Byproduct Material License does not require a sum of fractions calculation. The concentration limits are based on the average concentration of the 11e.(2) byproduct material over the transport vehicle upon receipt and not each individual container on the transport vehicle.

3.1.4.2 Acceptable Forms of 11e.(2) Byproduct Material

In addition to soil and soil-like 11e.(2) byproduct material, EnergySolutions may accept 11e.(2) contaminated debris. The generator must certify in the Radioactive Waste Profile Record that the debris was either generated during the cleanup of an 11e.(2) facility or is an integral part of the operations of extraction or concentration of uranium or thorium.

All debris must be less than 10 inches in at least one dimension and no longer than 12 feet in any dimension. Debris that exceeds this size limit (e.g., 11e.(2) oversize debris) is not acceptable for disposal under the 11e.(2) license. Generators with 11e.(2) contaminated debris that are unable to size the debris prior to shipment must contact EnergySolutions' Customer Service representative to make necessary arrangements for EnergySolutions to size the debris upon receipt.

Shipments of 11e.(2) byproduct material containing free liquid will be considered nonconforming and managed in accordance with EnergySolutions' 11e.(2) license.

3.1.4.3 Certification of 11e.(2) Byproduct Material

EnergySolutions requires that each generator or owner certify in writing that the waste is 11e.(2) byproduct material as defined by the Atomic Energy Act, as amended. Specifically, the generator or owner must certify that the waste materials are tailings or waste produced by extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. The generator or owner must also certify that the waste material does not contain any other radioactive waste or hazardous waste. The generator or owner must provide the following information as it relates to the 11e.(2) byproduct material:

- License under which the waste was processed
- Licensee that was issued the license
- License issue and/or expiration date
- Issuing agency
- Type of license
- Volume of tailings

The generator or owner must attach to the certification a list of all radiological and non-radiological constituents in the waste and the maximum and average concentrations of such constituents. EnergySolutions will perform an independent verification as to the accuracy of the information contained in the certification.

3.1.4.4 Shipping Paperwork for 11e.(2) Byproduct Material

Although 11e.(2) byproduct material is specifically excluded from the definition of Low-Level Radioactive Waste; EnergySolutions requires that all shipments be manifested using the Uniform Low-Level Radioactive Waste Manifest (NRC Forms 540 and 541). However, 11e.(2) byproduct material does not have to be classified in accordance with the requirements of URC R313-15-1009. Generators may enter “N/A” in column 16 of the NRC Form 541 for Waste Classification.

3.1.5 Special Nuclear Material

Condition 13 of the Class A LLRW Radioactive Material License incorporates the Special Nuclear Material Exemption issued by the NRC. Under specified conditions, the exemption allows the Clive facility to possess waste containing SNM in greater mass quantities than prescribed in 10 CFR Part 150 without obtaining an NRC license pursuant to 10 CFR Part 70. The conditions are based on concentration limits of SNM in the waste and have been established by the NRC to ensure criticality safety. Special Nuclear Material (SNM) is defined in the UAC R313-12-3 as:

Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and other material that the U.S. Nuclear Regulatory Commission, pursuant to the provisions of Section 51 of the Atomic Energy Act of 1954, as amended, determines to be Special Nuclear Material, but does not include source material; or any material artificially enriched by any of the foregoing but does not include source material.

Each generator shipping waste containing SNM (i.e., uranium enriched in U-235, U-233, Pu-236, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Pu-243, or Pu-244) must complete and sign EnergySolutions’ SNM Exemption Certification form as part of the waste profiling process. A copy of this form must also accompany each radioactive waste manifest for waste streams that contain any of the above isotopes. The SNM Exemption Certification form lists specific requirements that must be met in order for the Clive facility to receive and accept waste containing any amount of SNM.

The NRC developed the SNM Exemption conditions based on criticality studies and independent calculations. A variety of scenarios were analyzed to determine limiting criticality conditions for waste materials containing SNM. The NRC determined that several conditions in addition to concentration limits would be required to assure criticality safety. A discussion of their approach is documented in the *Safety Evaluation Report Regarding the Proposed Exemption from Requirements of 10 CFR Part 70* (SER) (Docket 40-8989). Specific guidance from the SER is included in this section.

The following information provides general guidance on completing the SNM Exemption Certification form. These guidelines are grouped into four sections similar to the sections on the form.

3.1.5.1 Condition 1 - Percent Enrichment of Uranium-235

The first section contains a table that lists U-235 concentration limits and related measurement uncertainty values for four different scenarios. These scenarios allow for different enrichments, waste configurations and commingling with moderating material in different percentages. The measured concentrations and associated uncertainties of U-235 in individual waste containers at time of receipt must not exceed the values listed in the RML, Condition 13. Generators with low SNM concentrations relative to the specified limits may select the most restrictive scenario which allows more flexibility in demonstrating compliance with other conditions in the SNM Exemption. Check “Not Applicable” if the waste does not contain enriched U-235. Other SNM isotopes including U-233, Pu-236, and Pu-238 through Pu-244 and their associated limits are also listed.

The measurement uncertainty values listed in the last column of the table represent a maximum allowable concentration limit rather than a percentage value. The NRC provides the following guidance in the SER:

Staff considers that a reasonable measurement uncertainty value (one-sigma) would be in the range of 15 percent. Staff used 30 percent (two-sigma) in calculating the operational limit to increase the confidence level that the concentration of the waste based on a measurement would not exceed the subcritical value. Other radiochemistry techniques may be used to quantify the concentration of these radionuclides. These techniques typically have lower measurement uncertainty levels, but introduce sampling uncertainty. The measurement uncertainty levels are included in condition 1 and represent 15 percent of the maximum concentration value. A concentration value was used for the measurement uncertainty rather than a percentage value to allow greater flexibility for generators with waste having very low SNM concentrations.

3.1.5.2 Condition 2 – Specified Limits for Waste Containing SNM

Each generator must certify to all five conditions listed in this section and provide justification based on process knowledge, physical observations, and/or testing. These conditions are categorized as follows:

- SNM Isotope Concentration Limits
- Spatial Distribution Requirements
- Bulk Chemical Limits
- Unusual Moderator Limits
- Soluble Uranium Limits

These conditions require the generator to adequately characterize the waste in terms of the range and variability of SNM concentrations in the waste.

SNM Isotope Concentration Limits

Condition 2.a requires the generator to certify that concentrations of SNM in individual waste containers do not exceed the applicable U-235 concentration limit and the concentration limits for all isotopes listed in Table 1 of the SNM Exemption Certification form. Generators must certify that measurement uncertainty values from radiological testing are less than the maximum allowable concentration values listed in Table 1. As previously stated, a concentration value was used for the measurement uncertainty rather than a percentage value to allow greater flexibility for generators with waste having very low SNM concentrations.

Spatial Distribution Requirements

Condition 2.b requires the generator to certify that the SNM is homogeneously distributed throughout the waste or that the SNM concentrations in any contiguous mass of 600 kilograms (1,323 lbs) do not exceed on average the specified limits. This certification may be based on process knowledge or testing of the waste. The SER provides the following guidance on verifying spatial distribution of SNM:

Knowledge of the process by which the waste was generated or laid down may assure that the concentration varies smoothly throughout the volume with a maximum in a known location. It is then only necessary to measure the concentration at this maximum plus other measurements confirming smooth variation. In other cases where a smooth variation in SNM concentration in the waste is not present, additional measurements and characterization will be needed.

If spatial distribution of SNM in the waste is not known through process knowledge, generators may be able to certify to this requirement by using the following example.

EXAMPLE: A generator's waste stream contains less than 10 percent enriched U-235. Based on the limits in Condition 1, the corresponding U-235 concentration limit is 1,900 pCi/g. The mass of U-235 at a concentration of 1,900 pCi/g in 600 kg of waste can be calculated using the specific activity for U-235 (2.16×10^6 pCi/g) as follows:

$$\frac{1,900 \frac{\text{pCi}}{\text{g}} \times 600,000 \text{g}}{2.16 \times 10^6 \frac{\text{pCi}}{\text{g}}} = 527.8 \text{ g U235}$$

If the total mass of U-235 per container does not exceed the mass of U-235 in 600 kg of waste at 1,900 pCi/g, then compliance with the spatial distribution requirement can be achieved. Therefore, for this example, the mass of U-235 in the waste containers must not exceed 527.8 grams. Compliance with DOT regulations must also be met for shipments containing SNM.

Radioactive liquid waste containing SNM may also be accepted for solidification prior to disposal provided the SNM concentration does not exceed the SNM concentration limits specified in Condition 1. For containers of liquid waste with more than 600 kg of waste, the total activity (pCi) in the manifested container must not exceed the SNM concentration in Condition 1 times 600 kg of waste. For example, the maximum activity of Pu-239 in any manifested container of liquid waste is 6.0 mCi as shown below:

$$10,000 \frac{\text{pCi}}{\text{g}} \times 600,000 \text{ g} = 6.0 \times 10^9 \text{ pCi} = 6.0 \text{ mCi Pu-239}$$

The maximum activity of SNM in the liquid waste is limited by the volume of liquid shipped in a container and the concentration of SNM in the waste. Consequently, to comply with this condition, the Pu-239 concentration allowed in the liquid waste decreases as the size of the shipping container increases.

Bulk Chemical Requirements

Condition 2.c excludes wastes containing "pure forms" of chemicals containing carbon, fluorine, magnesium, or bismuth in bulk quantities except as allowed by the conditions in Section 1 (e.g., a pallet of drums, a B-25 box). By "pure forms," it is meant that mixtures of the above elements such as

magnesium oxide, magnesium carbonate, magnesium fluoride, bismuth oxide, etc. do not contain other elements. Demonstration of compliance with this condition may be based on process knowledge or testing.

The exclusion of bulk quantities of these chemicals in waste containing SNM is based on the criticality studies conducted by Oak Ridge National Laboratories (ORNL) for the NRC. The ORNL studies used silicon dioxide (SiO_2) to represent the waste matrix in performing criticality calculations. Additional studies were performed replacing the silicon in the SiO_2 matrix with other common elements and determined that the above chemicals produced more reactive systems. Therefore, the NRC implemented this condition to restrict waste forms that contain pure forms of these chemicals.

Unusual Moderator Limits

Condition 2.d limits the total quantities of beryllium, hydrogenous material enriched in deuterium, or graphite to one percent or less of the total weight of the waste (except as allowed by the conditions in Section 1). Information supporting this requirement may be based on process knowledge, physical observations, or testing. The following explanation from the SER provides the basis for this limit:

Unusually effective neutron moderating materials, such as beryllium, graphite, or heavy water, could provide a more reactive matrix. Previous evaluations have shown that the presence of large amounts of beryllium can permit criticality to occur at lower concentrations of SNM in soil. Therefore, limiting unusual moderators is required to assure the effectiveness of the SNM concentration limits in maintaining criticality safety. Because prohibiting unusual moderators could result in problems demonstrating compliance, staff decided to set a finite maximum limit on unusual moderators.

Soluble Uranium Limits

Condition 2.e limits highly soluble forms of uranium in waste packages to 350 grams of uranium-235 or 200 grams of uranium-233. If the waste contains mixtures of U-233 and U-235, the waste must meet the sum of the fractions rule on a container basis. Highly soluble forms of uranium include, but are not limited to: uranium sulfate, uranyl acetate, uranyl chloride, uranyl formate, uranyl fluoride, uranyl nitrate, uranyl potassium carbonate, and uranyl sulfate. Compliance with this condition may be based on process knowledge or testing.

This condition is based on an evaluation performed by the NRC to determine mechanisms that could increase the concentration of SNM in the waste. The SER identifies one such mechanism which involves the potential for highly soluble uranium to be readily leached with water and concentrate in the waste. Generators must evaluate each waste stream to determine the chemical composition of uranium in the waste and to ensure that the presence of highly soluble forms of uranium do not exceed the mass limits specified above.

3.1.5.3 Condition 3 – Characterization of Waste Containing SNM

The NRC developed specific pre-shipment requirements that have been implemented into the waste profiling process. EnergySolutions reviews this information to determine if the pre-shipment waste characterization and assurance plan is complete and that the supporting information is sufficient to demonstrate compliance with all SNM Exemption requirements. This section describes the information that must be attached to the Waste Profile and includes the following items:

- Waste Description
- Waste Characterization Summary

- Uniformity Description
- Manifest Concentration

Condition 3.a requires the generator to describe how the waste was generated, the physical form of the waste, and the uranium chemical composition. The uranium chemical composition of the waste is required to support condition 2.e which limits highly soluble forms of uranium. If compliance with this requirement cannot be demonstrated by process knowledge, approved laboratory methods are available to determine the uranium leaching characteristics of the waste.

Condition 3.b requires the generator to describe how the waste was characterized, the range of SNM concentrations, and the analytical results with error values used to develop the concentration ranges. This information is required to support Conditions 1, 2.a, and 2.b. Generators must sufficiently sample and characterize the waste to ensure that the SNM concentrations do not exceed the specified limits and that the SNM is homogeneously distributed throughout the waste.

A description of the spatial distribution of SNM in the waste is required by Condition 3.c. This description supports the certification of Condition 2.b. The NRC provides guidance in the SER to assist generators in demonstrating compliance with this requirement. Section 3.3.3.2 contains the related NRC guidance.

Condition 3.d requires a description of the methods that will be used to determine the SNM concentrations on the manifests. If concentrations of SNM are significantly lower than the specified limits or the SNM is uniformly distributed throughout the waste, generators are not necessarily required to perform direct measurements on every container. Appropriate methods such as scaling factors may be used in these instances. As SNM concentrations approach the limits, however, generators must perform more extensive characterization to determine the range and variability of SNM in the waste. The following NRC guidance is provided in the SER:

Where the concentration is a small fraction of the concentration limit and characterization results indicate relatively small variation in that concentration, using scaling factors would be an appropriate method to determine SNM concentrations in individual waste containers. However, where the concentration of SNM approaches the concentration limit or the characterization results indicate large variations in SNM containers, using direct measurements on each package would be an appropriate method to determine SNM concentrations in individual waste containers.

Waste packages that contain elevated concentrations of SNM must be characterized by direct measurements which should involve sampling and/or radiological testing procedures for individual packages.

3.1.5.4 Condition 4 – Generator’s Certification

The generator’s certification of compliance is required in the final section. Each generator must certify that the information provided on the SNM Exemption Certification form is complete, true, and accurate. The form and all supporting information must be attached to the Waste Profile upon submission to EnergySolutions. In addition, the SNM Exemption Certification form must be included with each waste manifest. The information supporting the form, however, should not be included with the manifest.

3.1.6 Uranium Waste Shipments

3.1.6.1 Depleted Uranium

On April 13, 2010 the State of Utah Radiation Control Board voted to impose a moratorium on the disposal of concentrated (defined as >5%) depleted uranium (DU) at EnergySolutions' Clive, Facility. Under the moratorium limits, DU manifested isotopically (U-234, U-235, U-238) cannot have a U-238 concentration exceeding 16,500 pCi/g. Waste manifested as DU (without listing U isotopes) cannot exceed 18,000 pCi/g. Generators are encouraged to manifest only enriched uranium shipments isotopically. Compliance with moratorium limits will be evaluated on a manifested container basis.

The moratorium does not apply to waste manifested as natural uranium (U-Nat) or Special Nuclear Material with U-235 exceeding 0.711 weight percent.

This moratorium is effective for any waste received after May 26, 2010 and will remain in effect until the Utah DRC approves a DU-specific Performance Assessment. Generators with existing waste profile depleted uranium concentrations exceeding the moratorium limits will be contacted and requested to reduce the allowable DU concentrations to be compliant with activities specified above.

3.1.6.2 Uranium Shipment Manifesting

EnergySolutions recommends that generators use the following guidelines to evaluate manifested uranium entries.

	Maximum Theoretical or Regulatory Concentration (pCi/g)	Maximum Concentration Driver	Exceptions
Natural Uranium	710,000	Specific activity of Natural Uranium	None
Depleted Uranium	18,000	Utah DRC Moratorium	None
U-238	16,500	Utah DRC Moratorium for DU, SNM limits for U-235 enriched uranium	<2% enriched uranium
U-234	66,500	Utah DRC Moratorium for DU, SNM limits for U-235 enriched uranium	None
U-235 (<10% enrichment)	1,900	SNM Exemption	RML Condition 13.B
U-235 (>10% enrichment)	1,190	SNM Exemption	RML Conditions 13.B and 13.C

Contact EnergySolutions' Technical Staff regarding questions pertaining to uranium manifesting.

3.1.7 Radium-226 Waste

EnergySolutions' Radioactive Material License authorizes the receipt and disposal of waste containing radium-226 (Ra-226) in concentrations not to exceed 10 nCi/gram. In order to minimize potential generation of radon-222 gas and subsequent contamination of personnel, areas, and equipment by the radon particulate decay products; shipments containing radium-226 are subject to the following limitations:

- Any shipment containing Ra-226 in concentrations ≥ 300 pCi/g requires written approval by EnergySolutions' Technical staff, and,

- Any shipment containing Ra-226 in soil, soil-like material, or easily dispersible material such as fine rubble or floor sweepings in concentrations ≥ 300 pCi/g must be packaged in non-bulk containers (i.e. drums or boxes) unless written approval is obtained from EnergySolutions' Technical staff.

3.1.8 Bulk Shipments of Alpha Emitting Radionuclide Waste

Waste containing alpha emitting radionuclides received in bulk containers presents a potential hazard during disposition. Bulk containers may include intermodals, gondola rail cars, or soft-sided bags. EnergySolutions requests that generators provide written notification, either on the 5-day advance shipping notification or specific email to a Technical Services representative, when waste containing alpha emitting radionuclides shipped in bulk containers is scheduled for disposition at Clive.

3.1.9 Waste Containing Hot Particles

Hot particles are very small – often microscopic discrete radioactive fragments with high specific activity. Some are capable of delivering a high beta dose rate (>1 rem/hr and higher) to a localized area. They generally consist of radioactive fission and activation products and are insoluble in water. Their size ranges from less than one millimeter down to 10 nanometers or less. Due to their radioactivity, they are usually highly charged. This charge results in their affinity for clinging to skin, hair, and clothing and their ability to jump large gaps between objects. Because of this ability to jump wide distances, they are often referred to as “fleas”. Because of their small size, high specific activity, electrical charge, and very migrant unpredictable nature they are very difficult to control when released into the work area or environment.

Hot particle waste is defined as waste containing or potentially containing hot particles as defined in this document. Additionally, EnergySolutions considers any waste material marked as Hot Particle (e.g. pre-printed bags/labels or hand-written information on waste items) to be Hot Particle Waste. Because of potential radiological safety concerns associated with this type of waste, EnergySolutions requests that generators submit hot particle-dedicated profiles for each waste stream that includes hot particles. Additionally, hot particle waste must be packaged in drums or boxes for direct disposal. Contact your Technical Services representative for specific guidance.

3.1.10. Polychlorinated Biphenyl (PCB) Radioactive Waste

EnergySolutions is authorized to receive and dispose all types of PCB/radioactive and PCB/mixed wastes defined by the EPA in 40 CFR 761. The EPA issued EnergySolutions a TSCA Coordinated Approval for receipt and disposal of drained PCB Articles and PCB Containers that contained PCBs at concentrations equal to or greater than 500 ppm. Wastes received under the TSCA Coordinated Approval must be disposed in the Mixed Waste disposal embankment. All PCB waste shipped to the Mixed Waste disposal facility must be accompanied with a Uniform Hazardous Waste Manifest. As required by 40 CFR 761, the Uniform Hazardous Waste Manifest must include the date the PCB waste was removed from service. Articles and containers of PCB waste must also be dated with the removed from service date per 40 CFR 761.65(c)(8). Empty PCB containers that contained PCBs at concentrations less than 500 ppm may be disposed in the Class A LLRW Facility; however, this waste will require a Uniform Hazardous Waste Manifest and include the removed from service date on each outer container. A Uniform Hazardous Waste Manifest is not required for any other PCB wastes disposed at the Class A LLRW Facility.

The following sections describe the types of PCB waste categories acceptable for disposal at the Class A LLRW or Mixed Waste disposal embankments. Asterisks indicate PCB waste categories that require disposal in EnergySolutions' Mixed Waste disposal embankment.

EnergySolutions' Ground Water Quality Discharge Permit (GWQDP) and State-Issued Part B Permit prohibit the receipt of any PCB liquids except for 1) intact, non-leaking PCB Small Capacitors or 2) PCB waste that will be treated via VTD. Shipments of PCB wastes containing unauthorized free liquids will not be accepted by EnergySolutions unless re-profiled to a VTD waste stream. Generators shipping PCB wastes in re-usable containers must be lined to prevent PCB contamination on the internal surfaces of the container. Containers contaminated with PCBs will be returned to the shipper as a PCB Container.

3.1.10.1 PCB Remediation Waste

PCB Remediation waste is waste containing PCBs as a result of a spill, release, or other unauthorized disposal, at the following concentrations: (1) Materials disposed of prior to April 18, 1978, that are currently at concentrations ≥ 50 ppm PCBs, regardless of the concentration of the original spill; (2) materials which are currently at any volume or concentration where the original source was ≥ 500 ppm PCBs beginning on April 18, 1978, or ≥ 50 ppm PCBs beginning on July 2, 1979; and (3) materials which are currently at any concentration if the PCBs are spilled or released from a source not authorized for use under this part. PCB remediation waste means soil, rags, and other debris generated as a result of any PCB spill cleanup, including, but limited to soil, gravel, dredged materials, such as sediments, settled sediment fines, and aqueous decantate from sediment, sewage sludge containing < 50 ppm PCBs, buildings and other man-made structures (such as concrete floors, wood floors, or walls) porous surfaces, and non-porous surfaces. Unless sampled and analyzed in accordance with 40 CFR 761.283, .286, or .292, the PCB waste shall be assumed to contain ≥ 50 ppm PCBs (40 CFR 761.61(a)(5)(i)(B)(2)(i)).

PCB Remediation Waste Category	Definition	Acceptable
Non-liquid Cleaning Materials and PPE	Includes non-porous surfaces and other non-liquid materials such as rags, gloves, booties, other disposable PPE, and similar materials resulting from PCB cleanup activities.	Yes
< 50 ppm or $< 100 \mu\text{g}/100 \text{ cm}^2$	PCB Remediation waste containing < 50 ppm or $< 100 \mu\text{g}/100 \text{ cm}^2$.	
≥ 50 ppm or $\geq 100 \mu\text{g}/100 \text{ cm}^2$	PCB Remediation waste containing ≥ 50 ppm or $\geq 100 \mu\text{g}/100 \text{ cm}^2$.	Yes*

* Requires disposal in EnergySolutions' Mixed Waste disposal embankment.

3.1.10.2. PCB Bulk Product Waste

PCB Bulk Product waste is waste derived from manufactured products containing PCBs in a non-liquid state, at any concentration where the concentration at the time of designation for disposal was ≥ 50 ppm PCBs. PCB Bulk Product waste includes bulk wastes or debris from the demolition of buildings and other man-made structures manufactured, coated, or serviced with PCBs.

PCB Bulk Product Waste Category	Definition	Acceptable
Presumed or known to leach < 10 $\mu\text{g/L}$ PCBs	Plastics (such as plastic insulation from wire or cable; radio, television and computer casings; vehicle parts; or furniture laminates); preformed or molded rubber parts and components; applied dried paints, varnishes, waxes or other similar coatings or sealants; caulking; Galbestos; non-liquid building demolition debris; or non-liquid PCB bulk product waste from the shredding of automobiles or household appliances from which PCB small capacitors have been removed (shredder fluff). Other PCB Bulk Product waste that leaches PCBs at < 10 $\mu\text{g/L}$ of water measured using a procedure used to simulate leachate generation.	Yes
Presumed or known to leach ≥ 10 $\mu\text{g/L}$ PCBs	Paper or felt gaskets, fluorescent light ballasts with PCBs in the potting material ≥ 50 ppm	Yes*

* Requires disposal in EnergySolutions' Mixed Waste disposal embankment.

3.1.10.3 PCB Articles

A PCB Article is any manufactured article, other than a PCB Container, that contains PCBs and whose surfaces have been in direct contact with PCBs. A "PCB Article" includes capacitors, transformers, electric motors, pumps, pipes and any other manufactured item (1) which is formed to a specific shape or design during manufacture, (2) which has end use functions dependent in whole or in part upon its shape or design during end use, and (3) which has either no change of chemical composition during its end use or only those changes of composition which have no commercial purpose separate from that of the PCB Article.

EnergySolutions PCB management is regulated under a TSCA Coordinated Approval (CA) from the EPA. Under the CA, EnergySolutions can receive both drained PCB articles (certified flushed), as well as articles that require draining and flushing (PCB transformers or hydraulic machines). PCB Articles that have been drained must be filled with sufficient absorbent material to absorb all remaining liquid. EnergySolutions can also receive and process small leaking PCB capacitors through VTD. Large PCB capacitors require size reduction and VTD processing prior to disposal; EnergySolutions has permits in place that allow both of these activities.

The following table lists the various types of PCB Articles and whether the material is acceptable for disposal in either the mixed waste disposal embankment or LLRW disposal embankment.

PCB Articles Category	Definition	Acceptable
PCB Transformers	Any transformer that contains ≥ 500 ppm PCBs.	Yes* ¹
PCB Capacitors (Intact and non-leaking)	Any capacitor that contains ≥ 500 ppm PCBs. Capacitor is a device for accumulating and holding a charge of electricity and consisting of conducting surfaces separated by a dielectric. Assume PCBs ≥ 500 ppm in a capacitor of unknown concentration made prior to July 2, 1979. Assume PCBs < 50 ppm in a capacitor made after July 2, 1979.	--
PCB Small Capacitors	A capacitor which contains less than 3 lbs of dielectric fluid. A capacitor whose total volume is less than 100 cubic inches may be considered to contain less than 3 lbs of dielectric fluid. Includes fluorescent light ballasts containing intact and non-leaking PCB small capacitors and PCB potting material (< 50 ppm).	Yes*
PCB Large High or Low Voltage Capacitors	A large high voltage capacitor contains 3 lbs or more of dielectric fluid and which operates at or above 2,000 volts. A large low voltage capacitor contains 3 lbs or more of dielectric fluid and which operates below 2,000 volts.	Yes* ³
PCB Hydraulic Machines	Includes die casting machines	Yes* ²
PCB-Contaminated Electrical Equipment	Any electrical equipment (such as transformers, capacitors, and circuit breakers, including those in railroad locomotives and self-propelled cars) which contain ≥ 50 ppm and < 500 ppm PCBs in the dielectric fluid. In the case of dry electrical equipment, the electrical equipment is PCB-Contaminated if it has PCBs > 10 ug/100 cm ² and < 100 ug/100 cm ² as measured by a standard swipe test (40 CFR 761.123).	Yes
Other PCB Articles		--
PCB Article (≥ 500 ppm PCBs)		Yes*
PCB-Contaminated Article	Any article which contains ≥ 50 ppm and < 500 ppm PCBs in the dielectric fluid. In the case of dry electrical equipment, the electrical equipment is PCB-Contaminated if it has PCBs > 10 ug/100 cm ² and < 100 ug/100 cm ² as measured by a standard swipe test per 40 CFR 761.123.	Yes

* Requires disposal in EnergySolutions™ Mixed Waste disposal embankment.

¹ Requires solvent flushing (by generator or EnergySolutions™).

² Requires solvent flushing if PCB concentrations $\geq 1,000$ ppm.

³ Requires VTD treatment

3.1.10.4 PCB Containers

A PCB Container is any package, can, bottle, bag, barrel, drum, tank, or other device that contains PCBs or PCB Articles and whose surfaces have been in direct contact with PCBs. PCB Containers must be emptied to the extent practical and not contain any free standing liquid. All PCB Containers received for disposal require a Uniform Hazardous Waste Manifest and removed from service dates.

PCB Container Category	Definition	Acceptable
≥ 500 ppm PCBs	The PCB concentration of material which was contained in the PCB Containers was ≥ 500 ppm	Yes*
< 500 ppm PCBs	The PCB concentration of material which was contained in the PCB containers was < 500 ppm	Yes

* Requires disposal in EnergySolutions' Mixed Waste disposal embankment.

3.1.10.5 PCB Oils

EnergySolutions is authorized to process PCB oils through the VTD unit. Oils may originate from drained (either by the generator or EnergySolutions) large capacitors, transformers, or other PCB articles.

3.1.11 Dioxins and Furans

Dioxins/furans are generated by a variety of chemical and thermal industrial processes. Carrying EPA waste codes F020, F021, F022, F023, F026 and F027, dioxins and furans represent some of the most toxic compounds found in waste. EnergySolutions is authorized to receive LDR compliant dioxin/furan waste for direct disposal in the mixed waste embankment. Dioxin/furan waste requiring treatment will be evaluated on a case by case basis before acceptance is approved. Like PCB wastes, dioxin/furan waste streams must have dedicated radioactive waste profile records.

3.1.12 UCNI and Export Controlled Waste

EnergySolutions has been granted approval from the DOE to receive Unclassified Controlled Nuclear Information (UCNI) and Export Controlled radioactive waste. This type of waste primarily originates from the DOE gaseous diffusion enrichment facilities. DOE generators must contact EnergySolutions prior to shipping UCNI and Export Controlled radioactive waste.

3.1.13 Chelating Agents

EnergySolutions is authorized to dispose of waste containing up to 22 percent by weight chelating agents in the Mixed Waste disposal embankment. Waste disposed of in the LLRW disposal embankment must contain less than 0.1 percent by weight chelating agents. Generators may ship waste containing greater than 22 percent chelating agents to EnergySolutions' Treatment Facility once approved during the waste profiling process. EnergySolutions will treat waste containing greater than 22 percent chelating agents prior to disposal in order to comply with this requirement.

3.1.14 Asbestos and Beryllium

EnergySolutions is authorized to dispose of waste containing both friable and non-friable asbestos. The asbestos waste must be described in the Radioactive Waste Profile Record and packaged, marked, and labeled in accordance with applicable federal regulations. Friable asbestos must not be packaged in bulk containers unless approved in writing by EnergySolutions.

Asbestos waste that requires wetting to prevent dispersion must be inspected to minimize free liquids. However, unless the waste is to be solidified at the Treatment Facility, the free liquid may not exceed one percent of the waste volume. Absorbent material must be added to containers when free liquids are present. Waste streams containing greater than one percent free liquid by waste volume may be shipped to EnergySolutions' Treatment Facility for solidification prior to disposal. Contact EnergySolutions prior to shipping waste streams that contain free liquids.

Waste containing other potential inhalation hazards such as beryllium must be described in the Waste Profile and documented on the 5 Working-Day Advanced Shipment Notification form. A quantitative description of potential beryllium surface contamination and air monitoring measurements both before and after any fixatives or wrapping are applied should be included in the Waste Profile for beryllium contaminated waste. The description should also include information about the current management of the beryllium contaminated waste including specific work control procedures in handling and packaging the waste for shipment, details of the beryllium protection program as applicable, and air monitoring measurements, etc. Beryllium contaminated waste must be packaged in 55-gallon or smaller drums unless approved in writing by EnergySolutions.

3.1.15 Lab Packs

Lab packs are described as small containers of liquid with varying hazardous waste codes that are placed in a larger shipping or storage container. EnergySolutions is authorized to receive lab packs in which all of the contents are known and acceptable for treatment or disposal. Lab packs require a specific Waste Profile that must be approved by EnergySolutions prior to shipment. Generators must provide a description of unused chemicals within containers with the shipping paperwork.

3.1.16 Reactive Metal Waste

EnergySolutions will review the acceptance of reactive metals for treatment on a case by case basis. Acceptance requires State of Utah DRC and DSHW approval.

3.2 ACCEPTABLE FORMS OF RADIOACTIVE WASTE

EnergySolutions' Radioactive Material License authorizes the receipt of radioactive waste in the form of liquids and solids. Solid radioactive waste must contain less than one percent free liquid by waste volume. Generators shipping solid waste must minimize free liquid to the maximum extent practicable. Conversely, liquid radioactive wastes contain greater than one percent free liquid by waste volume (e.g., sludge, wastewater, evaporator bottoms, etc.). EnergySolutions will determine if a waste contains free liquids by either visual inspection or by performing the Paint Filter Liquid Test (EPA SW-846 Method 9095). Liquid radioactive waste is solidified at EnergySolutions' Treatment Facility prior to disposal.

Solid waste includes, but is not limited to, the following forms of waste: soil, sludge, dry active waste, metal, concrete, wood, glass, resin, etc. For simplicity, these waste forms are categorized into either soil or debris waste streams due to the placement criteria specified in the license.

3.2.1 Soil or Soil-Like Wastes

EnergySolutions constructs the disposal embankment by achieving specified compaction criteria and minimizing void spaces in the disposal lift. Construction of the disposal embankment in this manner ensures long-term integrity of the disposal facility. Soil and soil-like waste material are placed in the disposal embankment and compacted in lifts. The license requires these soil lifts to be compacted to greater than 90 percent of optimum density and at a moisture content not to exceed three percentage points above optimum moisture as determined by the Standard Proctor Method (ASTM D-698). Consequently, soil or soil-like waste must have soil-like properties and conform to the following specifications. Otherwise, the waste material will be considered debris and managed for disposal as described in Section 3.2.2.

Soil/Soil-Like Properties

- Greater than 70 percent by weight compactable material less than 3/4" particle size and 100 percent compactable material less than 4" particle size
- Maximum dry density greater than 70 pounds per cubic foot (dry weight basis)
- Moisture content of the soil or soil-like waste must not exceed three percentage points above optimum moisture upon receipt at EnergySolutions
- Maximum dry density and optimum moisture must be determined by Standard Proctor Method ASTM D-698

EnergySolutions may request a preshipment sample to perform an independent compaction test using Standard Proctor Method ASTM D-698. Generators must include their compaction test results as part of the waste profile submittal.

Shipments of soil or soil-like waste streams may contain some standard size debris in waste packages. For disposal in a bulk soil lift, debris must be less than 10 inches in a least one dimension and no longer than 12 feet in any dimension. Debris items that exceed this size limit should be profiled and packaged separately, unless prior written approval is granted by EnergySolutions. The percentage of allowable debris in the waste stream must be listed in the waste profile. Soil or soil-like waste streams with moisture content exceeding three percentage points above optimum moisture are acceptable by EnergySolutions and require additional handling prior to disposal. Contact EnergySolutions' Technical Services staff prior to shipping soil or soil-like waste streams with elevated moisture content. Generators should be aware that absorbed liquids typically do not exhibit soil-like properties.

Generators are requested to identify Department of Agriculture (DOA) regulated soils in the waste profile. Of particular concern are DOA regulated soils with the potential for witch weed, fire ants, golden nematodes, and corn cyst nematodes.

3.2.2 Debris

Waste material not meeting the specified soil or soil-like properties is considered debris by EnergySolutions. Debris includes both decommissioning and routinely generated operational waste including, but not limited to, radiologically contaminated paper, piping, rocks, glass, metal, concrete, wood, bricks, resins, sludge, tailings, slag, residues, and personal protective equipment (PPE) that conforms to the debris size requirements.

3.2.2.1 Standard Size Debris

Debris is defined into two broad categories based on size. The first category is standard debris and includes materials that are less than 10 inches in at least one dimension and no longer than 12 feet in any dimension. Debris that does not meet this size criterion is categorized as oversize debris.

Standard size debris is uniformly distributed throughout the engineered soil lifts. *EnergySolutions* adds either native clay or radioactive soil to the debris. Each soil lift is limited to the amount of debris that may be placed with soil to achieve the required compaction criteria. Depending upon the conditions of the disposal agreement, some generators that have both soil and debris may be able to achieve cost savings by delivering these materials together such that the shipping package contains enough soil to mix with the debris to achieve compaction requirements. All debris must be placed in such a way to minimize void space in the soil lift.

3.2.2.2 Oversize Debris and Large Components

Waste material is considered oversize debris if the debris has at one dimension greater than 12 feet or does not have one dimension less than 10 inches. Since oversize debris cannot be compacted directly into the soil lifts, this material is placed in different areas of the disposal embankment where void spaces are minimized to the maximum extent practicable both in and around the debris.

Bulk oversize debris, such as a large component, is also disposed of using this alternative disposal process. *EnergySolutions* has received and disposed of several large components over 250 tons including steam generators, reactor heads, turbine components, and other large equipment as illustrated in Figure 3-2. Generators should identify these types of materials as part of the waste profiling process. This will allow *EnergySolutions* to evaluate the off-loading and placement of the large component prior to shipment.

Generally, single items over 20,000 pounds are considered large components and require special handling and engineering reviews prior to placement. The type of information required for large components includes drawings, photographs, weight, dimensions, description of enclosed voids, packaging configuration, rigging and loading plan, identification of lifting points, transportation mode, and radiological characterization and survey documentation. Generators are requested to provide this type of information as early as possible in the project planning to help facilitate safe, efficient offloading at Clive. Void spaces within large components must be made accessible via a minimum of two access ports to allow grout in-fill during disposal operations at the Clive disposal facility. Access ports must be at least four inches in diameter unless approved in writing by *EnergySolutions*. Containers of oversize debris must exclude soil or soil-like waste due to placement criteria. Generators should be aware that waste disposed as large components is required to be free of external contamination. The Large Component disposal cell is a radiologically non-contaminated area.

EnergySolutions may also elect to dispose of dispersible waste forms (e.g., filter cake, dusty material, etc.) or waste with elevated dose rates by not emptying the waste from the container. Although ion-exchange media (resin) meets the standard size debris criteria, resins are not emptied from the container but grouted to minimize void spaces. Consequently, resin waste streams must be shipped under a resin specific waste profile unless approved in writing by *EnergySolutions*. Void spaces in and around the containers are minimized to the maximum extent practicable. Material that is excessively dusty cannot be disposed of as soil-like material and requires containerized disposal.



Figure 3-2. Large Component Disposal

3.2.3 Gaseous Waste

EnergySolutions is authorized to receive gaseous waste in accordance with Utah Administrative Code R313-15-1009(2)(a)(viii). Gaseous waste must be packaged at an absolute pressure that does not exceed 1.5 atmospheres at a temperature of 20 degrees Celsius and the total activity of any container shall not exceed 100 Curies. This information must be identified in the Radioactive Waste Profile Record.

3.2.4 Waste Containing Free Liquids

Wastes containing free liquids greater than one percent by volume are considered liquid waste streams. Generators may use visual inspection of the waste or the Paint Filter Liquids Test to determine if the waste contains free liquids. The Radioactive Waste Profile Record must describe the physical, chemical, and radiological characteristics of the liquid waste. EnergySolutions received approval from the Utah DRC to receive radioactive liquid wastes that are aqueous based. Non-aqueous radioactive liquids require case-by-case approval from the Utah DRC.

EnergySolutions may require a solidification study on a sample of the liquid waste prior to authorizing shipments. EnergySolutions has permitted liquid storage tanks to accommodate liquids delivered in tankers and other DOT approved bulk containers.

For generators with waste streams that may contain free liquids, the process by which the liquid will be minimized to less than one percent of the waste volume must be documented in the Radioactive Waste Profile Record. Approval of these waste streams would be considered authorized free liquids.

The presence of unauthorized free liquid within a package or shipment is a significant cause of non-compliance. Each incoming shipment will be tested for free liquids in accordance with EnergySolutions' Waste Characterization Plan using visual inspection of the waste or the Paint Filter Liquids Test.

If a solid waste shipment is found to contain unauthorized free liquids greater than one percent of the waste volume in any manifested container, EnergySolutions is required to promptly notify the generator and the Utah DRC. EnergySolutions may stop shipments of waste material until the cause of the problem is identified and corrected. The Waste Characterization Plan requires that the generator submit a quality control program that identifies the root cause of the problem and outlines corrective actions that will be taken to correct the problem and the quality control measures that will be implemented to prevent recurrence. Until this corrective action plan has been submitted, reviewed, and approved by EnergySolutions' Quality Assurance Manager, no further shipments may be permitted from the waste generator's site.

In order to control free liquid within the waste material, the use of absorbent materials is strongly recommended. Sufficient absorbent material to absorb twice the volume of the potential liquid should be used. Experience has shown that some soil matrices actually „bleed“ moisture out during transport due to vibration. If testing indicates that the waste material, as shipped, could exceed the optimum moisture content (as determined by the Standard Proctor Test) and that a risk of waste form separation exists while the shipment is en route, the precautionary addition of absorbents prior to shipment is strongly advised. To ensure that adequate absorbents are added, generators should also consider testing the moisture content of each shipment.

Although uncommon, in some cases it is possible for precipitation to enter the package resulting in free liquids. Detailed inspections should be completed before waste is placed in transit to ensure the package meets strong-tight criteria and that water cannot enter. EnergySolutions does not maintain a list of approved absorbents or manufacturers. If absorbents are added to the waste, the specific absorbent must be identified in the Radioactive Waste Profile Record (Section B.5).

3.3 PROHIBITED RADIOACTIVE AND MIXED WASTE

Condition 16 of the Radioactive Material License **prohibits** receipt of the following wastes:

- Sealed sources defined in UAC R313-12 as “radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions which are likely to be encountered in normal use and handling” (e.g., instrument calibration check sources, smoke detectors, nuclear density gauges, etc.).
- Radioactive waste which is classified as Class B, Class C, or Greater Than Class C waste.
- Solid waste containing unauthorized free liquids.
- Waste material that is readily capable of detonation, of explosive decomposition, reactive at standard temperature and pressure, or reactive with water or air.
- Waste materials that contain or are capable of generating quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste.
- Waste materials that are pyrophoric. Pyrophoric materials contained in wastes must be treated, prepared, and packaged to be nonflammable. Neither pyrophoric solids, or potentially pyrophoric solids as defined below may be accepted:
 - Ignitable (pyrophoric) solids: solid substances that under normal conditions (~standard temperature and pressure) are capable of causing fire through friction, absorption of moisture, or spontaneous chemical change; or can be ignited readily and when ignited burns vigorously and persistently.
 - Potentially ignitable (pyrophoric) solids: solid substances in which shavings or other small particles that may be generated through management of the material meets the definition of an ignitable material.

Note: As mentioned in Section 3.1.13, Reactive Metals may be accepted for treatment on a case by case basis under certain conditions. Technical Services staff may be contacted to determine deactivation at EnergySolutions is a viable alternative.

- Waste materials containing untreated biological, pathogenic, or infectious material including contaminated laboratory research animals. Generators desiring to ship this type of waste must document in the Radioactive Waste Profile Record the process used to treat the potential non-radiological hazard. Sharps including needles, scalpels, knives, syringes, pipettes, and similar items having a point or sharp edge or that are likely to break during transportation must not be packaged in bulk containers unless written approval is given by EnergySolutions. When these items are used in the medical industry or related research, they must be treated to remove the biohazard. Documentation of such treatment must be included in the Waste Profile.

The following Mixed Wastes are **not** acceptable for treatment or disposal at the Mixed Waste facility:

- Hazardous waste that is not also a radioactive waste
- Wastes that react violently or form explosive reactions with air or water (without written approval by EnergySolutions)
- Pyrophoric wastes and materials (without written approval by EnergySolutions)
- DOT Forbidden, Class 1.1, Class 1.2 and Class 1.3 explosives
- Shock sensitive wastes and materials
- Compressed gas cylinders, unless they meet the definition of empty containers
- Utah waste codes F999 and P999
- Aerosol cans that are not punctured or depressurized (these items will be segregated and shipped back to the generator or to an approved processing facility)

SECTION 4

WASTE ACCEPTANCE PROCESS

4.1 WASTE PROFILING PROCESS

This section details EnergySolutions' waste characterization and profiling process. Profiling a waste stream involves collecting samples and obtaining analytical results for the parameters specified on EnergySolutions' Radioactive Waste Profile Record (Waste Profile). The Waste Profile serves the following functions: (1) enables EnergySolutions to evaluate wastes for acceptance, (2) maintains an operating record for the material during acceptance, storage, treatment, if applicable, and disposal of waste shipments, (3) provides a historical record of the waste project for each waste stream, and (4) ensures compliance with EnergySolutions' licenses and permits. The Waste Profile and related instructions can be downloaded from EnergySolutions' web site Customer Portal tab at www.energysolutions.com. An EnergySolutions Technical Services Representative is also available to assist in the waste profiling process.

The waste profiling process consists of the following steps as illustrated in Figure 4-1:

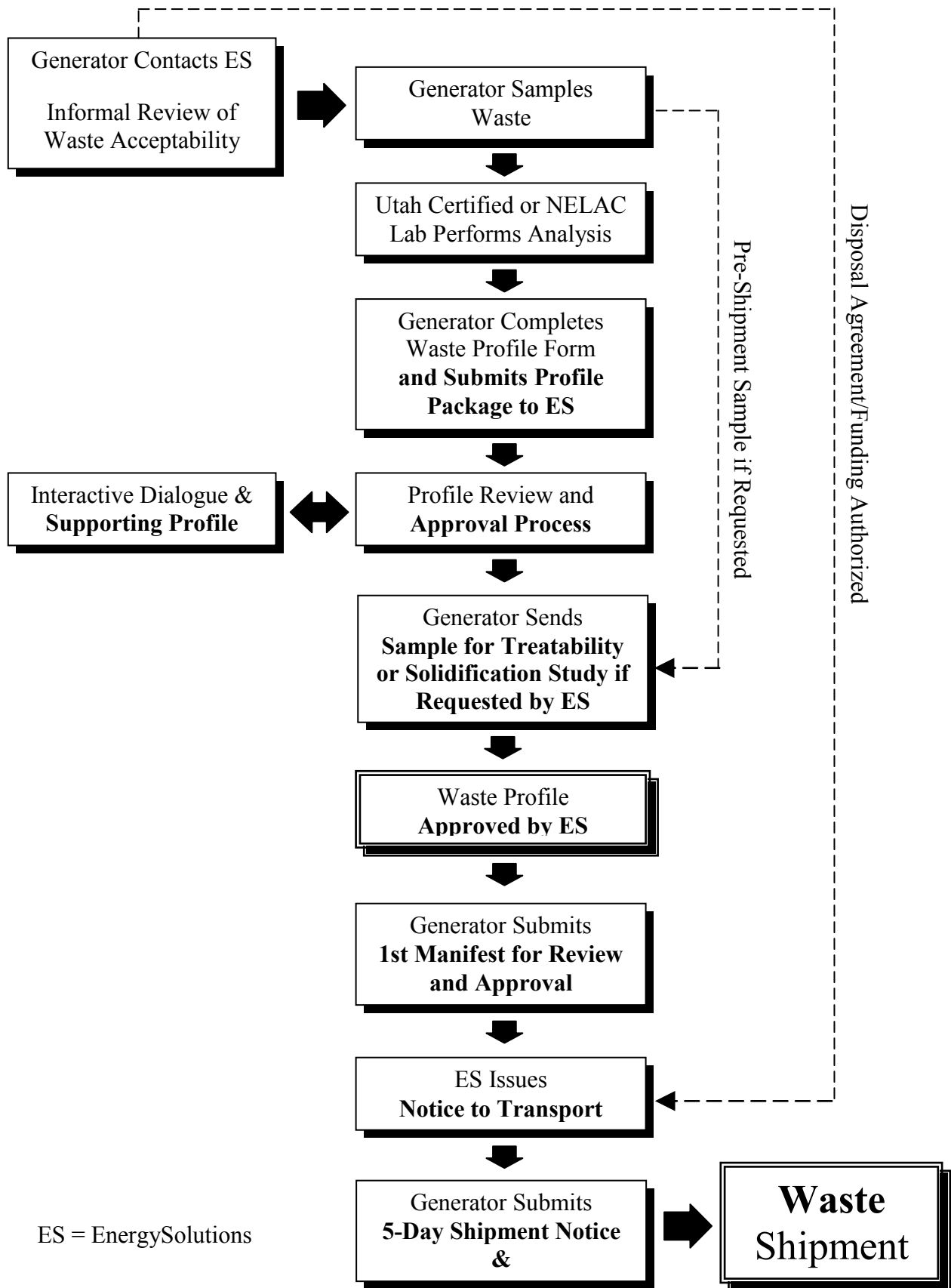
- Initial discussions
- Waste characterization
- Waste Profile Record completion and submittal
- Treatability and/or solidification study sample submitted, if requested
- Profile review and approval
- Notice to Transport

Initial discussions of the waste stream are critical in ensuring that the waste profiling process is accurate and efficient. Technical Services representatives are a resource to the generator in completing this process.

4.2 WASTE CHARACTERIZATION

Early in the process, the generator samples the waste stream where applicable and begins to accumulate the analytical data required in the waste profile record described below. It is critical that chemical analyses are performed by laboratories certified by either the State of Utah or the National Environmental Laboratory Accreditation Conference (NELAC). Generators may contact the Utah Department of Health at (801) 584-8501 or visit their website at <http://health.utah.gov> to obtain information on the Utah Laboratory certification requirements. Laboratories certified by NELAC are listed on the US EPA's website at www.epa.gov/nerlesd1/land-sci/nelac/accreditlabs.html. Technical Services representatives can also provide current laboratory certification information. Once the analytical support data is available, the generator completes the Waste Profile record as described in the following section.

Figure 4-1. Waste Acceptance Process



4.3 RADIOACTIVE WASTE PROFILE RECORD

The waste profile record is a document required by EnergySolutions' licenses and permits. It provides information in the following areas:

- Generator and waste stream information
- Physical properties and packaging
- Radiological information
- Chemical composition and hazard evaluation

Waste generators must complete a Radioactive Waste Profile Record for every waste stream shipped to EnergySolutions. To complete this form, the generator should use process knowledge along with analytical laboratory results. The form contains the following sections.

- **Generator and Waste Stream Information**
These sections request generator contact information and general overview of the type of waste material, physical characteristics, transportation and package modes, identification of specific radionuclides, and the average and range of radionuclide concentrations.
- **Chemical and Hazardous Waste Characteristics (LLRW or MW)**
The generator selects the applicable attachment for describing the chemical properties for either LLRW or Mixed Waste. These attachments request the chemical information to evaluate the waste relative to RCRA regulations. Only one of these attachments is required to be signed and submitted to EnergySolutions with the Waste Profile.
- **SNM Exemption Certification**
This form requests the radiological information to evaluate waste containing SNM with respect to the SNM Exemption issued by the NRC and incorporated into EnergySolutions' license. Condition 3 of the SNM Exemption Certification form requests specific information to be included with the narrative of the Waste Profile.
- **PCB Waste Certification**
This form requests information about the type of Polychlorinated Biphenyls (PCBs) waste included with the waste stream. PCB waste streams must be profiled separately from non-PCB waste streams. EnergySolutions uses this form and supporting information to evaluate PCB waste streams with respect to EnergySolutions' permits and TSCA regulations in 40 CFR 761.

4.3.1 Generator and Waste Stream Information

This section includes contact information for generators, including addresses and responsible parties. The contact information is required for the generator's representative as well as for the individual completing the Waste Profile. The generator must answer a series of questions designed to categorize the waste material that is profiled. The generator identifies the following:

- If the waste is hazardous, and whether it has been treated or requires treatment at EnergySolutions
- If the waste is Low-Level Radioactive Waste and subject to LLRW Compact Export approval
- If the waste contains Special Nuclear Materials, PCBs, or asbestos

4.3.2 Waste Physical Properties and Packaging

The physical and geotechnical properties of the waste include gradation of the material, density range, a full description of the physical composition and characteristics of the waste, moisture content, optimum moisture, and maximum dry density determined by the Standard Proctor Method (for soil or soil-like materials).

The purpose of the physical and geotechnical testing requirements is to demonstrate that the material can be managed at the Clive facility under existing license/permit requirements and in accordance with EnergySolutions' waste disposal placement methods.

The gradation of the waste may be determined through analysis or waste process knowledge. After an assessment of the entire waste stream, the generator is expected to estimate the amount of material that would pass through the various screens indicated. This information is necessary to determine the method of waste placement.

In this section, the generator addresses questions regarding free liquids. If the waste contains free liquids, the Waste Profile requires a description including the quantity and nature (aqueous or non-aqueous) of the liquid. Solid waste profiled to contain incidental free liquids must be minimized to the maximum extent practical but in no case shall the free liquid exceed one percent of the waste volume upon arrival and inspection at the Clive facility. Waste streams containing PCBs must not contain any free liquids unless shipped for VTD treatment.

The waste description is continued by addressing several items in a narrative description and history of the waste provided by the generator as an attachment, referred to as Attachment B.5. The narrative should include the following items as applicable:

- The process that generated the waste
- Waste material physical composition and characteristics
- Radiological and chemical characterization method
- Information requested on the SNM Exemption Certification form, if applicable
- The type and description of PCB waste, if applicable
- Basis for determining manifested radionuclide concentrations
- Description and amounts of absorbents, if applicable
- Basis of non-hazardous or hazardous waste determinations
- Treatment processes, if applicable
- Product information or Material Safety Data Sheets associated with the waste as applicable
- Information requested in other sections of the Waste Profile

4.3.3 Radiological Information

All waste streams must be analyzed to determine the radionuclide concentrations in the waste. The waste must be characterized via gamma spectroscopy, liquid scintillation, or other standard radiochemistry methods to determine the radionuclide concentrations in the waste. Indirect measurements such as dose-to-curie or use of scaling factors may also be used if the process has been validated with direct measurements. Radiological analysis does not need to be performed by Utah or NELAC Certified laboratories. Non-gamma emitting radionuclides such as Fe-55 and Ni-63, may be scaled from the gamma spectral analysis obtained from testing the material if the waste generator has specific process knowledge of the material being profiled (10 CFR Part 61 analyses).

Please note that discrepancies between radiological information, particularly concentration ranges, and waste manifest documents could delay or prevent acceptance of a shipment. The Waste Profile must always be reviewed with the waste manifest documents prior to shipping waste to *EnergySolutions*. In the event that radiological, physical, or chemical properties of a profiled waste stream have changed, an update to the Waste Profile must be submitted and approved before such waste can be shipped to *EnergySolutions*.

EnergySolutions requires that generators evaluate the maximum dose rates and contamination levels anticipated in each waste stream. In the radiological section of Waste Profile, the generator indicates whether or not the maximum dose rate on accessible surfaces exceeds the ALARA Criteria as described in Section 2.3.1.

While the Clive facility is permitted to receive Class A LLRW, certain radionuclides are subject to additional controls established by the Utah DRC. For example, Radium-226 is limited to 10,000 pCi/g. In addition, the Utah DRC regulates the following radionuclides under Condition 29E of *EnergySolutions*'s Radioactive Materials License:

- Aluminum-26
- Berkelium-247
- Calcium-41
- Californium-250
- Chlorine-36
- Rhenium-187
- Terbium-157
- Terbium-158

EnergySolutions is required to provide a one-time notice for each generator shipping one of these radionuclides to the Class A disposal embankment. For waste shipped for disposal at the Mixed Waste disposal embankment, *EnergySolutions* must provide a one-time notification for each generator shipping waste containing Chlorine-36 and Berkelium-247. The generator includes the anticipated presence of these nuclides in the radiological information provided in the Waste Profile.

Finally, the generator lists the radionuclides present in the waste stream in conjunction with the expected maximum manifested concentration and the weighted average concentrations expected for each radionuclide. The generator is expected to manifest values for each shipment that are within the maximum values stated in this section of the Waste Profile. In the event that a generator needs to ship waste to *EnergySolutions* that exceeds the limits in the radiological information section of the Waste Profile, the generator may submit a revised Waste Profile to *EnergySolutions* for review and approval.

Any additional information including laboratory results for gamma spectroscopy or radiochemistry analysis must be attached to the Waste Profile. Radiological characterization methods and the basis for determining manifested radionuclide concentrations should be included in Attachment B.5 as described above.

4.3.4 Chemical Composition and Hazardous Waste Evaluation

In accordance with the response to the hazardous waste question posed in the generator and waste stream information section, the generator provides one of two attachments with the Waste Profile addressing the chemical composition of the waste.

For hazardous wastes, the generator provides a completed and signed copy of the Hazardous Waste Analysis Certification Attachment. The chemical and hazardous characteristics of the waste stream must be provided in extensive detail. The purposes of chemical testing are to (1) demonstrate that the waste meets specific waste acceptance chemical requirements; and (2) demonstrate that the waste is either non-hazardous, compliant with RCRA treatment standards, or will require treatment prior to disposal. In addition, analysis is required to qualify wastes that may contain other specific regulated constituents.

EnergySolutions' licenses and permits require the results of the following minimum analyses be provided with the Waste Profile:

Analysis	EPA SW-846 Method(s)
pH (liquids only)	Method 9045
PFLT (solid waste only)	Method 9095
Organics (Totals)	Method 8260 & 8270
Results from applicable concentration based treatment standards	

The results of these analyses are documented on the Hazardous Waste Analysis Certification Attachment and attached to the Waste Profile.

The Hazardous Waste Analysis Certification Attachment also includes waste codes applicable to the waste stream with corresponding treatment standards or technology codes and worst case concentrations. This information is critical in evaluating wastes for treatment at EnergySolutions.

Applicable Underlying Hazardous Constituents (as defined in 40 CFR 268.48) and other chemicals present are identified at the end of the attachment.

For non-hazardous waste streams, the generator provides a signed copy of the Low-Level Radioactive Waste Certification Attachment. EnergySolutions' licenses and permits require the results of the following analyses be provided with the Waste Profile:

Analysis	EPA SW-846 Method
pH (liquids only)	Method 9045
TCLP Metals	Method 6010/7470
TCLP Herbicides	Method 8151
TCLP Pesticides	Method 8081
TCLP Semi-volatiles	Method 8270
TCLP Volatiles	Method 8260

The individual chemical compounds required for these analyses are listed on the Low-Level Radioactive Waste Certification Attachment and correspond to the characteristic D-list constituents (D004 through D043) identified in 40 CFR 261.24 Table 1 as shown below.

40 CFR 261.24 Table 1

TABLE 1—MAXIMUM CONCENTRATION OF CONTAMINANTS FOR THE TOXICITY CHARACTERISTIC

EPA HW No. ¹	Contaminant	CAS No. ²	Regulatory Level (mg/L)
D004	Arsenic	7440-38-2	5.0
D005	Barium	7440-39-3	100.0
D018	Benzene	71-43-2	0.5
D006	Cadmium	7440-43-9	1.0
D019	Carbon tetrachloride	56-23-5	0.5
D020	Chlordane	57-74-9	0.03
D021	Chlorobenzene	108-90-7	100.0
D022	Chloroform	67-66-3	6.0
D007	Chromium	7440-47-3	5.0
D023	o-Cresol	95-48-7	⁴ 200.0
D024	m-Cresol	108-39-4	⁴ 200.0
D025	p-Cresol	106-44-5	⁴ 200.0
D026	Cresol	⁴ 200.0
D016	2,4-D	94-75-7	10.0
D027	1,4-Dichlorobenzene	106-46-7	7.5
D028	1,2-Dichloroethane	107-06-2	0.5
D029	1,1-Dichloroethylene	75-35-4	0.7
D030	2,4-Dinitrotoluene	121-14-2	³ 0.13
D012	Endrin	72-20-8	0.02
D031	Heptachlor (and its epoxide)	76-44-8	0.008
D032	Hexachlorobenzene	118-74-1	³ 0.13
D033	Hexachlorobutadiene	87-68-3	0.5
D034	Hexachloroethane	67-72-1	3.0
D008	Lead	7439-92-1	5.0
D013	Lindane	58-89-9	0.4
D009	Mercury	7439-97-6	0.2
D014	Methoxychlor	72-43-5	10.0
D035	Methyl ethyl ketone	78-93-3	200.0
D036	Nitrobenzene	98-95-3	2.0
D037	Pentachlorophenol	87-86-5	100.0
D038	Pyridine	110-86-1	³ 5.0
D010	Selenium	7782-49-2	1.0
D011	Silver	7440-22-4	5.0
D039	Tetrachloroethylene	127-18-4	0.7
D015	Toxaphene	8001-35-2	0.5
D040	Trichloroethylene	79-01-6	0.5
D041	2,4,5-Trichlorophenol	95-95-4	400.0
D042	2,4,6-Trichlorophenol	88-06-2	2.0
D017	2,4,5-TP (Silvex)	93-72-1	1.0
D043	Vinyl chloride	75-01-4	0.2

¹Hazardous waste number.

²Chemical abstracts service number.

³Quantitation limit is greater than the calculated regulatory level. The quantitation limit therefore becomes the regulatory level.

⁴If o-, m-, and p-Cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200 mg/l.

The attachment also includes a question as to whether or not the waste was at the point of generation of a hazardous waste, and a section to address former hazardous waste codes and additional chemical constituents.

As stated previously, the chemical analysis must be performed by a laboratory holding a NELAC or State of Utah certification. Data provided to the generator prior to any discussions of waste characterization with *EnergySolutions* may be acceptable for waste profiling purposes upon investigation of associated quality control sample data.

EnergySolutions may waive the chemical laboratory analyses if the material is not amenable to chemical sampling and analysis (e.g., debris items including metal pieces, concrete, plastic, etc.). Justification for waiving the chemical analyses must be provided in the narrative in Attachment B.5. Technical Service representatives can provide direction in cases where the waste meets such a description.

Regardless whether the profiled waste is RCRA regulated or LLRW, the generator is responsible for notifying EnergySolutions of any waste that may present a safety and health risk to Clive operations staff.

4.3.5 Special Nuclear Material Exemption Certification Form

Waste containing Special Nuclear Material (SNM) must comply with the SNM requirements for concentration, spatial distribution, chemical mixture, solubility and chemical composition of SNM isotopes as described in Section 3.1.5 of the BWF WAC. The SNM Exemption Certification form guides the generator through the supporting information that must accompany the Waste Profile and each shipment of waste containing SNM. In addition to answering the questions on the form, the generator includes descriptions in Attachment B.5 for the requirements listed in items 3(a) through 3(d) of the SNM form. A completed and signed copy of the SNM Exemption Certification form must accompany the shipping paperwork for waste shipments containing Special Nuclear Material.

4.3.6 PCB Waste Certification Form

EnergySolutions' Statute-Issued Part B Permit and Groundwater Quality Discharge Permit include the authorizations and requirements for EnergySolutions to receive PCB waste regulated for disposal under 40 CFR 761. The PCB waste types acceptable at EnergySolutions are listed in Section 3.1.6 of the BWF WAC. The generator must include a description of the type of PCB waste in the narrative of Attachment B.5. The PCB Waste Certification form does not need to accompany the waste shipment unless requested by EnergySolutions during the Waste Profile approval process.

4.4 TREATABILITY AND SOLIDIFICATION STUDY SAMPLES

For waste streams requiring treatment or solidification, EnergySolutions may request a treatability sample to perform a treatability study and/or solidification study during the waste profiling approval process. This allows EnergySolutions to develop the necessary treatment and solidification formula prior to receipt of the waste. Treatability samples are not required for waste streams requiring treatment via macroencapsulation. EnergySolutions may request additional samples during the waste profiling process to evaluate the waste material prior to receipt.

Treatability study samples should represent the "worst case" for a waste stream destined for treatment at EnergySolutions. The samples should contain the highest anticipated levels of chemical contaminants in the waste stream to ensure that EnergySolutions can develop a treatment formula that is adequate for the entire waste stream. EnergySolutions may be required to perform additional treatability studies if the waste shipments contain chemical constituents of concern at concentrations that are higher than the treatability study sample.

Treatability samples may not be shipped to the EnergySolutions' Clive facility without prior authorization. At a minimum, a preliminary Waste Profile will need to be prepared and submitted that describes the waste and its generation. This preliminary Waste Profile must include both chemical and radiological assessments and must be approved by EnergySolutions prior to shipment of the sample. When approved for shipment, EnergySolutions will provide a Preshipment Sample Authorization Record to the generator.

Samples should be packaged into one or more sealed containers in such a manner that the sample container will not break during normal shipping conditions. Generally, the volume of sample requested will be less than 5 gallons. Sample containers should be labeled with the waste stream number, date, and a sample ID number. Sample closure devices should also be sealed with a custody or anti-tamper seal to ensure sample integrity.

Samples sent to *EnergySolutions* must be properly classed, described, packaged, marked, labeled, and in condition for transport as required by the DOT Hazardous Materials Regulations (HMR) contained in 49 CFR Parts 171 through 180. The Preshipment Sample Authorization forms must be completed and attached to the outside of the shipping package. A Uniform LLRW Manifest (Forms 540/541) must also accompany the shipping paperwork. The manifest number for the shipping paperwork is the Waste Stream ID number (e.g., XXXX-YY). The samples must be sent to the following address:

EnergySolutions
Attention: Sample Control
US I-80, Exit 49
Tooele County
Clive, UT 84029 (84083 if using Fed Ex)
Phone: (435) 884-0155

Treatability studies normally require 30 to 45 days to complete. Please keep this in mind when planning the first shipment of waste. Rush treatability studies are possible; however, there are higher costs for this service. Please contact *EnergySolutions* if a rush treatability study is required to meet a disposal schedule.

4.5 WASTE PROFILE REVIEW AND APPROVAL

EnergySolutions will assist waste generators throughout the waste profiling process to ensure shipping and acceptance of the waste can be accomplished within the desired timeframe. In order to facilitate timely shipment and receipt of waste materials, *EnergySolutions* requests that the Waste Profile forms and analytical reports be provided as far in advance of the anticipated shipping date as possible. Upon receipt, *EnergySolutions* will complete a preliminary review of the waste profile information provided. Comments concerning the Waste Profile will usually be provided within two weeks of *EnergySolutions* receipt of the profile information. If additional information is required for pre-acceptance, *EnergySolutions* will specify the information needed and communicate this to the generator. A comprehensive internal review is completed once all information has been submitted.

In order to assist each generator and accomplish the profile review and approval process as quickly as possible, *EnergySolutions* has developed a two-phase review process. During the first phase, an *EnergySolutions* Technical Services Representative will review and assess the Waste Profile, accompanying documentation, and analytical data for acceptability. If necessary, *EnergySolutions* will provide comments that delineate additional information needed for approval. This process typically takes one to two weeks. Once the additional information or revisions have been received by *EnergySolutions* and found to be satisfactory, phase 2 of the process begins.

The second phase involves an independent evaluation of the Waste Profile by *EnergySolutions* Health Physics, Compliance, Operations, and Safety and Health representatives. *EnergySolutions* will notify the generator as soon as the review and approval process is complete.

At this point, the waste stream has been “pre-approved” for management at *EnergySolutions*, since the waste has been shown to be in compliance with all waste acceptance criteria. *EnergySolutions* will issue

a Notice to Transport once the Waste Profile has been approved and a contractual disposal agreement or necessary funding is authorized for the waste stream.

4.6 NOTICE TO TRANSPORT

EnergySolutions will issue a Notice to Transport (NTT) to the generator that authorizes subsequent waste shipments. The Notice to Transport is completed and issued once the Waste Profile is completed and approved by *EnergySolutions*. A Notice to Transport is also issued in the following situations:

- The Waste Profile is revised in such a way that additional evaluations are required (radiological, chemical, or physical properties change significantly)
- An annual update letter is received for Mixed and LLRW waste streams
- The approval to ship is restored after the Notice to Transport is revoked

In the event that the Notice to Transport is revoked, customers will not be able to schedule shipments until the approval to ship is restored and a new NTT is issued.

SECTION 5

SHIPMENT SCHEDULING AND MANIFESTING

5.1 GENERATOR SITE ACCESS PERMIT

Prior to the first shipment of waste material to EnergySolutions' Clive facility, generators must receive a Generator Site Access Permit (GSAP) issued by the Utah DRC. Utah Administrative Code R313-26 establishes the terms for a Generator Site Access Permit Program that authorizes waste generators, waste processors, and waste collectors to deliver radioactive wastes to a disposal facility within Utah. Generators may apply for the GSAP on-line at the Utah DRC's website at www.radiationcontrol.utah.gov/DRC_prmt.htm. Generators should be aware that the length of time the DRC takes to process a GSAP application or annual renewal is typically thirty days.

The GSAP number must be listed in Block 5 of the Uniform LLRW Manifest Form 540 and correspond to the shipper's name and facility. Shippers must ensure the GSAP is renewed annually with the Utah DRC.

Shippers are subject to the provisions contained in the "Generator Site Access Permit Enforcement Policy" as amended, UAC R313-14, and UAC R313-19-100 for violations of state rules or requirements in the current land disposal facility operating license regarding radioactive waste packaging, transportation, labeling, notification, classification, marking, or manifesting requirements.

5.2 SHIPPING CHECKLIST

To assist generators with shipments to EnergySolutions, the "Shipping Checklist" shown below in Figure 5-1 provides general contact, scheduling, and manifesting information. Generators and shippers should use this checklist in conjunction with their shipping procedures to ensure compliance with EnergySolutions' waste acceptance process. EnergySolutions' Technical Service Representatives are available to assist generators and shippers during the shipment scheduling and transportation process.

5.3 5 WORKING-DAY ADVANCED SHIPMENT NOTIFICATION

Generators must schedule the shipment to arrive at the facility a minimum of five working days prior to the requested shipment arrival date. EnergySolutions strongly encourages generators to submit the 5 Working-Day Advanced Shipment Notification form prior to the shipment departing from the generator's site. A completed copy of the 5 Working-Day Advanced Shipment Notification form must be sent to the attention of EnergySolutions Scheduling Department to establish an arrival date for each shipment. This form may be downloaded from EnergySolutions' website at www.energysolutions.com. This form must be completed and either emailed to scheduling@energysolutions.com or faxed to the site at (435) 884-3549. Once this form has been received, the Scheduling Department will confirm the shipment's arrival date with the shipper. If all required information is not available at the time of submission, updates may be provided as the information becomes available. The Scheduling Department must be informed in the event that there are delays in the shipment scheduled arrival date.

Scheduling: Must be established at least 5 working days in advance of requested arrival date

- ☐ A “Notice to Transport” has been issued by EnergySolutions for the Waste Profile.
- ☐ Submitted “5 Working Day Advanced Shipment Notification” form to request shipping schedule. Email form to scheduling@energysolutions.com or fax to (435) 884-3549.
- ☐ Shipping schedule has been confirmed by EnergySolutions.
EnergySolutions’ Shipping & Receiving Scheduler: (435) 884-0155.

Advanced Manifesting: Must be submitted prior to releasing each shipment/conveyance

- ☐ Manifested information is consistent with the approved Waste Profile.
Verify that all manifested radionuclides are listed in the approved Waste Profile and that manifested concentrations do not exceed the approved ranges.
- ☐ Verified consignee information on manifests (see below).
Consignee: EnergySolutions, LLC Contact: Shipping and Receiving
Clive Disposal Site Phone: (435) 884-0155
Interstate 80, Exit 49
Clive, UT 84029
- ☐ Verified Shipment ID/Manifest Number (XXXX-YY-ZZZZ)
XXXX is the generator number, YY is the waste stream number, and ZZZZ is the shipment number (starting with 0001 for the first shipment/conveyance and incrementing by one for each additional shipment/conveyance). If a Hazardous Waste Manifest is submitted, include the Shipment ID Number in Block 15.
- ☐ Verified valid Utah Site Access Permit number in Block 5 on Form 540. Generators must apply for the permit with the Utah Division of Radiation Control (DRC). The Shipper Name and Facility must be consistent with the Utah Site Access Permit number.
- ☐ Verified that Block 9 of Form 540 specifies EnergySolutions’ “Treatment Facility” or “Bulk Waste Facility”. Enter “Bulk Waste Facility” for LLRW, 11e.(2) Byproduct Material, and Mixed Waste shipped for direct disposal or enter “Treatment Facility” for waste streams requiring treatment by EnergySolutions prior to disposal.
- ☐ Submitted manifests to EnergySolutions **at least three working days** prior to the shipment arrival date. If possible, please export the manifests and send electronically via email to manifest@energysolutions.com. Otherwise, fax manifests to “Shipping and Receiving – Manifest” at (801) 413-5643. If applicable, include the LDR Notification/Certification forms, Hazardous Waste Manifest, and SNM Exemption Certification form.

Shipment Paperwork and Inspection

- ☐ The original shipping paperwork/manifests accompany each shipment (conveyance). If applicable, include the LDR Notification/Certification forms and Hazardous Waste Manifest for each shipment.
- ☐ If applicable, a completed and signed copy of the SNM Exemption Certification form and DOE/NRC form 741 has been included with the shipping papers.
- ☐ If applicable, the Uniform Hazardous Waste Manifest lists all hazardous waste codes associated with the shipment.
- ☐ Containers have been inspected and comply with DOT packaging requirements. Waste must be packaged in a strong, tight container at a minimum.
- ☐ Containers do not contain unauthorized free standing liquids.
- ☐ If applicable, containers are labeled “Class A Unstable” or “Class AU”. Refer to Block 16 of NRC Form 541.

Figure 5-1. Shipping Checklist

Shipments containing radionuclides with total activities exceeding the limits listed below must be specified on the 5 Working-Day Shipment Notification form and approved prior to waste shipment.

- Californium-252 (in excess of 5.4 Ci)
- Co-60 (in excess of 8.1 Ci)
- Cs-137 (in excess of 27 Ci)
- Gd-153 (in excess of 270 Ci)
- Ir-192 (in excess of 22 Ci)
- Pm-147 (in excess of 11,000 Ci)
- Se-75 (in excess of 54 Ci)
- Tm-170 (in excess of 5,400 Ci)
- Yb-169 (in excess of 81 Ci)

5.4 SHIPPING PAPERWORK

Advance copies of the Uniform Low-Level Radioactive Waste Manifest (Forms 540/541, and 542 if applicable) are required to be sent to EnergySolutions at least three working days prior to the shipment arrival date. Shippers must submit the shipping paperwork electronically via email to manifest@energysolutions.com or fax to “Shipping and Receiving – Manifest” at (801) 413-5643. EnergySolutions encourages submittal of the Uniform LLRW Manifest electronically by exporting the manifest information to a specified file format as discussed below. The advance manifest must include the Uniform LLRW Manifest, and if applicable, LDR Notification/Certification forms, Uniform Hazardous Waste Manifest, and SNM Exemption Certification form.

Additional shipping paperwork may be required depending on the type of waste being shipped to EnergySolutions. Multiple waste streams on a single conveyance must include a unique set of shipping paperwork for each manifested shipment. The following paperwork may also need to accompany the shipping paperwork as applicable:

- SNM Exemption Certification form. This form must be completed, signed, and included with the shipping paperwork for shipments containing Special Nuclear Material.
- LDR Certification and/or Notification form must contain the information required in 40 CFR 268.7. EnergySolutions requires that this information be provided with each shipment of Mixed Waste or waste that has been treated to meet 40 CFR 268 treatment standards.
- Uniform Hazardous Waste Manifest must be included with the shipping paperwork for waste shipments of Mixed Waste. As applicable, EnergySolutions requests that shippers list the gross weight on the manifest.
- Compact Export Authorization letter as applicable. Contact a Technical Services representative for additional guidance. The EnergySolutions’ LLRW Export Approval procedure (Procedure CL-AD-PR-030) may be reviewed at the Customer Portal tab of the www.energysolutions.com website.

5.4.1 Instructions for the Uniform LLRW Manifest Forms 540, 541, and 542

The NRC’s guidance document “Instructions for Completing the NRC’s Uniform Low-Level Radioactive Waste Manifest” (NUREG/BR-0204, Rev. 2, July 1998) should be used by shippers when preparing the shipping paperwork. EnergySolutions requires shippers to include information in both metric units and English units following the International Standard of Units (SI). Additionally, EnergySolutions has specific

information that should also be included on the Uniform LLRW Manifest. The generator is encouraged to ensure that all isotopes listed on the NRC shipping forms have been included in Table C.3 of the waste profile.

Form 540

- Block 5, “Shipper” must list the shipper’s company name and facility that corresponds to the Utah Generator Site Access Permit (GSAP) number. Shippers shipping on behalf of the generator and using their GSAP number should list “(shipper’s company name) on behalf of (generator’s name)”.
- Block 5, “Shipment Number” and “Shipment ID Number” may be used by the shipper for their own tracking purposes. In most cases, shippers use the “Manifest Number” in Block 8 as the “Shipment ID Number”.
- Block 8, “Manifest Number” must list the *EnergySolutions* shipment number in the following format: (XXXX-YY-ZZZZ) where XXXX is the generator number, YY is the waste stream number, and ZZZZ is the shipment number (starting with 0001 for the first shipment and incrementing by one for each additional shipment).
- Block 9, “Consignee” must list *EnergySolutions*’ disposal site address as shown below, contact name and telephone number. The address must specify *EnergySolutions*’ “Treatment Facility” or “Bulk Waste Facility”. List “Bulk Waste Facility” for LLRW, 11e.(2) Byproduct Material, and Mixed Waste shipped for direct disposal or list “Treatment Facility” for waste streams requiring treatment by *EnergySolutions* prior to disposal.

EnergySolutions, LLC
Clive Disposal Site – Bulk Waste Facility
Interstate 80, Exit 49
Clive, UT 84029

Form 541

- Block 6, “Container Description” specifically applies to the disposal container. For bulk shipments (e.g., gondola railcars, intermodals, etc.), list “11” for “Bulk, Unpackaged Waste” along with the bulk packaging descriptor if the bulk package does not contain other manifested packages inside. For example, a gondola railcar with a super-load wrapper would be listed as “11A” in Block 6.
- Blocks 7 and 8, “Volume” and “Waste and Container Weight” must list the gross volume and weight of the disposal container and contents. For bulk, unpackaged waste where the waste package will not be disposed (e.g., gondola railcar, intermodal, etc.), list the weight and volume of the waste.
- Block 15, “Radiological Description” must also include a column for the radionuclide concentration expressed in units of pCi/g.
- Block 16, “Waste Classification” must list “AU” for Class A Unstable LLRW. Waste packages must also be labeled either “Class A Unstable” or “Class AU”. For NORM or 11e.(2) waste material, enter “N/A” since the waste classification requirements are not applicable.

Form 542

Form 542, “Manifest Index and Regional Compact Tabulation”) is required for processors and collectors of LLRW who are shipping LLRW attributed to others for ultimate disposal at *EnergySolutions*. *EnergySolutions* requires that processors or collectors submitting the Form 542 do so electronically using the file transfer protocol described in Section 5.4.2 due to the size of the manifest.

5.4.2 Electronic Submittal of the Uniform LLRW Manifest

EnergySolutions developed a document titled “Electronic Submittal of the Uniform Low-Level Radioactive Waste Manifest” to assist generators with the electronic submittal of the Uniform Low-Level Radioactive Waste Manifest (Forms 540, 541 and 542). Generators are able to submit their manifests electronically in a comma-delimited file format to the *EnergySolutions* disposal facility for review and distribution. Upon arrival, manifests are imported directly into *EnergySolutions*’ waste tracking system. Manifest information is checked against the information contained in the generators Waste Profile. Any discrepancy will be automatically flagged, allowing potential problems to be fixed well in advance of shipment arrival.

Electronic manifest submittal has numerous benefits for both the generator and *EnergySolutions* which include:

- Generators are able to e-mail their shipping manifests directly to the site, reducing the time and expense of express mailing or faxing copies to the disposal facility.
- The generator can use the electronic signature feature, eliminating the need for any advance hard copies to be sent to *EnergySolutions*.
- *EnergySolutions* personnel can print the required copies of the manifest, including electronic signature, and distribute for proper review.
- The import of manifest information directly to *EnergySolutions*’ waste tracking system will eliminate manual data entry.
- Electronic submittal will significantly reduce the time it takes *EnergySolutions* personnel to process the advanced paperwork.

5.5 90-DAY SHIPPING FORECAST

The 90-Day Shipping Forecast is used by *EnergySolutions* to properly staff and ensure adequate resources are available to ensure efficient and timely management of waste shipments. Generators are strongly encouraged to provide *EnergySolutions* with a 90-Day Shipping Forecast for all upcoming shipments. Current shippers will receive a fax or email from *EnergySolutions* every month and are requested to return the shipping forecast to *EnergySolutions* within three working days of receipt. The forecast can also be emailed to the appropriate Client Service Manager.

SECTION 6

PACKAGING AND TRANSPORTATION

6.1 COMPLIANCE WITH TRANSPORTATION REGULATIONS

Each shipment of waste material sent to *EnergySolutions* for disposal must be properly classed, described, packaged, marked, labeled, and in condition for transport as required by the Department of Transportation (DOT) Hazardous Materials Regulations (HMR) contained in 49 CFR Parts 171 through 180. Shipments of radioactive waste that are exempt from DOT regulations must be shipped to *EnergySolutions* disposal site in packages that prevent release of the waste during transit. Specifically, all waste packages must be secure to 1) prevent rain or snow from entering the manifested waste package and 2) prevent waste from being exposed to the environment at any time during transit. Shippers should review NRC IE Bulletin No. 79-19 for training requirements applicable to radioactive waste management.

EnergySolutions will inspect each shipment arriving at its disposal facility for compliance with the applicable licenses and/or permits including compliance with DOT HMR requirements. *EnergySolutions* will notify the generator of a non-compliant shipment and determine the best course of action to resolve the discrepancy in a safe, compliant, and timely manner.

6.2 WASTE PACKAGING GUIDELINES

EnergySolutions receives waste for disposal either in bulk or in non-bulk packages. The packaging used must be authorized for the specific material being shipped by the HMR. Each generator is responsible for ensuring that the packaging used meets the appropriate regulations. The shipper of waste material is responsible for the certification of the packaging as meeting the DOT requirements. The DOT and NRC have published a joint guidance document to assist shippers of LSA and SCO material. The title of this document is “Categorizing and Transporting Low Specific Activity Materials and Surface Contaminated Objects” (NUREG-1608 or RSPA Advisory Guidance 97-005). The document is available from either agency. The following minimum packaging requirements must be met for all packages received at *EnergySolutions*.

6.2.1 Bulk Packaging

Generators are able to minimize packaging and transportation costs by utilizing bulk packages that are intended for re-use. *EnergySolutions* receives various bulk packages illustrated in Figure 6-1 which include gondola railcars with either hard-top lids or super-load wrappers, intermodals, sealands, cargo containers, roll-offs, etc. Bulk packages are unloaded at *EnergySolutions* and then decontaminated, surveyed, and returned in accordance with the requested radiological release criteria specified in Section 6.5. Bulk packaging must conform to the following requirements:

- Bulk packaging must, at a minimum, meet the applicable requirements contained in 49 CFR 173.24, General Requirements for Packaging and Packages and in 49 CFR 173.410, General Design Requirements.
- Bulk packaging must be covered. The top must be completely enclosed with no opening along the sides or openings in the top.

- Bulk packaging (e.g., railcars, trucks, trailers, etc.) must also be tightly sealed to prevent waste from leaking out or water from leaking in to the package. Packages containing unauthorized free liquids will be considered non-compliant.
- Bulk packaging must be clean. It must not have any waste material, or other material that could be mistaken for waste material, on the outer surface. *EnergySolutions* will perform contamination surveys on suspect areas of the package to ensure compliance with DOT regulations.
- Bottom dump railcars and end-dump trucks are not permitted unless approved in writing by *EnergySolutions*.
- Bulk packaging in intermodals, sealands, cargo containers, roll-offs, etc. must have ISO connectors on the top corners as illustrated in Figure 6-1 to allow the containers to be lifted from the top unless approved in writing by *EnergySolutions*. Note: ISO connectors cannot be any greater than 40 feet apart for safe lifting of the container.
- Friable asbestos is prohibited in bulk packages unless approved in writing by *EnergySolutions*.
- Each bulk container, which requires marking, will be properly marked in accordance with 49 CFR 172 Subpart D.
- Bulk packaging may not contain a mixture of bulk, unpackaged waste and manifested packaged waste (e.g., an intermodal containing loose unpackaged soil with manifested disposal containers within the same intermodal).

6.2.2 Non-Bulk Packaging (Disposal Containers)

EnergySolutions receives non-bulk packages (disposal containers) including boxes, drums, super sacks, etc. The disposal container is generally disposed of with the waste contents and will not be returned to the generator. *EnergySolutions* recommends drums are palletized to reduce the amount of time required to offload drum shipments. Palletized drums are also safer to manage at the disposal site. Generators may be charged extra for shipments containing non-palletized drums. Drums on one pallet must be from the same waste stream unless approved in writing by *EnergySolutions*. Contact *EnergySolutions* to request approval to ship non-palletized drums prior to shipment. Non-Bulk packaging must conform to the following requirements:

- Non-Bulk packaging must, at a minimum, meet the applicable requirements contained in 49 CFR 173.24, General Requirements for Packaging and Packages and in 49 CFR 173.410, General Design Requirements.
- Containers must be properly sealed to prevent load movement from “pumping” dust-laden air out of the container.
- Containers must be clean. They must not have any waste material, or other material, which could be mistake for waste material, on the outer surface. *EnergySolutions* will perform contamination surveys on suspect areas of the package to ensure compliance with DOT regulations.
- Containers in a shipment must be properly loaded and blocked and braced securely to prevent shifting and damage during transport. The specific transport loading requirements contained in 49 CFR 174 for rail and 49 CFR 177 for highway should be examined as well as 49 CFR 393 Subpart I, Protection Against Shifting and Falling Cargo.
- Although preferred, containerized rail shipments are not required to be enclosed or covered.
- Do not have unnecessary container closures; e.g., welding of drum rings or box lids.
- Non-bulk packages will not be returned to the generator.
- Overpack containers only when necessary (e.g., to meet DOT requirements) for shipment.
- *EnergySolutions* prefers drums to be palletized to reduce the amount of time required to offload drum shipments. Palletized drums are also safer to manage at the disposal site. The pallets must

be strong enough to withstand collapse during transit. The drums should be securely banded to the pallet.

- Truck or railcar beds used to transport containers must be free of all loose material, waste or otherwise.
- Each container that is required to be labeled will be properly labeled in accordance with the requirements of 49 CFR 172 Subpart E and UAC R313-15-1009.
- Each container that is required to be marked will be properly marked in accordance with the requirements of 49 CFR 172 Subpart D and/or 49 CFR 173.421 and Subpart 425.





Figure 6-1. Bulk Shipping Containers

6.3 HIGHWAY TRANSPORTATION

For highway shipments (Figure 6-2), the EnergySolutions' Clive facility is located just three miles south of Interstate 80 at the Clive Exit (Exit 49). Highway shipments should arrive for receipt and acceptance between 7:00 AM to 12:00 PM MST, Monday through Friday only. Shipments that arrive after 12:00 PM may not be accepted until the next day unless special handling arrangements have been previously approved.



Figure 6-2. Truck Highway Shipments

Shipments are generally unloaded on a first-come, first-served basis. Non-compliant shipments may result in unexpected delays. Shipments may take up to four hours to be checked in, inspected, surveyed, evaluated, and unloaded. Consequently, drivers should be informed that there are no eating facilities within the vicinity of the site.

6.4 RAIL TRANSPORTATION

Rail shipments (Figure 6.3) will be delivered to the EnergySolutions' rail siding by the Union Pacific railroad on a predetermined schedule. Once at EnergySolutions' siding, they will be moved into the disposal site by EnergySolutions' equipment.



Figure 6-3. Rail Shipments

Since the signed copies of the Uniformed Low-Level Radioactive Waste Manifest or Uniform Hazardous Waste Manifest forms do not travel with the railcars during transport, the original signed manifest must be mailed or electronically transferred to the Clive Disposal Facility. The documents must arrive at the Clive Disposal Facility a minimum of 3 working days prior to the receipt of the rail shipment.

6.5 RELEASE OF SHIPPING CONVEYANCES

The timeframe for the release of shipping conveyances (e.g., trucks, intermodal containers, railcars, etc.) is based on the specific contractual arrangements that have been established between each generator and EnergySolutions. Generators must request the type of radiological release prior to the shipment's arrival and must be allowed under the Terms and Conditions of the disposal agreement. The requested release types must be authorized by EnergySolutions' Business Development Department. Containers released to the Unrestricted Use criteria require significantly more time and expense due to the resources needed to meet these release criteria. EnergySolutions performs the following types of radiological releases as listed in the following table. EnergySolutions recommends that any container being returned to be reloaded with waste be released DOT Empty or Sole-Use Release Criteria.

EnergySolutions Radiological Release Criteria

Release Type	Criteria	Reference
Unrestricted Use	Removable and fixed surface contamination levels are isotope specific. The most restrictive isotopic removable surface contamination levels are less than 20 dpm α /100 cm ² and 200 dpm β - γ /100 cm ² . The most restrictive isotopic total surface contamination levels are less than 100 dpm α /100 cm ² and 1,000 dpm β - γ /100 cm ² . The contamination levels apply to all internal and external surfaces. Contact EnergySolutions' Business Development Department to make contractual arrangements for this type of release.	US NRC Regulatory Guide 1.86, June 1974 (Consistent with EnergySolutions' RML Condition 27)
Return to Service	Removable surface contamination levels must be less than 220 dpm α /100 cm ² and 2,200 dpm β - γ /100 cm ² . The radiation dose rate at each accessible surface must be less than 0.5 mrem/hr. The contamination levels apply to all internal and external surfaces of the transport vehicle.	49 CFR 173.443(c)
DOT Empty	Removable surface contamination levels on the outside of the package must be less than 220 dpm α /100 cm ² and 2,200 dpm β - γ /100 cm ² . Removable surface contamination levels on the inside of the package must be less than 22,000 dpm α /100 cm ² and 220,000 dpm β - γ /100 cm ² . The package must be emptied of contents to the extent practical.	49 CFR 173.428
Sole Use	Removable surface contamination levels on the outside of the transport vehicle must be less than 220 dpm α /100 cm ² and 2,200 dpm β - γ /100 cm ² . The radiation dose rate on the internal surfaces must be less than 10 mrem/hr or 2 mrem/hr at one meter from the surface.	49 CFR 173.443(d)

APPENDIX A
CONTACT INFORMATION

EnergySolutions

Corporate Office Phone: (801) 649-2000 Fax: (801) 537-7345
Technical Service Fax: (801) 413-5664
Shipment Scheduling Phone: (435) 884-0155 Fax: (435) 884-3549
Email: scheduling@energysolutions.com
Shipping & Receiving Phone: (435) 884-0155 Fax: (801) 413-5643
Email: manifest@energysolutions.com
EnergySolutions Website: www.energysolutions.com

State of Utah


Utah Dept of Environmental Quality: www.deq.state.ut.us
Utah Division of Radiation Control (DRC) Email: drcadmin@utah.gov
Utah Division of Radiation Control Website: www.radiationcontrol.utah.gov
Utah DRC – Generator Site Access Permit: (801) 536-0077
Utah DRC – Generator Site Access Permit: www.radiationcontrol.utah.gov/DRC_prmt.htm
Utah DRC Rules: www.radiationcontrol.utah.gov/rules.htm
Utah Division of Solid and Hazardous Waste: www.hazardouswaste.utah.gov
Utah DSHW Rules: www.hazardouswaste.utah.gov/rpc.htm
Utah Dept of Health – Lab Certification: health.utah.gov/els/labimp/envlabcert.html
State-Issued Part B Permit: www.hazardouswaste.utah.gov/CFF_Section/EnvirocarePermit.htm

Attachment B
Sample Waste Documentation

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NON-HAZARDOUS WASTE MANIFEST

Please print or type (Form designed for use on elite (12-pitch) typewriter)

GENERATOR	NON-HAZARDOUS WASTE MANIFEST		1. Generator's US EPA ID No. N/A		Manifest Document No. CSI-001		2. Page 1 of 1		
	3. Generator's Name and Mailing Address Cabrera Services				Bill to: NA				
					ATTN: NA				
	4. Generators Phone								
	5. Transporter 1 Company Name N/A		6. US EPA ID Number N/A		A. State Transporter's ID N/A				
					B. Transporter 1 Phone N/A				
	7. Transporter 2 Company Name N/A		8. US EPA ID Number N/A		C. State Transporter's ID N/A				
					D. Transporter 2 Phone N/A				
	9. Designated Facility Name and Site Address U.S. Ecology Inc. 10.5 Miles on NW on Hwy 78, Lemley Rd. Grand View, Idaho 83624				10. US EPA ID Number NA				
					E. State Facility's ID				
				F. Facility's Phone					
TRANSPORTER	HM	11. WASTE DESCRIPTION			12. Containers No.		Type	13. Total Quantity	14. Unit Wt./Vol.
	a.	Remediation debris not regulated by US DOT			1		truck	30580	P
	b.								
	c.								
	d.								
	G. Additional Descriptions for Materials Listed Above Truck # XXXX				H. Handling Codes for Wastes Listed Above				
	15. Special Handling Instructions and Additional Information For questions Contact: Wade Fillingame (865) 300-5789								
									
	16. GENERATOR'S CERTIFICATION: I hereby certify that the contents of this shipment are fully and accurately described and are in all respects in proper condition for transport. The materials described on this manifest are not subject to federal hazardous waste regulation.								
	Printed/Typed Name Wade Fillingame				Signature		Month 1	Date 11	Year 2014
FACILITY	17. Transporter 1 Acknowledgement of Receipt of Materials				Date				
	Printed/Typed Name				Signature		Month	Date	Year
	18. Transporter 2 Acknowledgement of Receipt of Materials				Date				
	Printed/Typed Name				Signature		Month	Date	Year
	19. Discrepancy Indication Space								
	20. Facility Owner or Operator, Certification of receipt of the waste materials covered by this manifest, except as noted in item 19.								
	Printed/Typed Name				Signature		Month	Date	Year

NRC FORM 540 (5-1998)		U. S. NUCLEAR REGULATORY COMMISSION	
UNIFORM LOW-LEVEL RADIOACTIVE WASTE MANIFEST SHIPPING PAPER			
1. EMERGENCY TELEPHONE NUMBER <i>(Include Area Code)</i>		5. SHIPPER -- NAME AND FACILITY	
ORGANIZATION		SHIPPER I.D. NUMBER	
2. IS THIS AN "EXCLUSIVE USE" SHIPMENT?		COLLECTOR	
<input type="checkbox"/> YES <input type="checkbox"/> NO		PROCESSOR	
3. TOTAL NUMBER OF PACKAGES IDENTIFIED ON THIS MANIFEST =====➔		GENERATOR TYPE <i>(Specify)</i>	
4. DOES EPA REGULATED WASTE REQUIRING A MANIFEST ACCOMPANY THIS SHIPMENT? If "Yes," provide Manifest Number =====➔		9. CONSIGNEE -- Name and Facility Address	
<input type="checkbox"/> YES <input type="checkbox"/> NO		CONTACT	
EPA MANIFEST NUMBER		TELEPHONE NUMBER <i>(Include Area Code)</i>	
11. U.S. DEPARTMENT OF TRANSPORTATION DESCRIPTION <i>(Including proper shipping name, hazard class, UN ID number, and any additional information)</i>		6. CARRIER -- Name and Address	
12. DOT LABEL "RADIOACTIVE"		EPA I.D. NUMBER	
13. TRANSPORT INDEX		SHIPPING DATE	
14. PHYSICAL AND CHEMICAL FORM		TELEPHONE NUMBER <i>(Include Area Code)</i>	
15. INDIVIDUAL RADIONUCLIDES		SIGNATURE -- <i>Authorized carrier acknowledging waste receipt</i>	
16. TOTAL PACKAGE ACTIVITY IN SI UNITS		DATE	
17. LSA/SCO CLASS		AUTHORIZED SIGNATURE	
18. TOTAL WEIGHT OR VOLUME <i>(Use appropriate units)</i>		TITLE	
19. IDENTIFICATION NUMBER OF PACKAGE		DATE	
10. CERTIFICATION This is to certify that the herein-named materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation. This also certifies that the materials are classified, packaged, marked, and labeled and are in proper condition for transportation and disposal as described in accordance with the applicable requirements of 10 CFR Parts 20 and 61, or equivalent state regulations.			
FOR CONSIGNEE USE ONLY			

<div>NRC FORM 541 (5-1998)</div> <div>U.S. NUCLEAR REGULATORY COMMISSION</div> <div>UNIFORM LOW-LEVEL RADIOACTIVE WASTE MANIFEST</div> <div>CONTAINER AND WASTE DESCRIPTION</div> <div>Additional Nuclear Regulatory Commission (NRC) Requirements for Control, Transfer and Disposal of Radioactive Waste</div>										1. MANIFEST TOTALS							2. MANIFEST NUMBER		
										NUMBER OF PACKAGES/ DISPOSAL CONTAINERS	NET WASTE VOLUME (m ³)	NET WASTE WEIGHT (kg)	SPECIAL NUCLEAR MATERIAL (grams)				SOURCE (kg)	3. PAGE <u> 1 </u> OF <u> </u> PAGE(S)	
													U-233	U-235	Pu	TOTAL			
																			4. SHIPPER NAME
ACTIVITY (MBq)										SHIPPER ID NUMBER									
ALL NUCLIDES		TRITIUM		C-14		Tc-99		I-129											
DISPOSAL CONTAINER DESCRIPTION										WASTE DESCRIPTION FOR EACH WASTE TYPE IN CONTAINER									
5. CONTAINER IDENTIFICATION NUMBER/ GENERATOR ID NUMBER(S)	6. CONTAINER DESCRIP- TION (See Note 1)	7. VOLUME (m ³)	8. WASTE AND CONTAINER WEIGHT (kg)	9. SURFACE RADIATION LEVEL		10. SURFACE CONTAMINATION MBq/100 cm ²		11. PHYSICAL DESCRIPTION			14. CHEMICAL DESCRIPTION		15. RADIOLOGICAL DESCRIPTION		16. WASTE CLASSIFI- CATION AS-Class A Stable AU-Class A Unstable B-Class B C-Class C				
				(μSv/hr)	(mSv/hr)	ALPHA	BETA- GAMMA	11. WASTE DESCRIP- TOR (See Note 2)	12. APPROXIMATE WASTE VOLUME(S) IN CONTAINER	13. SORBENT SOLIDIFICATION, STABILIZATION, MEDIA (See Note 3)	CHEMICAL FORM/ CHELATING AGENT	WEIGHT % CHELATING AGENT IF > 0.1%	INDIVIDUAL RADIONUCLIDES AND ACTIVITY (MBq) AND CONTAINER TOTAL; OR CONTAINER TOTAL ACTIVITY AND RADIONUCLIDE PERCENT						

NOTE 1: Container Description Codes. For containers/waste requiring disposal in approved structural overpacks, the numerical code must be followed by "-OP."

1. Wooden Box or Crate	9. Demineralizer
2. Metal Box	10. Gas Cylinder
3. Plastic Drum or Pail	11. Bulk, Unpackaged Waste
4. Metal Drum or Pail	12. Unpackaged Components
5. Metal Tank or Liner	13. High Integrity Container
6. Concrete Tank or Liner	19. Other. Describe in item 8, or additional page
7. Polyethylene Tank or Liner	
8. Fiberglass Tank or Liner	

Note 2: Waste Descriptor Codes. (Choose up to three which predominate by volume.)

20. Charcoal	29. Demolition Rubble	38. Evaporator Bottoms/Sludges/Concentrates
21. Incinerator Ash	30. Cation Ion-exchange Media	39. Compactible Trash
22. Soil	31. Anion Ion-exchange Media	40. Noncompactible Trash
23. Gas	32. Mixed Bed Ion-exchange Media	41. Animal Carcass
24. Oil	33. Contaminated Equipment	42. Biological Material (except animal carcass)
25. Aqueous Liquid	34. Organic Liquid (except oil)	43. Activated Material
26. Filter Media	35. Glassware or Labware	59. Other. Describe in item 11, or additional page
27. Mechanical Filter	36. Sealed Source/Device	
28. EPA or State Hazardous	37. Paint or Plating	

Note 3: For solidification media that meet disposal site structural stability requirements, the numerical code must be followed by "-S." For all solidification media, the vendor (manufacturer) and brand name must also be identified in item 13. Code 100=NONE REQUIRED.

Sorption			Solidification			
60. Speedi Dri	64. Safe T Sorb	69. Chemsil 30	74. Petroset	89. Other.	90. Cement	94. Vinyl Ester Styrene
61. Celetom	65. Safe N Dri	70. Chemsil 50	75. Petroset II	Describe in item 13, or additional page	91. Concrete (encapsulation)	99. Other. Describe in item 13, or additional page
62. Floor Dry/ Superfine	66. Florco	71. Chemsil 3030	76. Aquaset		92. Bitumen	
63. Hi Dri	67. Florco X	72. Dicaperl HP200	77. Aquaset II		93. Vinyl Chloride	100. None Required
	68. Solid A Sorb	73. Dicaperl HP500				

Attachment C
Disposal Facility Directions/Travel Route

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Directions to US Ecology in Grand View, Idaho

Distance: 294 miles, 4 hours 19 minutes

Disposal Facility Address: US Ecology Idaho Inc., 20400 Lemley Rd, Grand View, ID 83624

Route to Disposal Facility:

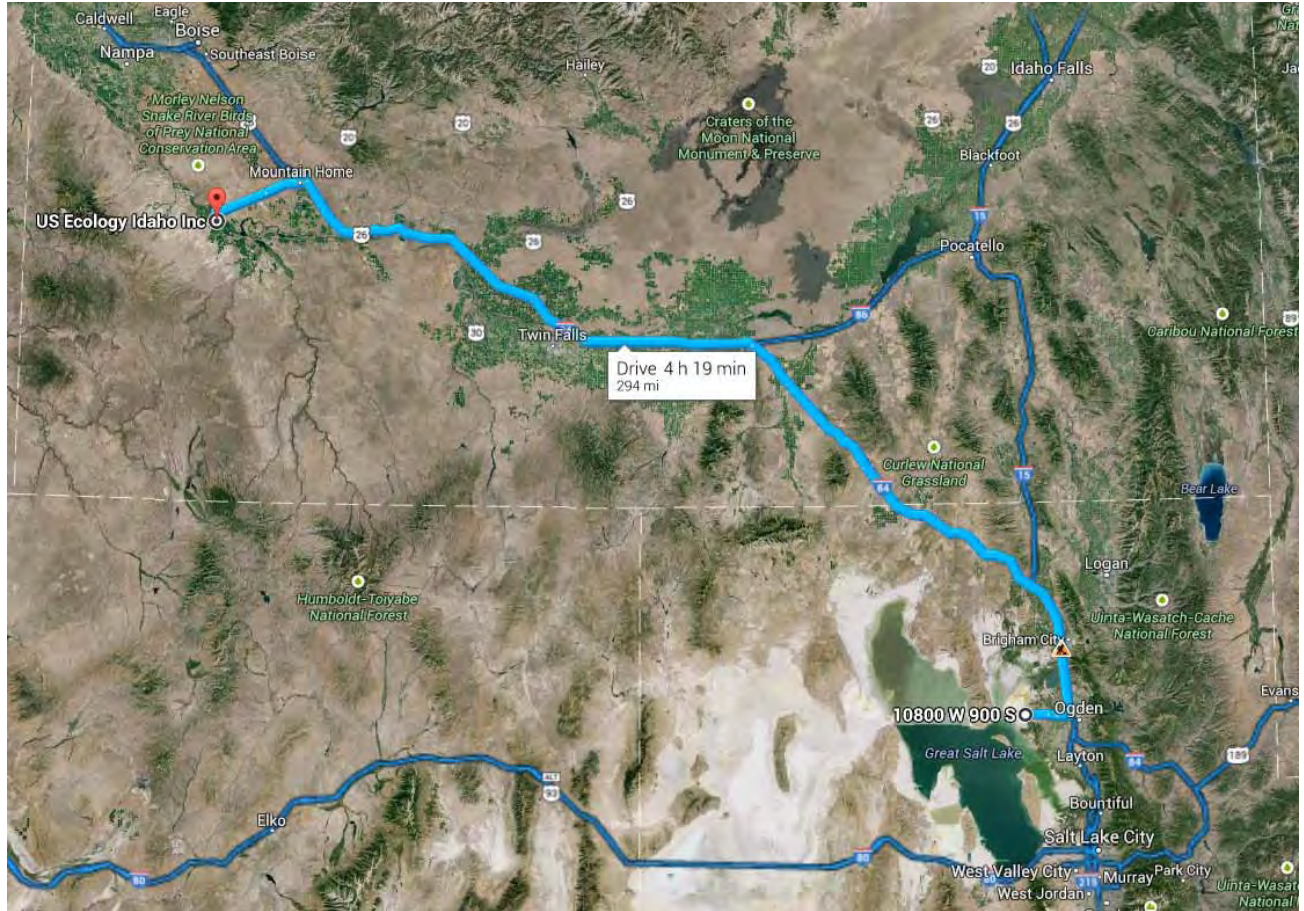
Starting Location: **Little Mountain Test Annex**

End Address: **20400 Lemley Rd, Grand View, ID 83624**

1. Exit the site to W 900 S
2. Continue onto W 1100 S
3. Continue onto W 1150 S
4. Continue onto UT-39 E/W 1200 S / W 12th Street
5. Turn left onto entrance ramp to I-15N/ I-84W
6. Stay on I-84 W
7. Take Exit 95 toward State Hwy 67/I-84 BUS/Mountain Home/Fairfield
8. Turn left onto Hwy 20 W/Hwy 51 S
9. Turn left onto N Main St/Old U.S. 30 E
10. Continue onto W 6th S St
11. Turn right onto ID-167/Grand View Rd
12. Turn left onto Riverside Ave
13. End US Ecology Idaho, Inc. Phone: (208) 834-2275

See map, next page.

MAP WITH ROUTE TO US ECOLOGY - IDAHO



Directions to EnergySolutions in Grantsville, Utah

Distance: 81 miles, 1 hour 20 minutes

Disposal Facility Address: EnergySolutions Clive Facility., Interstate 80 Exit 49, Grantsville, UT 84029

Route to Disposal Facility:

Starting Location: **Little Mountain Test Annex**

End Address: **Interstate 80 Exit 49, Grantsville, UT 84029**

1. Exit the site to W 900 S
2. Continue onto W 1100 S
3. Continue onto W 1150 S
4. Continue onto UT-39 E/W 1200 S / W 12th Street
5. Turn right onto entrance ramp to I-15S
6. Stay on I-15S
7. Keep right to continue on I-215 S/Belt Route, follow signs for S.L. Int'l Airport
8. Take Exit 22B to merge onto I-80W
9. Take exit 99 to merge onto Hwy 36 S/Rte 36 S/State 36 S/State Hwy 36 S/State Rte 36 S/UT-36 S toward Stansbury Tooele
10. Turn right onto UT-138 W
11. End EnergySolutions Phone: (801) 649-2010

See map, next page.

MAP WITH ROUTE TO ENERGY SOLUTIONS – UTAH



Appendix E

Project Completion/Closeout Plan

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Appendix E

Project Completion/Closeout Activities

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1.0 Performance Objective

The performance objective for Site WR111 is to obtain site closure with no land use controls by 2015. Investigations have confirmed radiological impact to surface and subsurface soil at the site, and remedial action is required to address those identified impacts. Remediation activities at WR111 are being conducted under the Hill Air Force Base (AFB) PBR Contract No. FA8903-09-D-8560 Task Order 0006 and in coordination with the Nuclear Regulatory Commission (NRC) via the U.S. Air Force Radioisotope Committee (USAF RIC).

2.0 Key Tasks Required to Achieve the Performance Objective

It is anticipated that the following key tasks are required to achieve the performance objective for Site WR111:

1. Completion of a supplemental investigation to confirm the nature and extent of radiological impact in surface and subsurface soil, and delineate excavation area;
2. Preparation of a Decommissioning Plan to identify the radionuclides of concern and the nature and extent of radiological contamination, document the development of derived concentration guideline levels (DCGLs), and to outline the planned decommissioning activities and the programs to be implemented during decommissioning, including the management program, health and safety program, environmental monitoring and control programs, waste management program, and the quality assurance (QA) program;
3. Development of a Remedial Design/Remedial Action Work Plan (RD/RAWP) to fully describe the remedy elements and program components (e.g., health and safety protocols, quality control elements, etc.), and to document the metrics for evaluating and documenting completion of the remedy;
4. Excavation of radiologically-impacted soil, in accordance with the remedial action objectives, and disposal at a facility that is licensed to accept the material;
5. Completion of a Final Status Survey (FSS), in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), to document that the remedial action objectives have been met (note: As part of FSS activities, USAF RIC will be provided the opportunity to conduct verification surveys, if desired);
6. Preparation of a Site Closure Report, which will include the FSS Report, for review and regulatory approval by the U.S. Air Force in coordination with the USAF RIC;
7. Completion of site restoration, including abandonment of four existing groundwater monitoring wells (proximal and associated with Site WR111), and removal of any remaining fencing around the site; and
8. Preparation and submittal of Site Closeout Letter to U.S. Air Force documenting completion of site restoration activities.

The completion status for each key task is discussed further in the sections below.

2.1 Completed Tasks

The following key tasks have been completed:

Task 1 (Supplemental Investigation) – Fieldwork was conducted in July 2013. Results of the supplemental investigation were utilized during preparation of the Decommissioning Plan.

Task 2 (Decommissioning Plan) – The Decommissioning Plan (*WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Decommissioning Plan*, dated [date]) was approved for implementation by NRC on [date].

Task 3 (RD/RAWP) – This RD/RAWP (*WR111 Little Mountain Test Annex Magnesium-Thorium Disposal Trench Remedial Action Work Plan*, dated [date]) was approved for implementation by AFCEC on [date].

2.2 Tasks Completed Under This RAWP

Task 4 (Excavation/Disposal Activities) and Task 5 (FSS) will be completed in accordance with this RD/RAWP and the approved Decommissioning Plan for Site WR111.

2.3 Remaining Tasks to be Completed

Once FSS activities at Site WR111 are complete, any disturbed areas will be restored to pre-existing conditions, and the EA/Cabrera team will demobilize from the site. Tasks 6 through 8 will then be completed, as discussed below.

Task 6 (Site Closure Report) – EA/Cabrera will prepare a Site Closure Report to document completion of excavation activities in accordance with this RD/RAWP and the approved Decommissioning Plan. The Site Closure Report will include the following elements, at a minimum:

- Introduction
- Chronology of Events
- Performance Objective and Standards
- Description of Construction Quality Control
- Summary of Construction Activities
 - Key Construction Elements
 - Contractor Information
 - Duration of Construction
 - Inspections/Problems Encountered During Construction
 - Deviations from Planning Documents
 - Health and Safety Summary
- Final Inspection Documentation
- Certification that the Remedy is Functional
- Final Status Survey Report (Appendix)
- Copies of Topographic Surveys (Appendix)

The Site Closure Report will be submitted to U.S. Air Force for review and approval.

Task 7 (Completion of Site Restoration) – Upon approval of the Site Closure Report, EA/Cabrera will remobilize to Site WR111 and complete site restoration activities, including abandonment of four

existing groundwater monitoring wells (proximal and associated with Site WR111) and removal of any remaining fencing around the site. It is anticipated that a brief addendum to the RD/RAWP will be prepared for these additional site restoration activities. Field activities will be conducted in accordance with the approved addendum.

Task 8 (Site Closeout Letter) – Upon completion of Task 7, EA/Cabrera will prepare and submit a Site Closeout Letter for U.S. Air Force files. The Site Closeout Letter will summarize the activities conducted to complete site restoration and notify U.S. Air Force that remedial action activities for Site WR111 are complete.

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