AECOM

Final
Remedial Investigation
Work Plan

Camp Blauvelt, New York

Munitions Response Site NYHQ-007-R-01
New York Army National Guard

Army National Guard

Contract No. W9133L-14-D-0001
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Acronyms and Abbreviations

ARNG	Army National Guard
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CSM	conceptual site model
DU	decision unit
FS	Feasibility Study
HRR	Historical Records Review
ISM	incremental sampling methodology
MC	munitions constituents
MEC	munitions and explosives of concern
MRS	munitions response site
NDNODS	Non-Department of Defense Owned Non- Operational Defense Site
NYARNG	New York Army National Guard
NYSDEC	New York State Department of Environmental Conservation
NY RP SCOs	NYSDEC New York Remedial Program Soil Cleanup Objectives
PA	Preliminary Assessment
PIPC	Palisades Interstate Park Commission
RI	Remedial Investigation
SI	Site Inspection
SSHP	Site Safety and Health Plan
UFP-QAPP	Unified Federal Policy - Quality Assurance Project Plan
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WW	World War
XRF	X-ray fluorescence

1 Work Plan

This Work Plan has been developed to support the long-term management of the Non-Department of Defense, Non-Operational Defense Site (NDNODS) Camp Blauvelt Munitions Response Site (MRS). The Camp Blauvelt (Army Environmental Database Restoration No. NYHQ-007-R-01) is located in Orangetown, New York. This is not a stand-alone document, but is supplemented by the Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) for Camp Blauvelt (**Appendix A**), and is meant to aid in the execution of Remedial Investigation (RI) field work. For a full description of work to be performed for this RI, please refer to the Camp Blauvelt UFP-QAPP, which is referenced throughout this Work Plan.

Environmental work is being conducted at the MRS by the Army National Guard (ARNG) Directorate and the New York ARNG (NYARNG). This project is being executed by AECOM Technical Services, Inc. under ARNG Contract Number W9133L-14-D-0001, Delivery Order 0006, issued 20 September 2016 and modified 27 June 2017.

The RI of Camp Blauvelt is being conducted to determine whether there is an unacceptable risk to human and ecological receptors from potential munitions constituents (MC) remaining at the MRS from historical training use. This Work Plan includes methods and procedures that the investigative team will employ at Camp Blauvelt. Additional field safety information can be found in the Site Safety and Health Plan (SSHP) (**Appendix B**), which will be reviewed by field personnel prior to mobilization and adhered to during all field tasks.

1.1 Site Description

The Camp Blauvelt MRS is a former small arms range located in Blauvelt State Park, approximately 0.5 miles west of the Tappan Zee Bridge (**Figure 1**). The 447-acre MRS is owned by the Palisades Interstate Park Commission (PIPC) as part of Blauvelt State Park, and contains vast undeveloped, forested land. Range features are located in the central and northern portion of the MRS. There are a few residential properties within the southwestern portion of the MRS, outside of the area used for former firing activities, and a water tower on the southern border of the MRS. Hiking and biking trails are maintained within the MRS. Camp Bluefields Road, a former carriage road, also traverses the MRS.

The former range includes concrete target walls 200, 300, 600, and 1,000 yards from the firing line. The range also includes concrete bunkers, interconnected aboveground and underground tunnels, and observation areas. Additionally, an earthen berm with target structures exists 800 yards from the firing line. The direction of fire of the rifle ranges was to the east/northeast (**Figure 2**). A hillside exists east of the 1,000 yard target wall that acted as a natural backstop during firing. The MRS surface is undulating with steep elevation changes. The eastern portion of the MRS is comprised mostly of rocky surface without soil cover. The soil in the western portion of the MRS is gravelly silt loam on undulating steep slopes.

CLIENT	Army National Guard			
PROJECT	RI through DD for Camp Blauvelt, NY MRS			
REVISION NO	0	GIS BY	MS	3/21/2018
SCALE	1:126,720	CHK BY	JW	3/21/2018
SOURCE	Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors,	PM	LS	3/21/2018

Camp Blauvelt Site Location

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Figure 1

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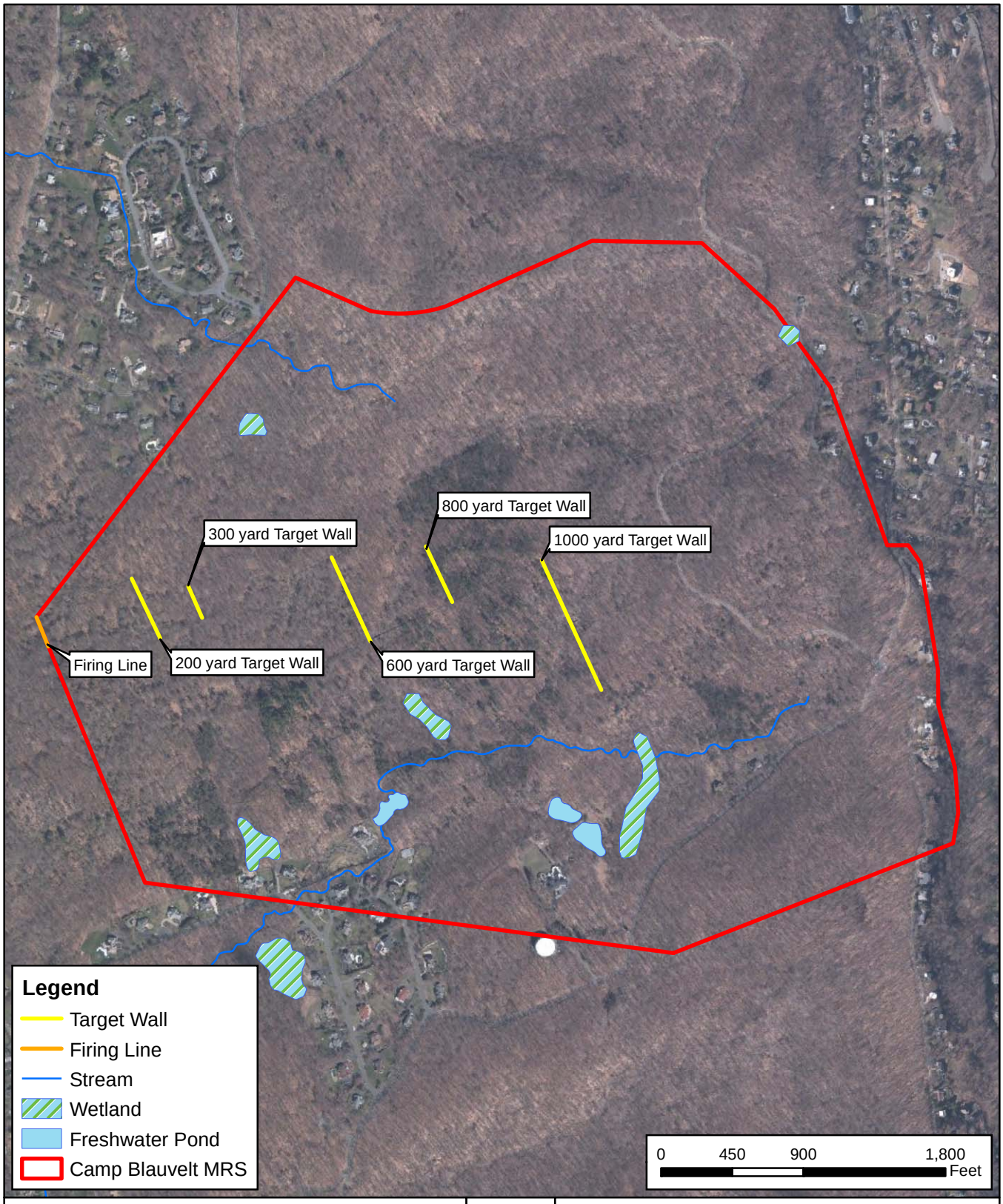

CLIENT	Army National Guard			
PROJECT	RI through DD for Camp Blauvelt, NY MRS			
REVISION NO	0	GIS BY	MS	5/1/2018
SCALE	1:10,800	CHK BY	JW	5/1/2018
SOURCE	ARNG; State of New York, ESRI & Partners	PM	LS	5/1/2018

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Camp Blauvelt Site Layout

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Figure 2

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1.2 History

According to historical documents, Camp Blauvelt was a training camp used by the NYARNG from 1910 to 1913 and then again from an unknown date to 1925. The camp contained a small arms range that was used from 1910 to 1913. Although it is unknown if the range was used during training camps that occurred after 1913, it is unlikely. Therefore, 1910 and 1913 are considered the start and end use dates (Malcolm Pirnie, Inc., 2009).

When the range opened on 3 October 1910, it had 200 and 300 yard ranges; by 1913 the range had 198 targets with firing lines from 200 to 1,000 yards (Forest and Stream, 1910). Underground tunnels were installed to connect the downrange targets to the firing lines and to connect one range to another. Due to numerous complaints from nearby residents about the safety of the range, it was closed in 1913 (Rockland Audubon Society, 2018). According to the residents, stray bullets from the range were landing on the Boulevard and Shady Side Avenue (Malcolm Pirnie, Inc., 2009).

After Camp Blauvelt was closed, the land was given to the PIPC. The PIPC website provides the following information about Blauvelt Park:

> "Located on a former United States (U.S.) Army rifle range, the property was transferred to PIPC in 1913 after local residents raised safety concerns regarding the potentially hazardous use of the site. The Army temporarily reclaimed use of the site for its emergency needs in both World Wars. Since World War (WW) II, the park has been allowed to return to its natural state. Almost all signs of past human use have been erased. The plan is to let it pursue its quiet existence as a green buffer against the surrounding sprawl" (Palisades Park Conservancy, 2018).

According to the Rockland County Audubon Society, in 1918 the rifle range at Camp Blauvelt was turned over to the NY State Military Training Commission for use as a summer camp by the Reserve Officers Training Corp (Historical Society of Rockland County, 1985). It is unknown how long the Reserve Officers Training Corp used this camp.

Reportedly, Camp Blauvelt was used by the U.S. Army as a prisoner of war camp during WWI and for training and as an air raid post during WWII (Rockland Audubon Society, 2018). Although numerous sources indicate the camp was used by the NYARNG only from 1910 to 1913, a 1925 list of NYARNG training camps lists Camp Blauvelt as active (Malcolm Pirnie, Inc., 2009).

The former range is located in what is currently Blauvelt State Park, a public park that consists of 590 acres of undeveloped forest with hiking trails.

Munitions usage data is not available for training activities at the Camp Blauvelt range. However, it is known that training was limited to small-caliber ammunition. Potential munitions used were small arms (i.e., .22, .30, .38 and .45 caliber).

1.3 Previous Investigations

Three environmental assessments have been completed at Camp Blauvelt since 2009. These include:

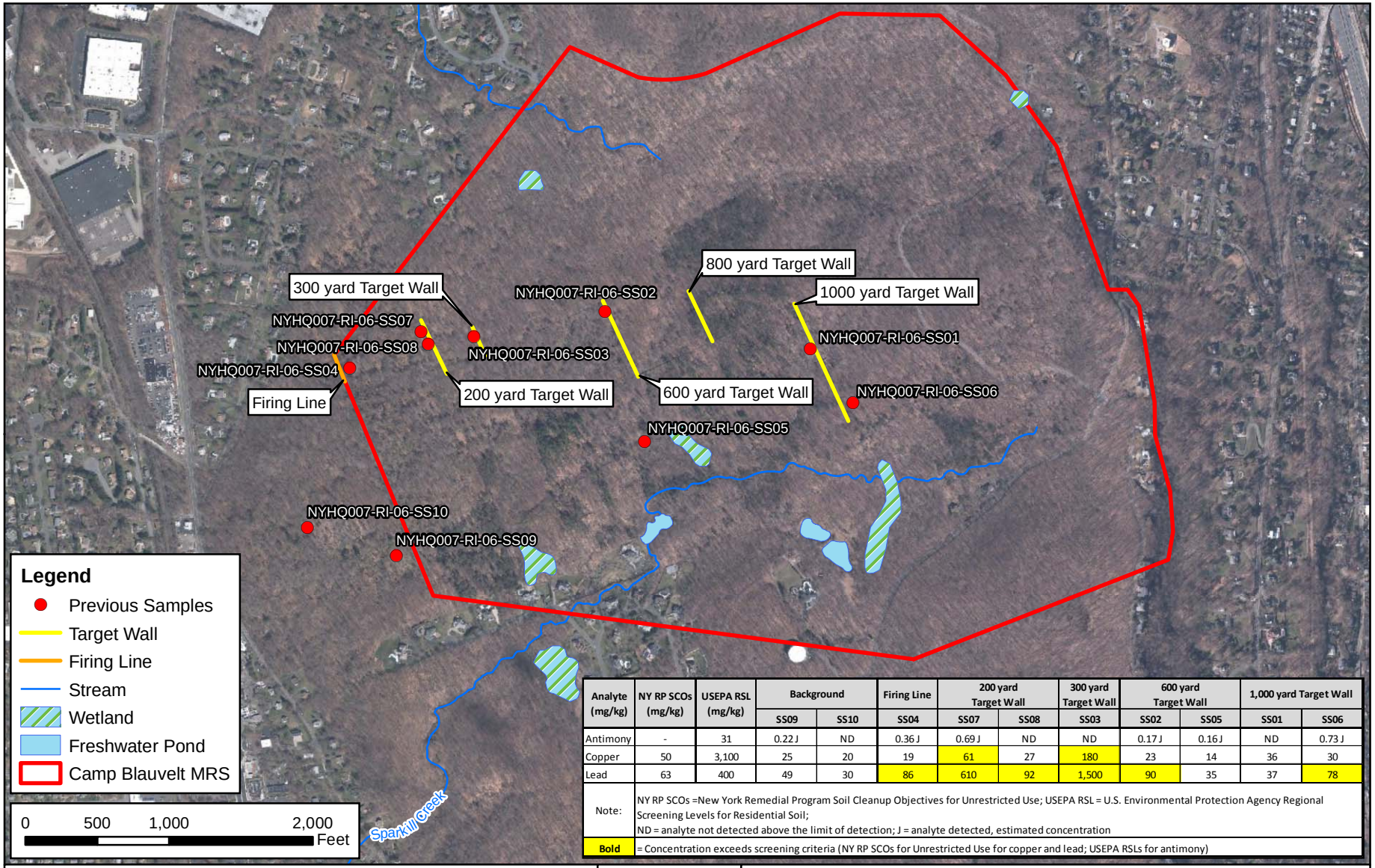
- Final National Guard Bureau NDNODS Inventory New York, July 2009 (Preliminary Assessment [PA]; Malcolm Pirnie, Inc., 2009)
- Final Historical Records Review (HRR)/Work Plan, New York, July, 2011 (Parsons, 2011).
- Final New York Site Inspection (SI) Report, ARNG MMRP, 2012 (Parsons, 2012)

In 2009, the ARNG completed its NDNODS Inventory, resulting in the identification of more than 500 sites where Guardsmen trained and discharged munitions. NDNODS Inventory Reports are considered to have met the requirements of a PA under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). In 2009, the NDNODS Inventory for New York was completed; it identified the Camp Blauvelt MRS as one of 33 eligible MRSs within New York with a potential munitions risk and was recommended for further investigation.

An HRR and SI of Camp Blauvelt were conducted by Parsons in 2011 and 2012, respectively. The HRR detailed historical site use of Camp Blauvelt. The SI approach included both visual survey and targeted soil sampling for MC to confirm the small arms range location and to evaluate the potential presence of munitions and explosives of concern (MEC) and MC. Parsons performed 4.64-miles of magnetometer-assisted visual survey that focused on range features to refine MC sampling locations. No evidence of MEC was observed within the MRS. During the visual survey .30-caliber and.45-caliber casings were identified at the former firing line. The field team also observed multiple concrete structures and one multi-level target area. The multi-level wall was located 600 yards away from the firing line and was approximately 50 feet tall. No evidence of MEC was observed within the MRS during SI activities.

In total, eight composite surface soil samples were collected from the firing line and range the 200, 300, 600, and 1,000 yard target areas using a spoke and hub compositing method. An additional two background surface soil samples (called ambient samples in the SI) were collected near but outside the MRS (behind the firing line) for comparison. Firing line and background samples were analyzed for explosives and the small arms indicator metals antimony, copper, and lead. Samples were not analyzed for zinc. Target area samples were analyzed for antimony, copper, and lead. **Figure 3** presents the SI findings and current United States Environmental Protection Agency (USEPA) Regional Screening Levels for Residential Soil (USEPA, 2018) and New York Remedial Program Soil Cleanup Objectives [NY RP SCOs] for Unrestricted Use (New York State Department of Environmental Conservation [NYSDEC], 2006). Soil samples were not screened using X-ray fluorescence (XRF) during the SI due to high soil moisture content.

Explosives were not detected in any samples collected from the MRS or background locations. Samples collected from the 200 and 300 yard target areas exceeded background reference concentrations and human health screening criteria for copper and lead (NY RP SCOs for Unrestricted Use). Antimony concentrations exceeded the calculated background reference concentration but did not exceed human health screening criteria (USEPA RSL for residential soil).



Analyte (mg/kg)	NY RP SCOs (mg/kg)	USEPA RSL (mg/kg)	Background		Firing Line	200 yard Target Wall		300 yard Target Wall	600 yard Target Wall		1,000 yard Target Wall	
			SS09	SS10	SS04	SS07	SS08	SS03	SS02	SS05	SS01	SS06
Antimony	-	31	0.22 J	ND	0.36 J	0.69 J	ND	ND	0.17 J	0.16 J	ND	0.73 J
Copper	50	3,100	25	20	19	61	27	180	23	14	36	30
Lead	63	400	49	30	86	610	92	1,500	90	35	37	78

Note: NY RP SCOs =New York Remedial Program Soil Cleanup Objectives for Unrestricted Use; USEPA RSL = U.S. Environmental Protection Agency Regional Screening Levels for Residential Soil;
ND = analyte not detected above the limit of detection; J = analyte detected, estimated concentration

Bold = Concentration exceeds screening criteria (NY RP SCOs for Unrestricted Use for copper and lead; USEPA RSLs for antimony)

CLIENT	Army National Guard			
PROJECT	RI through DD for Camp Blauvelt, NY MRS			
REVISION NO	0	GIS BY	MS	5/30/2018
SCALE	1:12,000	CHK BY	JW	5/30/2018
SOURCE	New York Statewide Orthoimagery Program, 2016	PM	LS	5/30/2018

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Camp Blauvelt SI Results

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Figure 3

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Based on the HRR and SI investigation findings, the Camp Blauvelt MRS was recommended to be carried forward to RI/Feasibility Study (FS). This area is the focus of this work plan.

Physical and ecological characteristics of the Camp Blauvelt area (e.g., geology) were detailed within the 2012 SI's conceptual site model (CSM) and are updated with recent data in **Table 1**. This information was incorporated into the development of the Camp Blauvelt CSM (see UFP-QAPP Worksheet #10) that informed the RI approach summarized below.

Table 1. Camp Blauvelt Physical and Ecological Characteristics

Physical Characteristics	
Climate	The climate at Camp Blauvelt is classified as humid and subtropical characterized by hot summers and mild winters with high precipitation. Temperature varies from the 70s in the summer to the low 30s in the winter. The warmest month of the year is July, with an average maximum temperature of 83.7° F. The coldest month of the year is January, with an average minimum temperature of 23.4° F. The long-term average annual temperature is 53° F for the Orangetown, NY area. The annual average rainfall is 41.2 inches with rainfall evenly distributed throughout the year. The wettest month of the year is July, with an average rainfall of 4.7 inches. Snowfall data for the region is incomplete, but registers approximately 20 inches during January and February (National Oceanic and Atmospheric Administration, 2017).

Physical Characteristics	
Geology	The Camp Blauvelt MRS is in the Newark Basin within the Piedmont physiographic province in southern New York (Yager and Ratcliffe, 2010). The Newark Basin extends approximately 150 mile from Rockland County, New York, through New Jersey and into eastern Pennsylvania. The Basin was formed by faulting during the early rifting stage of the opening of the Atlantic Ocean. The Newark Basin is a half graben that contains a 2.5 to 3 mile thick sequence of westward dipping continental red beds and lake deposits with intrusive sheets of diabase and basalt flows, collectively known as the Newark Supergroup (Yager and Ratcliffe, 2010). The Ramapo Fault bounds the Newark Basin on the west within Rockland County. Sedimentary rocks of the Newark Supergroup range in age from Late Triassic to Early Jurassic (229 to 175 million years ago) and consist of interbedded shale, sandstone, and siltstone that are typically red, reddish brown, or maroon. Magmatism in the Early Jurassic (approximately 201 million years ago) produced voluminous basalt lava flows and the intrusion of diabase, including the Palisades Sill (Yager and Ratcliffe, 2010). The Palisades Sill underlies the Camp Blauvelt MRS and outcrops in prominent cliffs along the west bank of the Hudson River (structure map in Yager and Ratcliffe, 2010). Sedimentary formations that outcrop west of the MRS generally dip westward at approximately 10 degrees. The glaciers that covered most of Canada and the northern United States episodically over the last 1.8 million years extended only a few miles south of the Camp Blauvelt MRS during the most recent glacial advance approximately 22,000 years ago (Skehan, 2008). Glaciers scoured and removed soil and soft weathered surface rocks as they moved. As the ice melted, the sediment load was dropped in place as unsorted till or was redistributed as outwash by the vast amounts of meltwater released by the glacier. Till is a mixture of silt, gravel, and boulders of various sizes in a clay matrix. The glacial outwash sediments, deposited by streams and rivers of meltwater in front of the receding glaciers (glaciofluvial deposits), tend to be graded from coarse to fine with increasing distance from the glacier. Meltwater could also be impounded in lakes that were dammed either by the ice or by glacial sediments. Lake plains, terraces, and beaches were left in place when the dammed water found a lower outlet (Olcott, 1995). Based on surface geology maps (Heisig, 2010) unconsolidated deposits of glacial till, lake deposits and alluvium cover bedrock in the vicinity of the Camp Blauvelt MRS. Within the MRS, unconsolidated material is thin or absent on the igneous bedrock of the Palisades Sill.
Topography	The Camp Blauvelt MRS is on the westward sloping outcrop of the Palisades Sill. The surface of the MRS is undulating with elevations ranging from approximately 250 to 610 feet above sea level with isolated peaks at 350 feet, 410 feet, and 610 feet. East of the MRS, there is steep slope down to the Hudson River at approximately 10 feet above sea level. To the west of the MRS, there is a steep slope down to approximately 150 feet above sea level (USGS, 1979).
Soil	The eastern half of the Camp Blauvelt MRS is a rock surface without soil cover. The soil in the western portion of the MRS is predominantly Wethersfield gravelly silt loam on undulating to steep slopes. The material is glacial till derived from reddish sandstone, shale and conglomerate with some basalt. A typical soil profile is gravelly silt loam from 0 to 13 inches; gravelly loam from 13 to 22 inches; and gravelly fine sandy loam from 22 to 60 inches (Natural Resources Conservation Services, 2011).

Physical Characteristics	
Hydrogeology	Although sedimentary rocks are thin or absent over the igneous Palisades Sill within the Camp Blauvelt MRS, Newark Basin sediments outcrop just west of the MRS boundary. The aquifer beds near the MRS consist of sandstone, mudstone, siltstone, and shale. At the western margin of the basin, aquifer beds are coarser consisting of conglomerate, pebbly sandstone, and sandstone. Fractures parallel to the bedding planes are the major water-bearing zones (Heisig, 2010). The Newark Basin aquifer is unconfined where the water table is below the bedrock surface. Where the water table is within the overlying glacial till, the relatively low permeability of till and lake sediments constitute a confining layer (Yager and Ratcliffe, 2010). Approximately 32 percent of the public water supply in Rockland County is obtained from the sedimentary bedrock aquifer identified as the Newark Basin aquifer. Most of the public supply wells are in the coarse-grained sedimentary formations in the Newark Basin lowlands west of the MRS. The Lake DeForest Reservoir, approximately 2.5 miles northwest of the MRS, provides 37 percent of the public water supply (Heisig, 2010). There are no groundwater wells within the Camp Blauvelt MRS. USGS data show four wells at or near the western boundary of the MRS. Well number RO 688 is 0.3-mile west of the MRS boundary. The well was completed in the Brunswick Formation local aquifer. The well depth is 276 feet below land surface and water depth is 99 feet (USGS, 2018).
Hydrology	Seven small ponds and an intermittent stream are located within the MRS. The surface water bodies are not in the vicinity of the former range. The ponds are located approximately 300 yards north of the southern MRS boundary. The stream flows from southeast to northwest and is located in the northwest corner of the MRS. The stream discharges into a pond approximately 0.5-mile northwest of the MRS (United States Fish and Wildlife Service [USFWS], 2017a).
Vegetation	The majority of the MRS is heavily wooded with exception of the southwestern portion that has some residential properties.
Cultural, Archaeological and Historical Resources	There are no historic or cultural resources at Camp Blauvelt. Additionally, there are no National Historic Landmarks located in Rockland County, NY (National Park Service, 2017 & 2018).
Wetlands	There are five types of wetlands within the MRS, these include: PUBHh (Palustrine, Unconsolidated Bottom, Permanently Flooded, Dikes/Impounded), R4SBC (Riverine, Intermittent Streambed, Seasonally Flooded), PFO1A (Palustrine, Forested, Broad-Leaved Deciduous, Temporary Flooded), PFO1C (Palustrine, Forested, Broad-Leaved Deciduous, Temporary Flooded) and PFO1E (Palustrine, Broad-Leaved-Deciduous, Seasonally Flooded/Saturated) (USFWS, 2017a). The wetlands are not in the vicinity of the former range.
Demographics	The total population in Orangetown based on the 2016 estimates from the U.S. Census Bureau is 50,324. The square mileage of Orangetown is 24.10 miles. The population density of Orangetown (based on 2010 square mileage) is 2,088 people per square mile. . The 2016 estimated total population of Rockland County is 326,780. The 2016 population density of Rockland County (based on the 2010 square mileage of 174 sq. mi.) is 1,878 persons per square mile (U.S. Census Bureau, 2017a, b).
Ecological Characteristics	
Habitat Type	The area is forested. No critical habitats are present (USFWS, 2017b).

Physical Characteristics	
Ecological Receptors	Forested areas, which may provide habitat for ecological receptors, are present within the MRS. There are three federally-listed threatened and endangered species that occur in Rockland County; the Indiana Bat (*Myotis sodalist*), the Northern Long-Eared Bat (*Myotis septentrionalis*), and the Bog Turtle (*Clemmys muhlenbergii*). No federally designated critical habitat is located within the MRS (USFWS, 2017b); however, habitat supporting ecological receptors is present within the MRS. New York State also lists numerous threatened and endangered species with known ranges or locations within the vicinity of the MRS, including species of mollusks, insects, fish, amphibians, reptiles, birds, and mammals (NYSDEC, 2015). For a full list of New York State listed threatened and endangered species with the potential to be found within the vicinity of the MRS, see UFP-QAPP Worksheet #10.
Degree of Disturbance	Low disturbance of the MRS is present. The MRS is a forested state park with a few residential properties. The area is used only for recreational and residential purposes.

1.4 Investigation Approach

The sampling approach of the RI is designed to characterize the nature and extent of MC contamination in the soil at the range target features (firing line, 200, 300, 600, 800, and 1,000 yard target walls). To accomplish this, a phased approach that includes assessing the lateral extent of MC contamination in the field using XRF analysis followed by laboratory analysis of soil samples collected using incremental sampling methodology (ISM) will be used.

Based on the findings of the SI, potential MC are limited to small arms metals: antimony, copper, lead, and zinc. All soil samples collected for laboratory analysis will be sent to Katahdin Analytical Services, Inc., in Scarborough, Maine, for analysis of target small arms metals. Katahdin Analytical Services, Inc. is certified for the state of New York in the National Environmental Laboratory Accreditation Program. Select samples may also be analyzed for waste characterization parameters (e.g., toxicity characteristic leaching procedure). The results of waste characterization will be used to inform the FS, should one be warranted.

Six areas have been identified within the MRS as decision units (DUs) for MC: Firing Line, 200 yard target wall, 300 yard target wall, 600 yard target wall, 800 yard target wall, and 1,000 yard target wall (**Figure 4**). The soil at the firing line and in front of the target wall DUs will be screened for lead in the field using XRF. The results of this analysis will characterize the lateral extent of contamination in surface soil (0-6 inches below ground surface [bgs]), refine the boundaries of DUs that will be sampled using ISM, and identify high concentration (worst case) areas to collect subsurface samples from 12 to 18 inches bgs to determine the vertical extent of MC in soil. Surface soil samples will be collected from the A soil horizon after detritus, humus, and surface debris have been removed from the sample location.

Locations where XRF values exceed the human health screening criterion for lead will refine the boundary of the MRS DUs. Should samples taken along the boundary of the initial DUs exceed the screening criterion, step-out samples will be taken until exceedances are no longer encountered. Step-out samples with screening exceedances may increase the size of their respective DUs. Once all DU

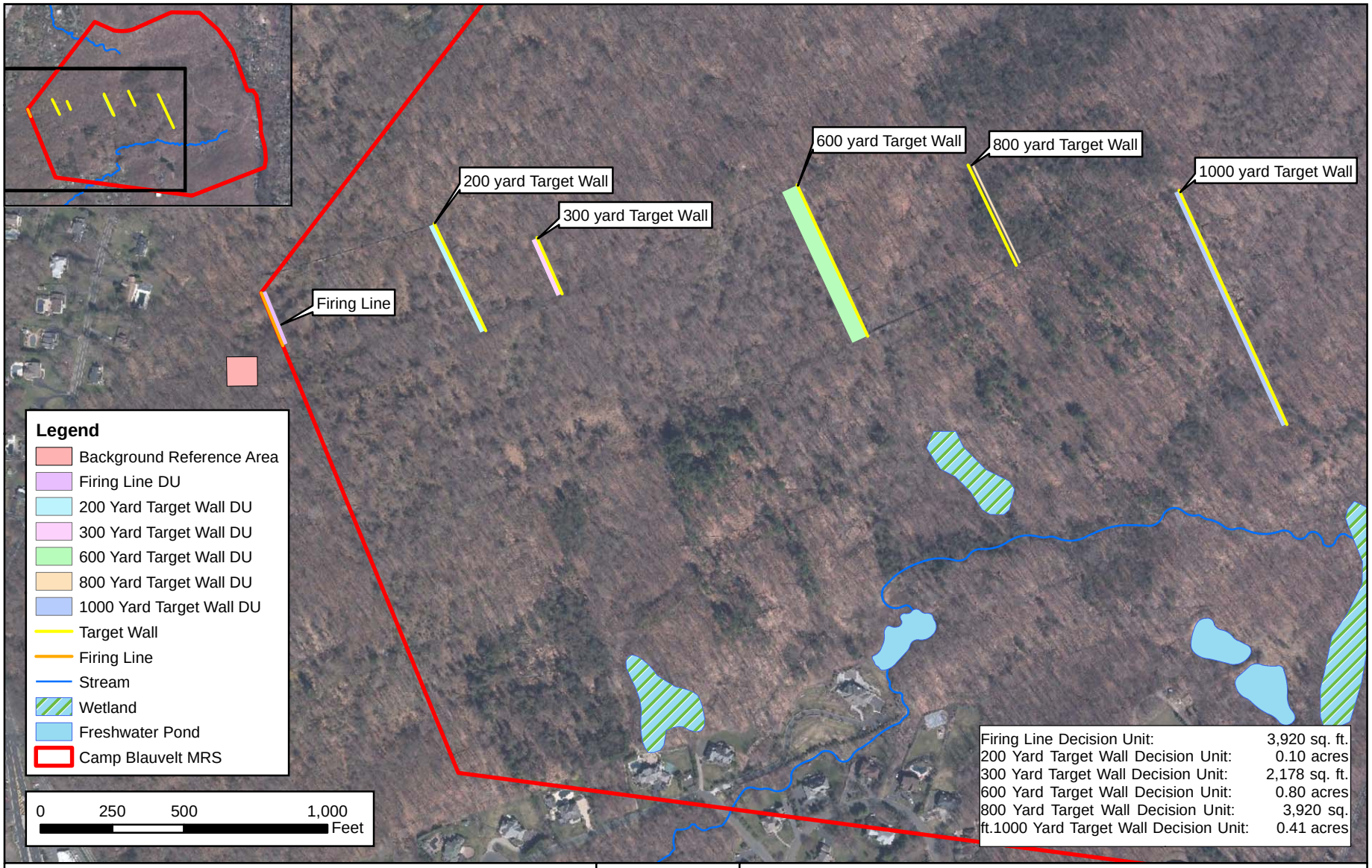
boundaries are confirmed, an approximate 30- to 50-part incremental sample will be collected in triplicate from surface soil at each DU and analyzed for metals MC (antimony, copper, lead, and zinc).

A discrete soil sample will be collected from the location with the highest XRF lead result at each DU for waste characterization analysis (e.g., toxicity characteristic leaching procedure). These data may be used in alternative evaluation during the FS, should one be warranted.

The vertical extent of MC will be characterized by collecting discrete subsurface soil samples from 12 to 18 inches bgs by hand auger where select surface soil XRF readings exceed the NY RP SCO for lead (63 mg/kg). If no exceedances are found in surface soil, subsurface sampling will not occur. Subsurface samples will be analyzed by both XRF (where applicable) and laboratory analytical methods for metals MC. The results of the subsurface XRF analysis will be used to determine whether deeper samples are needed from 24 to 30 inches bgs to delineate the vertical extent of contamination. If soil is too moist for XRF use at any DU, two random locations will be selected within that DU for subsurface sampling. At each location, a 12 to 18 inches bgs and 24 to 30 inches bgs sample will be collected. Laboratory analysis of samples collected from 24 to 30 inches bgs will be contingent on the results from the above sample. In anticipation of the end use of data (i.e., soil removal volume estimates) it is unlikely that resolution finer than 12 inches vertically within the soil profile is needed as most soil removal equipment will excavate soil in 1-foot lifts. If RI results indicate unacceptable risk exists, remedial alternatives evaluated will assume concentrations in the 6-12 inch horizon are the same as those measured at the surface (0-6 inch horizon). This assumption is considered conservative based on multiple factors, including the typical penetration depths of small arms into soil berms and the predominant deposition of pulverized/fragmented bullets in the upper 6 inches, as well as the relatively low mobility of MC metals. Such alternatives would necessarily include collection of confirmatory samples to ensure underlying soil left in place does not exceed cleanup levels.

In addition, a background reference surface soil sample will be collected in triplicate using ISM from an area not affected by historical training activities. The area will be representative of undisturbed media and of an appropriate size to adequately characterize background concentrations and be comparable to investigative samples. The proposed location for background reference sample collection is shown on **Figure 4**. The results of all ISM samples will be used in the risk assessment in the RI report.

Details regarding the investigative approach, including the site specific CSM (Worksheet #10), Data Quality Objectives (Worksheet #11), and detailed sampling design and rational (Worksheet #17), are provided in **Appendix A**. Rights of entry are required for parcels of land to be accessed during RI activities and will be obtained prior to RI soil sampling. If non-munitions-related concerns are identified at the site during fieldwork, they will be documented and reported to the landowner, NYSDEC, and New York State Department of Health, but would be investigated and managed under a different contract, depending upon available funding.



CLIENT	Army National Guard			
PROJECT	RI through DD for Camp Blauvelt, NY MRS			
REVISION NO	0	GIS BY	MS	5/1/2018
SCALE	1:6,000	CHK BY	JW	5/1/2018
SOURCE	New York Statewide Orthoimagery Program, 2016	PM	LS	5/1/2018

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Camp Blauvelt RI Approach

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Figure 4

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Appendix A

Uniform Federal Policy – Quality Assurance Project Plan

AECOM

Final
Uniform Federal Policy – Quality Assurance Project Plan Military Munitions Response Program
Camp Blauvelt, New York

Munitions Response Site NYHQ-007-R-01

New York Army National Guard

Army National Guard

Contract No. W9133L-14-D-0001

Delivery Order No. 0006

NOVEMBER 2018

Prepared for:
Army National Guard
NGB-AQ-W9133L
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Acronyms and Abbreviations

AECOM	AECOM Technical Services, Inc.
ARNG	Army National Guard
ARNG-IED	Army National Guard – Cleanup and Restoration Branch
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CSM	Conceptual Site Model
CCV	Continuing Calibration Verification
DD	Decision Document
DO	Delivery Order
DoD	Department of Defense
DQI	Data Quality Indicators
DQO	Data Quality Objective
DU	decision unit
DUA	Data Usability Assessment
EPA	Environmental Protection Agency
EQB	equipment blank
FS	Feasibility Study
HHRA	Human Health Risk Assessment
HRR	Historical Records Review
ICAL	Initial Calibration
ICB/CCB	Initial and Continuing Calibration Blank
ICS	Interference Check Solutions
ICV	Initial Calibration Verification
IDW	investigative derived waste
ITRC	Interstate Technology Regulatory Council
IS	Internal Standards
ISM	incremental sampling methodology
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicates
LDR	Linear Dynamic Range
LOD	level of detection
LOQ	level of quantitation
MB	Method Blank

MC	munitions constituents
MEC	Munitions and Explosives of Concern
mm	millimeter
MMRP	Military Munitions Response Program
MRS	Munitions Response Site
MRSPP	Munitions Response Site Prioritization Protocol
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NDNODS	Non-Department of Defense-owned, Non-Operational Defense Sites
NFA	No Further Action
NY RP SCOs	New York Remedial Program Soil Cleanup Objectives
NYARNG	New York Army National Guard
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OSHA	Occupational Safety and Health Administration
Katahdin	Katahdin Analytical Services, Inc.
PALs	Project Action Limits
PDS	Post-Digestion Spike
PIPC	Palisades Interstate Park Commission
PM	Project Manager
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QL	Quantitation Limit
RI	Remedial Investigation
ROE	right of entry
RSD	relative standard deviation
SDG	sample delivery group
SI	Site Inspection
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
TCLP	toxicity characteristic leaching procedure
TPP	Technical Project Planning
TSA	Technical Systems Audit

UCL	upper confidence limit
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
USEPA	U.S. Environmental Protection Agency
XRF	X-ray fluorescence

QAPP Worksheets #1 & #2 - Title and Approval Page

(UFP-QAPP Manual Section 2.1; EPA 2106-G-05 Section 2.2.1)

Project Name:	Remedial Investigation through Decision Document for Six Army National Guard Munitions Response Sites, Camp Blauvelt MRS
Site Location:	Rockland County, NY
Contract/Delivery Order:	Contract No. W9133L-14-D-0001 Delivery Order No. 0006
Preparation Date (Month/Year):	November 2018

Investigative Organization's Project Manager: — Signature — **6 November 2018** Date
Printed Name / Organization: **Rosa Gwinn / AECOM**

Investigative Organization's Project QC Manager: — Signature — **6 November 2018** Date
Printed Name / Organization: **Jerry Kashatus / AECOM**

Lead Organization's Project Manager: — Signature — Date
Printed Name / Organization: **John Haines / ARNG-IED**

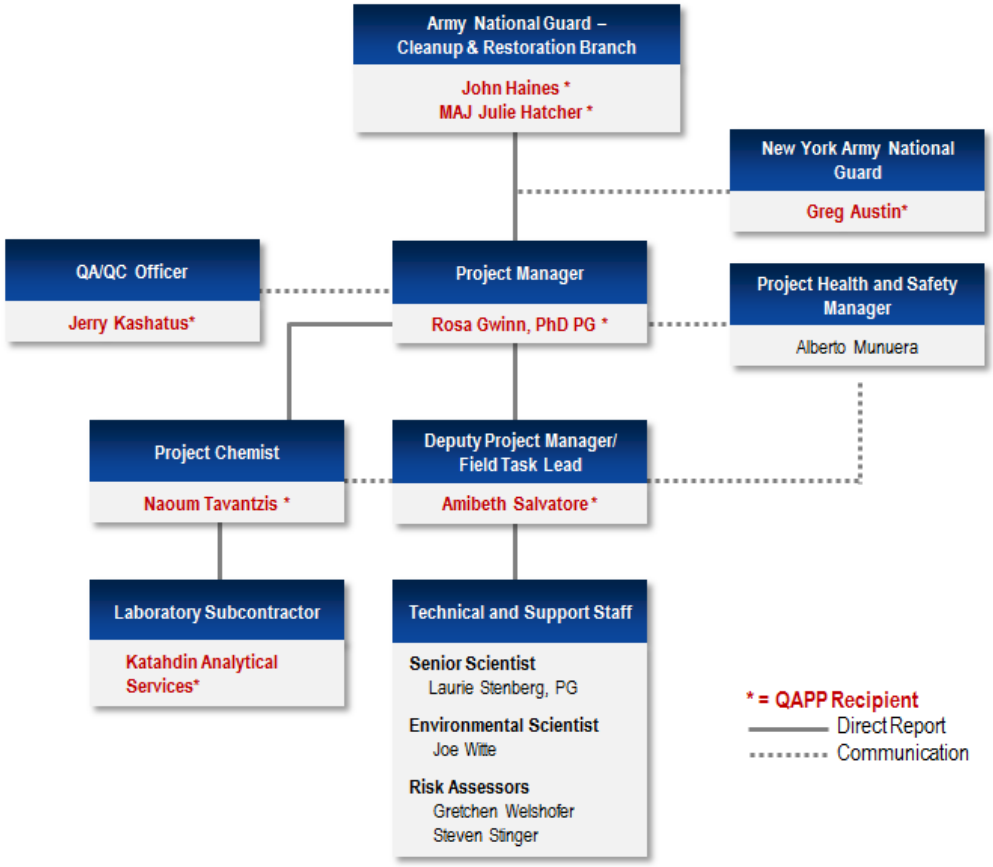
Regulatory Agency Project Manager: — Signature — Date
Printed Name / Organization: **John Swartwout / New York State Department of Environmental Conservation**

QAPP Worksheets #3 & #5 – Project Organization and QAPP Distribution

(UFP-QAPP Manual Sections 2.3 and 2.4; Environmental Protection Agency (EPA) 2106-G-05 Sections 2.2.3 and 2.2.4)

The project team organization for this project is presented in the chart below. Recipients of controlled copies of the Quality Assurance Project Plan (QAPP) are identified with an asterisk in the chart below. The draft QAPP, final QAPP, and any changes/revisions will be provided to the QAPP recipients, who are responsible for document control within their organization.

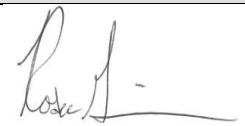
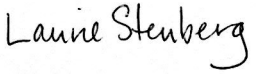
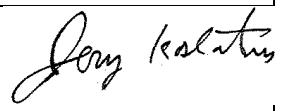
Project Organizational Chart

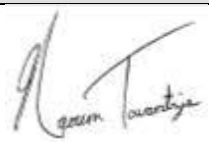


QAPP Worksheets #4, #7, & #8 – Personnel Qualifications and Sign-off Sheet

(UFP-QAPP Manual Sections 2.3.2 – 2.3.4; EPA 2106-G-05 Sections 2.2.1 and 2.2.7)

Organization: AECOM Technical Services, Inc. (AECOM)

Name	Project Title/Role	Education/Experience	Specialized Training/ Certifications	Signature/Date
Rosa Gwinn	Project Manager (PM)	Education: PhD, Geological Sciences; MS, Geological Sciences; BA, Geological Sciences Experience: 26+ years of experience performing and managing environmental investigations and remediation projects; 10+ years at military ranges; installation team leader on multiple Army National Guard (ARNG) ORA Phase II sites.	Professional Geologist (WA, UT)	 6 November 2018
Amibeth Salvatore	Deputy PM	Education: Master of Environmental Science & Management Experience: 5+ years of experience working on munitions constituent (MC) investigations under Military Munitions Response Program (MMRP) and ORA for ARNG and USMC. Direct experience developing QAPPs and other planning documents and serving as field and technical leader for MC investigation at multiple sites.	40hr HAZWOPER, 8hr OSHA Supervisor, First Aid/CPR	 6 November 2018
Laurie Stenberg	Project Senior Scientist (Independent Technical Reviews)	Education: BA, Geology Experience: 27 years of experience. ARNG Operational Range Assessment (ORA) Phase II Installation Team Leader at 8 Installations. Directed QAPP development for ORA Phase IIs at ARNG Installations. Experience executing MMRP projects at ARNG installations.	Professional Geologist (PA), AECOM Certified PM	 6 November 2018
Jerry Kashatus	Project Quality Assurance (QA)/Quality Control (QC) Officer	Education: MS, Geological Sciences; BS, Earth Sciences Experience: 30+ years of experience performing and managing environmental investigations for federal clients. Has served in QA/QC capacity on projects for 25+ years; completed training for performing quality audits per AECOM's internal requirements. Works with staff to ensure compliance with the corporate Quality Management System.	Professional Geologist (Pennsylvania)	 6 November 2018

Name	Project Title/Role	Education/Experience	Specialized Training/ Certifications	Signature/Date
Naoum Tavantzis	Project Chemist	Education: MBA; BA, Environmental Science Experience: 9+ years of experience, 2 years of experience as an analyst in an environmental laboratory; 6+ experience in developing UFP-QAPPs for field investigations at military ranges, as well as working with analytical laboratories to ensure project objectives are achieved; Senior Chemist on multiple ORA and MMRP investigations and military restoration projects.		 6 November 2018
Gretchen Welshofer	Human Health Risk Assessor	Education: MS, Environmental Science; BA, Communication Experience: 16+ years of experience performing human health risk assessments (HHRAs); expertise in evaluating potential risks and hazards to human health posed by MC emanating from small arms and large caliber ranges; expertise in evaluating contaminant fate and transport for validity of exposure pathways.		 6 November 2018
Steven Stinger	Ecological Risk Assessor	Education: MS, Environmental Science and Engineering; BS, Environmental Resource Management Experience: 30+ years of experience in the management and remediation of hazardous waste sites, including preparation of human health and ecological risk assessments and development of risk-based cleanup levels.		 6 November 2018
Joe Witte	Environmental Scientist/ Field Task Leader	Education: BS, Environmental Science and Policy Experience: 4+ years of experience in developing planning documents and serving as field leader for environmental investigations.	40hr HAZWOPER, First Aid/CPR	 6 November 2018
Alberto Munuera	Regional Health & Safety Manager	Education: MS, Occupational Health and Safety; BS, Geological Sciences Experience: 10+ years as a Health and Safety Manger responsible for managing large scale safety programs that include risk assessments and implementation of control measures, ergonomics, industrial hygiene, social psychology and environment protection.		Signature included in Appendix B (Site Safety and Health Plan) of the Work Plan

Organization: Katahdin Analytical Services, Inc. (Katahdin)

Name	Project Title/Role	Education/Experience	Specialized Training /Certifications	Signature/Date
Leslie Dimond	Laboratory QA Manager	Education: BA, Chemistry Experience: Over 17 years environmental laboratory experience; knowledgeable in a wide variety of U.S. Environmental Protection Agency (USEPA) methodologies including SW846 methods, USEPA 500 and 600 series and CLP Protocols.		
Heather Manz	Laboratory PM	Education: BS, Earth Sciences Experience: Over 8 years environmental laboratory experience including data management and project management. Currently serves as the POC for all Department of Defense (DoD) projects performed by the laboratory.		

*Signatures indicate personnel have read and agree to implement this QAPP as written

QAPP Worksheet #6 – Communication Pathways

(UFP-QAPP Manual Section 2.4.2; EPA 2106-G-05 Section 2.2.4)

Communication Driver	Responsible Entity	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Small Arms Ranges Program Manager and/or Contract Office Representative decisions and modifications	ARNG Cleanup & Restoration Branch (ARNG-IED) PM	MAJ Julie Hatcher	703-607-9166 julie.a.hatcher4.mil@mail.mil	Communicate award of work and options as directed by National Guard Bureau Contracting Officer. Track project progress through monthly reporting and daily field reporting. Stop work for quality or performance concerns.
Non-DoD Owned, Non-Operational Defense Sites (NDNODS) Program Manager decisions and modifications	ARNG-IED PM	John Haines	703-607-7986 john.b.haines.ctr@mail.mil	Track NDNODS project progress through monthly reporting and daily field reporting.
New York Munitions Response Site (MRS)-specific decisions and modifications	ARNG-IED New York PM	John Haines	703-607-7986 john.b.haines.ctr@mail.mil	Communicate New York-specific decisions and status updates to AECOM PM.
Regulatory agency interface	New York ARNG (NYARNG) PM	Greg Austin	518-786-4318 gregory.t.austin.nfg@mail.mil	Communicate technical approaches and decisions directly to regulatory agency representative(s).
Coordination of work at Camp Blauvelt MRS	NYARNG PM	Greg Austin	518-786-4318 gregory.t.austin.nfg@mail.mil	Communicate with AECOM Field Task Leader to schedule field tasks and timing.
Monthly status and field progress reports	AECOM PM	Rosa Gwinn	301-820-3131 rosa.gwinn@aecom.com	Provide progress reports to the ARNG-IED PM.
Stop work due to safety issues	AECOM All	Alberto Munuera	757-408-4276 (mobile) alberto.munuera@aecom.com	Work may be stopped at any time for any safety concern. Refer to the Site Safety and Health Plan (SSHP) for specifics related to health and safety. Persons other than the responsible entity may also stop work for safety concerns.
QAPP changes prior to field work	AECOM PM	Rosa Gwinn	301-820-3131 rosa.gwinn@aecom.com	Notify ARNG-IED PM of QAPP revisions and requests for concurrence.
QAPP changes during project execution	AECOM PM	Rosa Gwinn	301-820-3131 rosa.gwinn@aecom.com	Approval will be obtained for modifications to the QAPP as necessary from ARNG-IED. All approved modifications will be included in Nonconformance Report(s) and resolution / corrective action will be determined.

Communication Driver	Responsible Entity	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Field corrective actions	AECOM PM	Rosa Gwinn	301-820-3131 rosa.gwinn@aecom.com	Approval will be obtained for any modifications to the QAPP as necessary from ARNG-IED, including but not limited to changes to sampling locations/strategies. All approved modifications will be included in Nonconformance Report(s) and resolution / corrective action will be determined.
Sample receipt variances	Katahdin Laboratory PM	Heather Manz	207-874-2400 x17 hmanz@katahdinlab.com	Report all project nonconformances and problems to the AECOM Project Chemist.
Laboratory quality control (QC) variances	Katahdin Laboratory PM	Heather Manz	207-874-2400 x17 hmanz@katahdinlab.com	Report all project nonconformances and problems to the AECOM Project Chemist.
Analytical corrective actions	Katahdin Laboratory PM	Heather Manz	207-874-2400 x17 hmanz@katahdinlab.com	Report all project nonconformances and problems to the AECOM Project Chemist.
Eurofins laboratory modifications and performance problems	Katahdin Laboratory PM	Heather Manz	207-874-2400 x17 hmanz@katahdinlab.com	Report all project nonconformances and problems to the Katahdin PM. Katahdin PM will report to AECOM Project Chemist.
Reporting laboratory data quality issues	Katahdin Laboratory PM	Heather Manz	207-874-2400 x17 hmanz@katahdinlab.com	All QA/QC issues with project field samples will be reported to AECOM as soon as possible, and no longer than within two business days.
Data validation issues, e.g., non-compliance with procedures	AECOM Project Chemist	Naoum A. Tavantzis	301-267-8761 naoum.tavantzis@aecom.com	Report non-compliance, etc. to Katahdin Laboratory PM. Resolution / corrective action will be determined.
Data review corrective actions	AECOM Project Chemist	Naoum A. Tavantzis	301-267-8761 naoum.tavantzis@aecom.com	Report non-compliance, etc. to Katahdin Laboratory PM. Resolution / corrective action will be determined.

QAPP Worksheet #9 – Project Planning Session Summary

(UFP-QAPP Manual Section 2.5.1; EPA 2106-G-05 Section 2.2.5)

The meeting minutes below include discussion of the Camp O'Ryan Rifle Range MRS, which will be addressed under a separate remedial investigation.

Technical Project Planning (TPP) Meeting 1 and Site Visit for
Camp Blauvelt & Camp O'Ryan Rifle Range
Munitions Response Sites (MRS) – Meeting Minutes
Army National Guard (ARNG) Remedial Investigation through
Decision Document for Six ARNG MRSs
Contract No. W9133L-14-D-0001, DO 0006
Tuesday, 14 November 2017
0900 to 1110 hrs

Participants

Name	Title/Role	Affiliation	Phone #	E-mail Address
John Haines*	Program & Camp Blauvelt and Camp O'Ryan Project Manager	ARNG IED	703-607-7986	john.b.haines.ctr@mail.mil
Greg Austin	Environmental Program Manager	NYARNG	518-786-4318	gregory.t.austin.nfg@mail.mil
John Swartwout	Environmental Program Manager	NYSDEC	518-402-9620	john.swartwout@dec.ny.gov
Edward Moore	Regional Hazardous Waste Remediation Engineer	NYSDEC Region 3	845-256-3137	edward.moore@dec.ny.gov
Eugene Melnyk*	Project Manager	NYSDEC Region 9	716-851-2770	eugene.melnyk@dec.ny.gov
Scarlett McLaughlin	Project Manager	NYSDOH	518-402-7860	scarlett.mclaughlin@health.ny.gov
Mark Sergott	Project Manager	NYSDOH	518-402-7860	mark.sergott@health.ny.gov
Steve Lawrence	Project Manager	NYSDOH	518-402-7860	stephen.lawrence@health.ny.gov
Sara Bogardus	Project Manager	NYSDOH	518-402-7860	sara.bogardus@health.ny.gov
Rosa Gwinn	Project Manager	AECOM	301-820-3131	rosa.gwinn@aecom.com
Joe Witte	Project Coordinator	AECOM	301-820-3267	joe.witte@aecom.com

*Joined via teleconference

An in-brief package (Attachment 1) was provided in advance of the meeting. Key points that augment the package are provided below. The meeting was held at the New York Division of Military and Naval Affairs on Old Niskayuna Road, Latham, New York.

The in-brief meeting began at 0900 hours EST.

Introductions and Agenda (Slides 1-6)

Rosa Gwinn (AECOM) welcomed everyone and began the meeting by circulating a sign-in sheet (Attachment 2). Introductions began with John Haines (Army National Guard – Environment Division; ARNG IED) welcoming everyone, and emphasizing the interactive nature of the meeting.

Rosa presented a health & safety moment on the danger of slipping in the shower. Hotel bathrooms undergo cleaning between each visitor's stay, and sometimes cleaning agents leave the shower/bathtub floor very slippery. Greg Austin (New York ARNG; NYARNG) pointed out emergency exits and bathroom locations at the New York Division of Military and Naval Affairs building.

Rosa presented the meeting agenda and goals. It was noted that a site-visit would be conducted at Camp Blauvelt following the meeting, but Camp O'Ryan would not be visited during this trip.

TPP Process (Slide 7)

The group reviewed the value of the Technical Planning Process (TPP) process in building consensus, and reviewed at what stages TPP meetings will be held during the current project. The main goal of applying the TPP is to collectively determine the study data quality objectives (DQOs), what data are needed to meet those objectives, and plan for appropriate data collection. There will be a TPP to address investigation findings as well. The TPP meeting format is flexible and may include teleconferences. Additional meetings may be held during Proposed Plan and Decision Document (DD) phases of the project.

Program Drivers and Overview (Slides 8-13)

Several slides addressed the Department of Defense (DoD) environmental program to investigate historic munitions sites--the MMRP--and the unique status of Non-DoD Non-Operational Defense Sites (NDNODS). The MMRP was established to address the potential for Munitions and Explosives of Concern (MEC) and MC contamination as a result of former DoD use. Historically, the Camp Blauvelt MRS and Camp O'Ryan MRS 2 were solely used for small arms training, and MEC is not anticipated at either site.

John Swartwout (New York State Department of Environmental Conservation; NYSDEC) noted that Camp O'Ryan included a tank maneuvering and training area, and questioned why it was not being studied. John Haines stated that sites were funded in priority of their Munitions Response Site Prioritization Protocol (MRSPP) score. He described that the two sites investigated in this project have a very low probability of MEC, but that metal detectors may be considered in safety planning for MEC avoidance by the contractor.

Because NDNODS sites are not under DOD control, there will be a need to obtain rights of entry (ROEs) from landowners to access sites for field work. A ROE for parcels accessed during the Camp Blauvelt RI will be obtained prior to RI soil sampling. Camp O'Ryan MRS2 is private property, and will require an ROE for any site access by the contractor.

The current project includes all phases of the Comprehensive Environmental Response, Compensation & Liability Act (CERCLA) process from Remedial Investigation (RI) through DD. The goal of the RI is to characterize the nature and extent of potential MC and quantitatively assess risks to human health and the environment associated with MC exposure. The Feasibility Study (FS) will evaluate potential remedial actions to mitigate those risks, and, after public comment during the Proposed Plan, and remedy will be selected and legally memorialized in a DD.

To address the objectives of the RI, AECOM will prepare a site-specific Work Plan and Uniform Federal Policy (UFP)-Quality Assurance Project Plan (QAPP), which will undergo stakeholder review. A Community Relations Plan (CRP) will be prepared to include discussion of assessing community interest from nearby residents and recreational visitors.

Camp Blauvelt MRS (Slides 14-24)

Joe Witte reviewed the location and site history of Camp Blauvelt MRS. The MRS is a 447-acre area located approximately 0.5 miles west of the Tappan Zee Bridge in Rockland County, New York, that was formerly used as a 1,000-yard outdoor rifle range. There are concrete target structures located 200, 300, 600, and 1,000 yards from the former firing line. Concrete tunnels connect the target berms, and support structures are also present. The MRS is part of the Blauvelt State Park, and abuts residential areas beyond the park boundary. No historical evidence of MEC has been documented or found at the site.

A Site Inspection (SI) was completed in 2012, and these results established that an RI was necessary at Camp Blauvelt. In the SI, lead and copper concentrations in soil at the 200 and 300 yard berms exceeded the NYSDEC New York Remedial Program Soil Cleanup Objectives (NY RP SCOs). Metals were compared to both restricted and unrestricted use NY RP SCOs during the SI. The group discussed that unrestricted use NY RP SCOs should be considered for screening during the RI. John Swartwout indicated that NYSDEC believes the NYSDEC DER-10 *Technical Guidance for Site Investigation and Remediation* should be reviewed for the basis of DQO development in the Work Plan for each MRS.

The RI will address the potential for MC contamination in both surface soil and subsurface soil. AECOM proposed Decision units (DUs), feature locations targeted for RI sampling, at the 200 and 300 yard berms where NY RP SCOs were exceeded during the 2012 SI. John Swartwout indicated that NYSDEC believes all four target berms should be included as DUs in the RI.

Incremental sampling methodology (ISM) was discussed as a potential option for MRS surface soil characterization. ISM is used to collect surface soil from 0 to 6 inches below ground surface (bgs) in front of the target berms where MC naturally collects during firing. Rosa Gwinn described the benefits of ISM as a best estimate of realistic exposure point concentrations at DUs at each MRS. The group discussed that surface soil samples may need to be collected from 0 to 2 inches bgs, per NYSDEC guidance. DU boundaries will be refined using a portable X-Ray Fluorescence (XRF) analyzer to screen surface soils for lead. Joe Witte explained that XRF analysis will direct the location for laboratory analytical sampling, and will only be used in determining DU boundaries, not in quantitative risk assessment. The SI did not include XRF analysis due to rainy sampling conditions and moist soil; portable XRF analysis is best under relatively dry conditions. Once boundaries are established, samples will be collected for laboratory analysis in accordance with an approved work plan.

Discrete sampling at each target berm was also discussed as a means of assessing MC contamination at specific locations versus average exposure at each DU. Additionally, discrete sampling will be utilized at each DU to characterize subsurface soil from 12 to18 inches bgs, and 24 to 40 inches bgs (contingent on analytical results from samples collected 12 to 18 inches bgs). Subsurface soil will also be analyzed for Toxicity Characteristic Leachate Procedure (TCLP) analysis for use in potential future remedial actions.

Scarlett McLaughlin (New York State Department of Health; NYSDOH) inquired whether the sampling would assess other chemical releases from gun cleaning activities. John Haines reinforced that this program is focused on the MC released from small arms firing.

AECOM will propose a defensible approach to surface and subsurface soil sampling in the RI Work Plan / UFP-QAPP.

The field schedule will target optimal sampling conditions (dry and no snow).

Camp O'Ryan MRS 2 (Slides 26-36)

Joe Witte described the location and site history of Camp O'Ryan MRS 2, which is a 17.5-acre area located approximately 45 miles east-southeast of Buffalo, New York, formerly used as an outdoor rifle range. Camp O'Ryan MRS 2 lies within Camp O'Ryan MRS 3, a 394-acre former tank maneuver and training area, and is north of Camp O'Ryan MRS 1, a former pistol range. Only MRS 2 is included in this phase of work. Camp O'Ryan MRS 2 has a cement retaining wall with target structures still intact. The MRS is currently located adjacent to a retail outlet for building construction materials. It was mentioned that the former barracks associated with the MRS were located where retail outlet currently exists. No historical evidence of MEC has been documented or found at the site.

John Haines noted that solid waste from activities at the neighboring property are spilling onto MRS 2. Eugene (Gene) Melnyk (NYSDEC) noted that this is a building construction retail outlet. John Haines reminded the team that this waste will not be characterized as part of the MMRP; the focus is on determining the nature and extent of MC.

In completing the SI, the prior contractor relied on prior soil sampling results from a 2008 NYSDEC investigation. Gene Melnyk offered to provide that document, because AECOM was not confident that the data were clearly presented in the 2012 SI Report. Gene also mentioned that there was a 2011 investigation by Woods Hole Oceanographic Institute in concert with the US Army Corps of Engineers that he will provide to the team prior to preparing the Work Plan.

Antimony, copper, and lead exceeded NY RP SCOs in surface soil samples collected during the 2008 NYSDEC investigation. Metals were compared to both restricted and unrestricted use NY RP SCOs according to the 2012 SI Report. For the RI, AECOM will propose a defensible screening level for metals for use in the RI Work Plan / UFP-QAPP that accounts for current and potential future land use.

Field sampling methods, including the use of XRF for screening and DUs at the former berms, will follow similar procedures described for Camp Blauvelt.

The field schedule will target optimal sampling conditions (dry and no snow).

Schedule and Open Discussion (Slides 25, 37, and 38)

Mark Sergott (NYSDOH) inquired as to why the Camp O'Ryan MRS 2 RI was discussed, but not MRS 1 or 3. Rosa reminded the group that the ARNG had prioritized the sites at the SI phase through the MRSPP, and was addressing MRS 2 first. Future studies would be pursued through other ARNG contracts, and are not part of this effort.

Scarlett McLaughlin requested that official NYSDEC site names be included on all document submittals for the Camp Blauvelt and Camp O'Ryan MRSs.

A general schedule was discussed. The next phase for regulatory engagement will be upon submittal of the draft-final Work Plan and QAPP, likely to occur in mid-January 2018. TPP2 will be held during the review. The field work would be targeted for March 2018 at the earliest, and TPP3 would be used to discuss the RI findings.

John Swartwout is the primary POC for NYSDEC. Gene Melnyk will operate as the POC for Camp O'Ryan, and Edward Moore (NYSDEC) will be the POC for Camp Blauvelt. Steve Lawrence (NYSDOH) is the NYSDOH POC for Camp O'Ryan, and Sara Bogardus (NYSDOH) is the NYSDOH POC for Camp Blauvelt.

AECOM will require further guidance on document distribution from each stakeholder organization.

TPP1 Presentation concluded at 1110 hours EST.

Camp Blauvelt Site Visit (Tuesday, 14 November 2017)

The Camp Blauvelt MRS Site Visit began at 1410. Attendees were Greg Austin (NYARNG); Edward Moore (NYSDEC); Sara Bogardus (NYSDOH); and Rosa Gwinn and Joe Witte (AECOM).

The group walked on marked trails from the Tackamack Park (south of Blauvelt State Park) parking area north on trails towards the MRS. At the MRS, the group observed each range wall feature, as well as concrete tunnels and walkways, associated buildings, target structures, and site debris. Each target area is described in the photographs provided below with brief descriptions of the key features. Photograph locations are shown on the attached Blauvelt State Park trail map (Attachment 3). Major takeaways from the Camp Blauvelt MRS site visit include:

- The 600-yard and 1000-yard targets were behind concrete stops that rise over 6 feet above the ground surface. The 200- and 300-yard berms have soil piled up against their concrete faces.
- The soil on the berm face at the 200- and 300-yard berms will be evaluated for sampling as separate DUs.
- Soil from the flat areas in front of the 600- and 1000-yard berms will be evaluated for

sampling as separate DUs.

- Soil is eroded away from the center in front of the 600-yard target wall, where there is a sinkhole. Sampling locations at this DU will require adjustment to avoid the sinkhole.
- The area is heavily vegetated with thick brush, inhibiting access for sampling.
- Target structures and a stone wall berm are present approximately 800-yards from the firing line within the MRS. These do not appear on range maps, and targets are not present. The tunnel leading from the 600-yard to 1000-yard berms does not have an exit/entrance at this distance, suggesting it was not part of regular use.
- Parking for RI activities will need logistical consideration. Parking at the Tackamack Park parking area adds unnecessary distance walking to the sampling locations compared to parking locations on neighborhood streets in the residential area on the southern end of Blauvelt State Park. An additional parking area off of Greenbush Road to the west appears to link directly to the former Camp Bluefields Road, an overgrown track that connects the berms, and seems to serve partly as a biking trail.

The site visit concluded at approximately 1650 hrs EST.

Photograph 1: View looking north from above a concrete tunnel at the south end of the 200-yard target wall. The firing direction is from left to right in this field of view. The area is covered with leaf litter and natural grasses.

Photograph 2: View looking north across the 300-yard target wall from atop the concrete tunnel connecting target walls at 200 yards and 300 yards. A support structure can be seen on the eastern side of the target wall. The firing direction is from left to right in this field of view.

Photograph 3: View looking northeast at the front of 600-yard target wall. Thick vegetation covers the area in front the target wall. The range floor is eroded away directly in front of the wall. No soil was piled up against this target wall. The firing direction is from left to right in this field of view.

Photograph 4: View looking northeast towards the southern edge of the 600-yard target wall. A concrete tunnel begins at the base of the target wall and runs east up the hill away from the 600-yard target wall to the 1,000-yard wall. The lack of soil in front of the target wall is evident in this view.

Photograph 5: View looking northwest towards the back of the 600-yard target wall (graffiti in the middle distance). The concrete tunnel connecting the 600-yard target wall and 1,000-yard target wall is the structure running across the center to the right of the photograph.

Photograph 6: View looking northeast from the concrete tunnel connecting the 600-yard target wall and 1,000-yard target wall. A pile of rocks that may have been in planning for a berm and concrete target slabs can be seen among the trees.

Photograph 7: View looking southeast towards the front of the 1,000-yard target wall. A hillside is visible behind the target wall that likely acted as a natural backstop. Firing would have been from the right to left in this field of view.

Photograph 8: View looking southeast towards one of several support structures located behind the 1,000-yard target wall. Similar structures were located behind the 300-yard target wall.

Photograph 9: Collapsed tunnel behind the 1,000-yard target. Belowground tunnels spanned the distance of the 1,000-yard target wall behind the wall in addition to the aboveground tunnels that connected the target walls at 600 yards and 1,000 yards.

Action Items

- NYSDEC and NYSDOH will identify POCs to AECOM for the purposes of document submittals.
- AECOM will work towards scheduling a visit to Camp O'Ryan that fits the schedule of Gene Melnyk (NYSDEC) and Steve Lawrence (NYSDOH).

QAPP Worksheet #10 – Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2; EPA 2106-G-05 Section 2.2.5)

The Conceptual Site Model (CSM) for Camp Blauvelt MRS is presented within this worksheet as a combination of diagrams/figures and narratives. This profile was generated based on the information and findings presented in the 2012 SI (Parsons, 2012) as well as the information gathered during the 2009 Preliminary Assessment (Malcolm Pirnie, Inc., 2009) and 2011 Historical Records Review (HRR) (Parsons, 2011). The CSM describes the potential physical, chemical, and biological processes that may transport contaminants from sources to receptors and provides the basis for evaluating potential risks to human health and the environment. The Work Plan presents the site-specific history of Camp Blauvelt MRS, a brief site description, and the physical and ecological characteristics of the area.

Sources

Based on a review of the available historical records, former munitions-related training was limited to small arms (rifles and potentially pistols) at the Camp Blauvelt MRS. The MRS was used by the New NYARNG for live-fire, small-arms weapon training from 1910 to 1913. NYARNG used the MRS again from an unknown date to 1925, but training during that time was unlikely. Historically, Camp Blauvelt was used as a 1,000-yard known distance rifle range. Based on the 2012 SI (Parsons, 2012), the Camp Blauvelt MRS encompasses 447 acres of park land and includes the former range firing line and target walls. The MRS includes the historic 200-, 300-, 600-, and 1,000-yard concrete target walls, as well as concrete bunkers, interconnected aboveground and underground tunnels, and observation areas. Additionally, an earthen berm with target structures exists 800 yards from the firing line. Firing at the former range occurred in an east/northeast direction toward the target walls.

Based on the 2012 SI visual survey observations, range type, timeframe of use, and location, it is assumed that .22 caliber, .30 caliber, .38 caliber, and .45 caliber were used at the MRS (Parsons, 2012). Potential MC present within berm soil as a result of small arms projectiles are primarily lead and secondarily antimony, copper, and zinc. Copper was confirmed in surface soil at the 200-yard and 300-yard target walls at concentrations above NY RP SCOs for unrestricted use during the 2012 SI. Lead was also confirmed in surface soil at the 200- and 300-yard target walls at concentrations above NY RP SCOs for restricted use during the 2012 SI. Lead was not compared against NY RP SCOs for unrestricted use during the SI, but samples from the firing line, and 200-, 300-, 600-, and 1,000-yard target walls also exceeded NY RP SCOs for unrestricted use.

Pathways

MC deposited in surface soil as a result of firing activities at the MRS has limited potential to migrate from source areas (i.e., firing line and target walls). Given the MRS topography, range orientation, and vegetation, stormwater runoff from significant rain events is unlikely to transport suspended soil particles off site or to wetlands near and within Blauvelt State Park. This was confirmed with a visual inspection during the November 2017 site visit with stakeholders (**Worksheet #9**). Stormwater runoff from the MRS generally flows west, but is mostly encumbered by thick vegetation. **Figure 10-1** presents a pictorial diagram of the site; it shows that transport pathways from DUs to surface water bodies are incomplete. **Figure 10-2** presents a conceptual diagram of transport from MC in soil to receptors.

Metals MC have a strong affinity to sorb to soil particles, particularly soils that are rich in organic matter, and usually only migrate via physical transport pathways. Because of these chemical properties, they typically do not leach to groundwater except where shallow groundwater exists less than 5 feet bgs. According to United States Geological Survey National Water Information System (USGS, 2018) data presented in the 2012 SI, groundwater at the MRS is approximately 99 feet bgs (cross sections A-A' and B-B' of **Figure 10-1**). Therefore, groundwater pathways are incomplete for the Camp Blauvelt MRS.

MC within soil at the MRS is anticipated to remain in soil at the firing line and target walls, and not be transported off site. Exposure pathways between MC and receptors are restricted to source areas, which is potentially the soil at the firing line and target walls.

Receptors

Historic range features are centralized within the MRS, and surrounded by undeveloped, forested land. The areas surrounding the MRS are predominantly residential (Parsons, 2012) (see Figure 1-2 of the Work Plan). Additionally, there are a few residential properties within the southwestern portion of the MRS. The MRS includes hiking and biking trails that are maintained as a part of Blauvelt State Park. Access to the MRS is unrestricted. Potential human receptors include park visitors and workers (e.g., construction, industrial).

There are no federally designated critical habitat areas located within the MRS (USFWS, 2017). Rockland County is host to three federally listed threatened and endangered species: the Indiana Bat (*Myotis sodalist*), the Northern Long-Eared Bat (*Myotis septentrionalis*), and the Bog Turtle (*Clemmys muhlenbergii*). However, no federally listed threatened and endangered species are known to occur at the Camp Blauvelt MRS (USFWS, 2017). New York State also lists threatened and endangered species (NYSDEC, 2015). Listed in the table below are New York State threatened and endangered species with the potential to occur at or near the MRS based on their known home ranges and preferred habitat.

New York State Endangered Species		New York State Threatened Species	
Type	**Name**	**Type**	**Name**
Molluscs	Dwarf Wedgemussel (*Alasmidonta heterodon)*	**Molluscs**	Brook Floater (*Alasmidonta varicosa*)
	Clubshell (*Pleurobema clava*)		Green Floater (*Lasmigona subviridis*)
Insects	Tomah Mayfly (*Siphlonisca aerodromia*)	**Insects**	Pine Barrens Bluet (*Enallagma recurvatum*)
	Hessel's Hairstreak (*Callophrys hesseli*)		Scarlet Bluet (*Enallagma pictum*)
	Karner Blue Butterfly (*Lycaeides melissa samuelis*)		Little Bluet (*Enallagma minisculum*)
	Regal Fritillary (*Speyeria idalia*)		Frosted Elfin (*Callophrys irus*)
	Persius Duskywing (*Erynnis persius*)	**Fish**	Gravel Chub (*Erimystax x-punctatus*)
	Grizzled Skipper (*Pyrgus centaureae wyandot*)		Banded Sunfish (*Enneacanthus obesus*)
	Arogos Skipper (*Atrytone arogos arogos*)	**Reptiles**	Blanding's Turtle (*Emydoidea blandingii*)
	Bog Buckmoth (*Hemileuca maia*)		Fence Lizard (*Sceloporus undulates*)
Amphibians	Northern Cricket Frog (*Acris crepitans*)		Timber Rattlesnake (*Crotalus horridus*)
Reptiles	Bog Turtle (*Clemmys muhlenbergii*)	**Birds**	Pied-billed Grebe (*Podilymbus podiceps*)
Birds	Peregrine Falcon (*Falco peregrinus*)		Least Bittern (*Ixobrychus exilis*)
	Piping Plover (*Charadrius melodus*)		Bald Eagle (*Haliaeetus leucocephalus*)
	Roseate Tern (*Sterna dougallii dougallii*)		Northern Harrier (*Circus cyaneus*)
	Black Tern (*Chlidonias niger*)		King Rail (*Rallus elegans*)
	Short-eared Owl (*Asio flammeus*)		Common Tern (*Sterna hirundo*)
Mammals	Indiana Bat (*Myotis sodalist*)	**Mammals**	Northern Long-eared Bat (*Myotis septentrionalis*)

Preferential habitat quality exists at the MRS and its surrounding areas (e.g., wetlands), but ecological receptors are anticipated to be minimally exposed to MC within the MRS or in surrounding areas.

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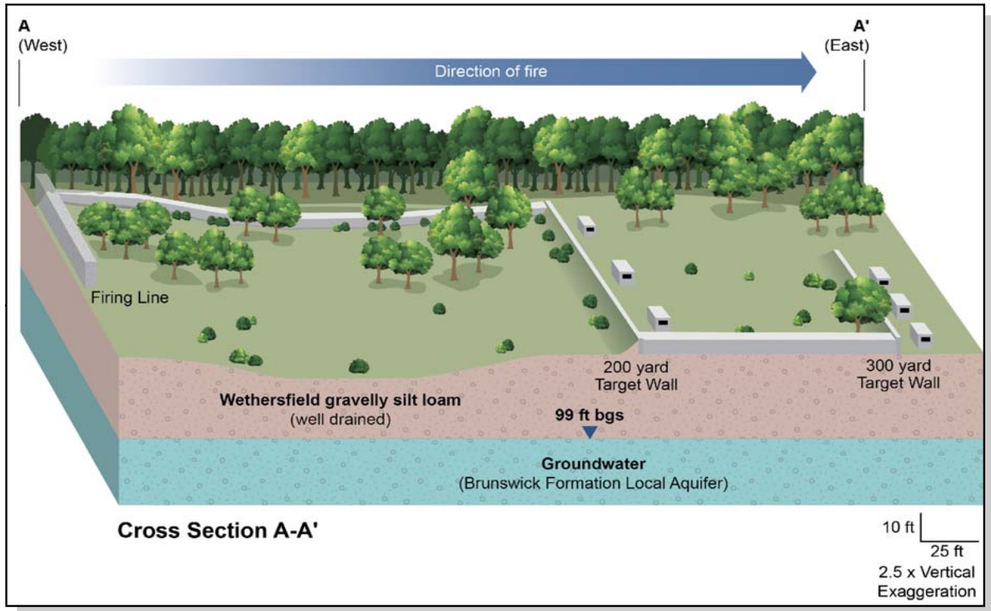
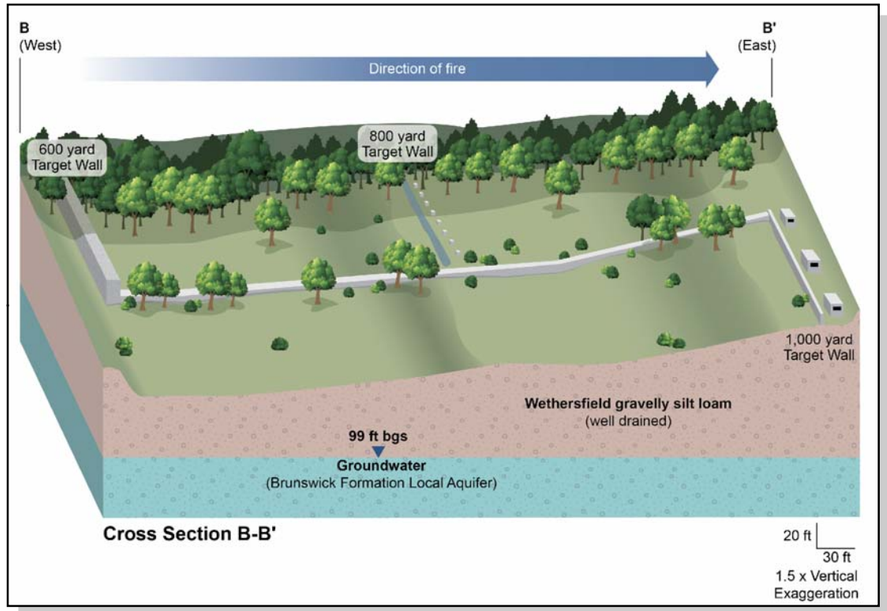
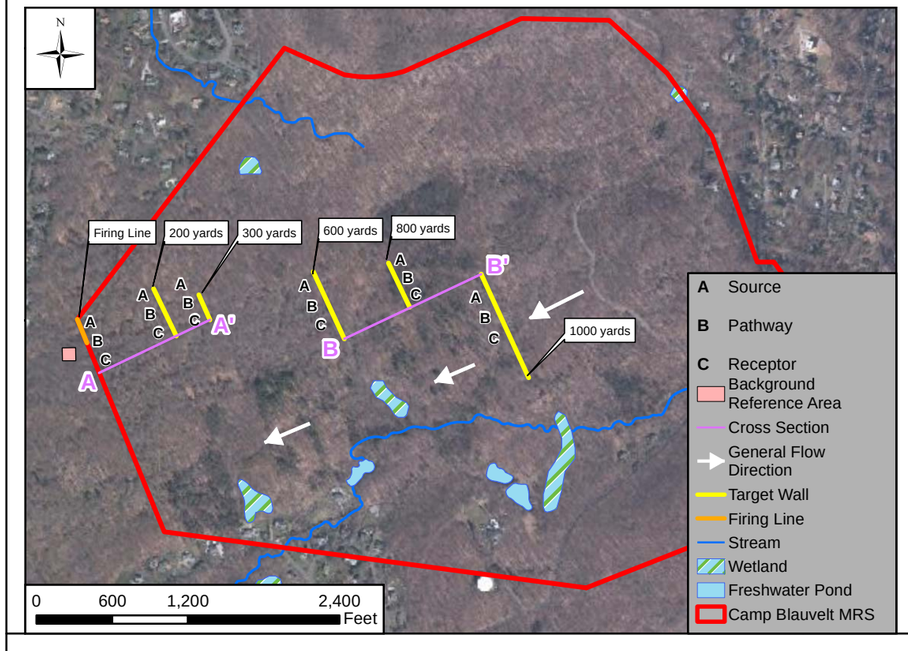




A – Sources
Metals, particularly lead, in soil at the target walls and in front of the firing line as a result of historical small arms training.



B – Pathways
Metals MC have limited potential to migrate from soil at the target walls or firing line (Source areas: "A" on map) beyond MRS boundaries. MC from the target walls and firing line is unlikely to travel offsite due to the retardation of transport from vegetation and adhesion to soil. Groundwater at the MRS is approximately 99 feet below ground surface (Cross section A-A' and B-B'). Groundwater pathways are incomplete since metals are highly unlikely to leach from target wall soil or firing line soil to groundwater. MC within MRS soil is anticipated to remain at the target walls and firing line

C - Receptors
Historic range features are centralized within the MRS, and surrounded by vastly undeveloped, forested land. The MRS includes hiking and biking trails are maintained as a part of Blauvelt State Park. The areas surrounding the MRS are predominantly residential. Human receptors may recreationally visit the MRS for sightseeing, hiking/exercise (recreational users). Future maintenance workers may also visit the MRS to conduct maintenance activities.

Rockland County is host to three federally listed threatened and/or endangered species: the Indiana Bat (Myotis sodalist), the Northern Long-Eared Bat (*Myotis septentrionalis*), and the Bog Turtle (*Clemmys muhlenbergii*). There is no federally-designated critical habitat located within the MRS; however, habitat supporting ecological receptors is present within the MRS. New York State also lists numerous threatened and endangered species with known ranges or locations within the vicinity of the MRS. New York State listed threatened and endangered species with the potential to be found at or near the MRS include species of molluscs, insects, fish, amphibians, reptiles, birds, and mammals.

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 10-1
Conceptual Site Model
Camp Blauvelt, New York

New York Statewide Orthoimagery Program, 2016

Date.....May, 2018
Prepared by.....AECOM

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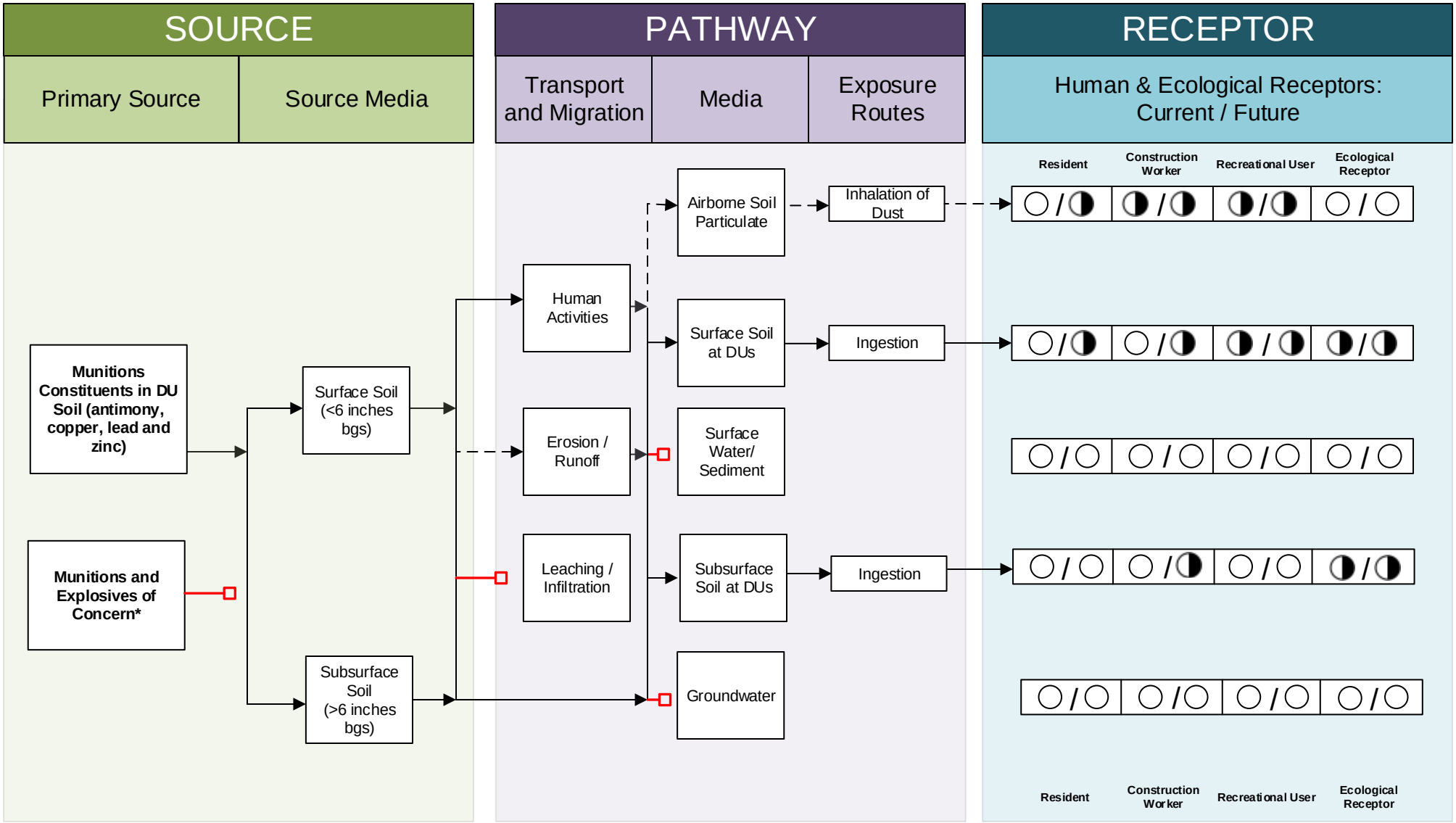

LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway
- Complete Pathway

*Munitions and explosives of concern are not present at the MRS

Figure 10-2
Conceptual Site Model Diagram
Camp Blauvelt MRS, New York

QAPP Worksheet #11 – Project/Data Quality Objectives

(UFP-QAPP Manual Section 2.6.1; EPA 2106-G-05 Section 2.2.6)

DQOs are used to help decision makers collect data of the right type, quality, and quantity to support the decision-making process. The approach to developing DQOs is an iterative process geared toward generating data that will be appropriate to making the decisions needed to reach the project goals. The DQO process consists of seven steps as presented in the USEPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006). Each step is presented below.

Step 1: State the Problem

Historical small-arms firing is known to have occurred at the Camp Blauvelt MRS from 1910 to 1913 during the site's use by the NYARNG. The soil at range target walls may have been affected by MC from bullets used during small arms training. SI data collected in 2012 indicates there is likely metals MC contamination in soil at the Firing Line, 200 yard, 300 yard, 600 yard, and 1,000 yard target walls: MC, lead and copper in particular, is present in soil above background concentrations and human health screening levels. The 800-yard target wall was not sampled during the 2012 SI.

The lateral and vertical distribution of MC in soil at the firing line and target walls is unknown and additional data are needed to confirm whether there is an effect on soil at these locations. Additionally, background (also called reference) data for metals MC, collected using the same methods used for this RI, are needed so that data sets are comparable.

As described in **Worksheet #9**, the general plan for investigating the nature and extent of MC in soil at the firing line and target walls was presented to stakeholders at the project kickoff meeting. Site maps showing detailed sampling locations appear on **Figures 17-2 through 17-7** of **Worksheet #17**.

Step 2: Identify the Goals of the Study

Sampling at the Firing Line and target walls will provide answers to the following questions:

- If present, do MC concentrations in soil exceed Project Action Limits (PALs) and background?
- What is the lateral and vertical distribution of MC in soil exceeding screening PALs and background?
- If MC is present in concentrations above the PALs and background, do these concentrations pose an unacceptable risk to human health and the environment?
- If MC concentrations in soil are below the PALs, can a No Further Action (NFA) decision be supported?
- If MC is present at concentrations that pose an unacceptable risk to human health and/or the environment, is/are they sufficiently defined to support an informed risk management decision of potential remedial actions?

Step 3: Identify Information Inputs

Inputs needed to answer the questions identified in Step 2 are detailed below:

- Historical information and previous SI data were reviewed to design the sampling and analysis approach. Details regarding the sampling design are presented in **Worksheet #17**.
- Soil data are needed from discrete locations to understand the lateral and vertical extent of MC. For risk assessment, defensible exposure concentrations within a DU are needed and will be accomplished by either a sufficient quantity of discrete samples or the ISM described in **Worksheet #17** and detailed in standard operating procedure (SOP) **MC-4**.
- Naturally occurring background metals MC concentrations will be determined in a nearby area that is unaffected by historical site activities, see **Worksheet #17, Figure 17-1**.
- During the RI, ISM results will be compared to the PALs established by following screening criteria detailed on **Worksheet #15** (and area-specific background concentrations):
    - U.S. Environmental Protection Agency (USEPA) Regional Screening Levels protective of a residential scenario using a target hazard quotient of 0.1 and a target cancer risk of $1x10^{-6}$ (USEPA, 2017).
    - New York Remedial Program Soil Cleanup Objectives (NY RP SCOs) for Unrestricted Use (NYSDEC, 2006)
    - New York Remedial Program Soil Cleanup Objectives (NY RP SCOs) for Restricted Use, Protection of Ecological Resources (NYSDEC, 2006)
- Based on these screening criteria and the sampling design, data will be obtained using two methods: on-site XRF and off-site laboratory analysis by analytical methods. USEPA SW-846 Method 6020B (metals) was selected to achieve the required levels of detection (LODs) and levels of quantitation (LOQs).

Step 4: Define Boundaries of the Study

The physical boundaries of the MRS and proposed DUs are shown in **Figure 17-1** of **Worksheet #17**. The investigation/DU boundaries may be refined based on results of the MC investigation during which step-out samples may be collected to define the edge of MC concentrations above the NY RP SCOs for unrestricted use (NYSDEC, 2006) for lead as applicable. There are no significant practical constraints on the sampling, and ROE is not needed since the land is owned by the Palisades Interstate Park Commission (PIPC) and designated as Blauvelt State Park.

Step 5: Develop the Analytic Approach

The purpose of this step is to integrate the outputs from the previous steps into a statement that defines the conditions that would cause the decision-maker to choose among alternative actions. For this RI, the risk-based assessment will use results from incremental samples collected from each DU. Data from these samples represent the potential exposure risk to receptors across the entire DU. The primary concern is the limited number of human receptors who have access to the site. Ecological receptors may be present; however, there is little or no sensitive habitat at the MRS. XRF sample data will be used to delineate DU boundaries in the field. Discrete sample data will be used for delineation of MC extent. Both human and ecological PALs are listed in **Worksheet #15**. The selection process for location of DUs and collection of incremental samples for MC analysis is outlined in **Worksheet #17**.

The decision rules for this RI are:

- Firing line and 200-, 300-, 600-, 800-, and 1,000-yard target walls: If XRF results of the 0- to 6-inch historic surface soil samples along the DU boundary exceed the NY RP SCOs for unrestricted use for lead (**Worksheet #15**), then step-out samples will be collected and analyzed with XRF until exceedances are no longer observed; the DU boundary will be revised; and ISM samples will be collected from the revised DU.
- Firing line and 200-, 300-, 600-, 800-, and 1,000-yard target walls: If XRF results of the 0- to 6-inch historic surface soil samples along the DU boundary do not exceed the NY RP SCOs for unrestricted use for lead for lead (**Worksheet #15**), then ISM samples will be collected from the initial DU.
- Firing line and 200-, 300-, 600-, 800-, and 1,000-yard target walls: If the ISM MC concentrations are less than the PALs (**Worksheet #15**), then there is no unacceptable risk of MC exposure to receptors, the assessment will be considered complete, and this portion of the MRS will be recommended for NFA.
- Firing line and 200-, 300-, 600-, 800-, and 1,000-yard target walls: If the ISM MC concentrations exceed the PALs (**Worksheet #15**), then MC concentrations pose a potential risk to receptors, a HHRA and/or (as applicable) Screening Level Ecological Risk Assessment will be conducted, and the DU will be retained for evaluation in the FS if unacceptable risks are identified.
- Firing line and 200-, 300-, 600-, 800-, and 1,000-yard target walls: If laboratory analysis of a discrete 12- to 18-inch soil sample shows MC above PALs, then the laboratory will analyze the 24- to 30-inch contingency sample for vertical delineation of MC. If laboratory analysis of a discrete 24- to 30-inch soil sample shows MC above PALs, then a second mobilization will be required to determine depth of MC. (Note: discrete samples collected below the surface interval are for MC delineation purposes.)
- Firing line and 200-, 300-, 600-, 800-, and 1,000-yard target walls: If laboratory analysis of ISM samples from a DU shows lead above the USEPA RSL for lead, then the laboratory will analyze the respective discrete contingency sample for TCLP lead and pH. (Note: TCLP data will be used during alternative evaluation during the Feasibility Study.)

Step 6: Specify Performance or Acceptance Criteria

This step is to specify the decision maker's acceptable limits on decision errors, which are used to establish appropriate performance goals for limiting uncertainty in the environmental data. These acceptable limits on decision errors allow decision makers to generate resource-effective sampling designs while limiting uncertainties in the collected data. Decision errors are associated with both field sampling and laboratory analyses.

The baseline condition (i.e., null hypothesis) for MC sampling is that MC is present. The false negative decision error would be deciding that MC is not present when it actually is or deciding that the extent of a MC has been defined when it actually has not. This type of decision error is controlled by having a high degree of confidence that the sample locations selected will identify an MC if present, and that the analysis selected is sufficient to detect selected analytes in the sampled media, the detection limits are adequate to ensure an accurate quantification of the MC, and there is a high degree of confidence that the dataset is of sufficient quality and completeness.

The following mechanisms are incorporated into the sampling design to address the above criteria. MC samples will be collected in areas most likely to have an MC release. Procedures are in place for

minimizing field sampling decision errors. These procedures include adhering to the planning documents and SOPs and using proper sampling techniques (**Worksheet #17**). If the total percent relative standard deviation (RSD) (total error) between three field replicates from the same DU meets the measurement performance criteria listed in **Worksheet #12-1**, then the sampling design and execution are adequate and the distribution of replicate results can be assumed to be approximately normal. **Worksheets #12 and #28** specify analytical performance and acceptance criteria.

There are several types of decision errors that may stem from laboratory analysis. The data can be biased high (false positive), biased low (false negative), or completely invalid (rejected). The level of error associated with the laboratory data will be minimized by adherence to analytical methods that produce precise, high-quality data and will be verified through the data validation process. As part of the data validation process, the project chemist will assess data usability (**Worksheet #37**).

Step 7: Develop the Design

This step is used to produce the most resource-efficient sampling design that will meet the DQOs. The sampling design for the DUs at the Camp Blauvelt MRS includes a combination of statistical and judgmental sampling and is described in the steps below. Details on sample design are presented in **Worksheet #17**.

- Collect discrete samples and perform real-time analysis by XRF for evaluating extent of MC at all DUs (firing line and 200-, 300-, 600-, 800-, and 1,000-yard target walls). Step-out samples may be needed to delineate the extent of MC.
- Collect incremental samples in triplicate from the firing line and 200-, 300-, 600-, 800-, and 1,000-yard target wall DUs as well as a background location.
- Collect discrete, subsurface samples at firing line and 200-, 300-, 600-, 800-, and 1,000-yard target wall DU locations where XRF results exceed NY RP SCOs for unrestricted use for lead.
- Submit incremental and discrete subsurface samples to the laboratory for analysis using USEPA SW-846 Method 6020B.

QAPP Worksheet #12-1 – Measurement Performance Criteria – Aqueous and Solid – 6020B

(UFP-QAPP Manual Section 2.6.2; EPA 2106-G-05 Section 2.2.6)

Matrix: Discrete/Incremental Soil/ Aqueous Equipment Blank (EQB)
Analytical Group or Method: Metals 6020B – Katahdin
Concentration Level: Low

Data Quality Indicator (DQI)	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision (overall)	Field Duplicates [Discrete Soil]	Relative Percent Difference (RPD) <30% when detects are at least 5x LOQ, or within ±4x the LOQ for results <5x LOQ
Precision (overall)	Field Triplicates [Incremental Soil]	Relative Standard Deviation (RSD) <30% when detects are at least 5x LOQ, or average deviation within ±4x the LOQ for results <5x LOQ
Accuracy/Bias (overall)	Field Blanks (aqueous only; e.g., equipment and rinsate blanks)	No results greater than LOD
Precision and Accuracy-overall	Method Blank (MB)	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes >LOQ.
Analytical Accuracy/Bias (laboratory)	Laboratory Control Spike (LCS)	Analyte-specific. See **Worksheet #15**.
Analytical Precision	Laboratory Control Sample Duplicates (LCSD)	RPD ≤20%
Analytical Accuracy/Bias (matrix interference)	Matrix Spike Duplicate (MSD)	Analyte-specific % Recovery. See **Worksheet #15**.
Analytical Accuracy/Bias (laboratory)	Serial Dilution Test	Five-fold dilution must agree within ± 10% of the original measurement. Only applicable for samples with concentrations > 50 X LOQ (prior to dilution).
Analytical Accuracy/Bias (laboratory)	Post Digestion Spike	% Recovery = 80%-120%
Analytical Accuracy (laboratory)	Internal Standards (IS)	Response within 30%-120% of intensity in calibration blank

QAPP Worksheet #12-2 – Measurement Performance Criteria – Aqueous and Solid – TCLP Metals

(UFP-QAPP Manual Section 2.6.2; EPA 2106-G-05 Section 2.2.6)

Matrix: Toxicity Characteristic Leaching Procedure (TCLP) Soil
Analytical Group or Method: Metals, Mercury/6010C/7470A/7471B – Katahdin
Concentration Level: Low

Data Quality Indicator (DQI)	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision (overall)	Field Duplicates	RPD <30% when detects are at least 5x LOQ, or within ±4x the LOQ for results <5x LOQ
Accuracy/Bias (overall)	Field Blanks (aqueous only; e.g., equipment and rinsate blanks)	No results greater than LOD
Precision and Accuracy-overall	Method Blank	No analytes detected > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes >LOQ.
Analytical Accuracy/Bias (laboratory)	Laboratory Control Spike (LCS)	Analyte-specific See DoD QSM 5.0 Table 5, 6 and 12
Analytical Precision	Laboratory Control Sample Duplicates (LCSD)	RPD ≤20%
Analytical Accuracy/Bias (matrix interference)	Matrix Spike Duplicate (MSD)	Analyte-specific % Recovery. See **Worksheet #15**.
Analytical Accuracy/Bias (laboratory)	Serial Dilution Test	Five-fold dilution must agree within ± 10% of the original measurement. Only applicable for samples with concentrations > 50 X LOQ (prior to dilution).
Analytical Accuracy/Bias (laboratory)	Post Digestion Spike	% Recovery = 80%-120%

QAPP Worksheet #13 – Secondary Data Uses and Limitations

(UFP-QAPP Manual Section 2.7; EPA 2106-G-05 Chapter 3)

Data Type	Data Source	Data Uses Relative to the Current Project	Factors Affecting the Reliability of Data and Limitations on Data Use
Previous Analytical Data	Site Inspection (SI) Report for Camp Blauvelt (Parsons, 2012)	Soil data has been used to inform the sampling approach and design.	Data collection was limited in scope and was not collected using the same methods planned for the RI. SI data will not be used to supplement risk evaluations.
Historical Site Use	Historical Records Review (HRR), 2011 (Parsons, 2011)	Location of MRS features. Types of munitions used. Timeframe for active firing use.	No known limitation.
Historical Sites Use	Preliminary Assessment Report (Malcolm Pirnie, Inc., 2009)	Location of MRS features. Types of munitions used. Timeframe for active firing use.	No known limitation.

QAPP Worksheets #14 & #16 – Project Tasks and Schedule

(UFP-QAPP Manual Section 2.8.2; EPA 2106-G-05 Section 2.2.4)

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Mobilization/ Demobilization	Field Team Leader	August 2018	August 2018	Field documentation	N/A
Soil sampling	Field Team Leader	August 2018	August 2018	Field notes, trip report	N/A
Analysis	Katahdin	August 2018	September 2018	Report of Analyses/Data Package	28 days after samples arrive at laboratory
Validation	Project Chemist	September 2018	October 2018	Validation Summary Report	45 days after Analysis/Data Packages received
Summarize Data	PM	September 2018	October 2018	Draft RI Report*	TBD

*Final RI Report submitted with all data in the Category B Data Package and DUSR format.

The Schedule provided below is a detailed schedule broken down by each subtask that will occur for the activities associated with the RI through DD for the Camp Blauvelt MRS. The timeframes for post- RI documents are somewhat speculative.

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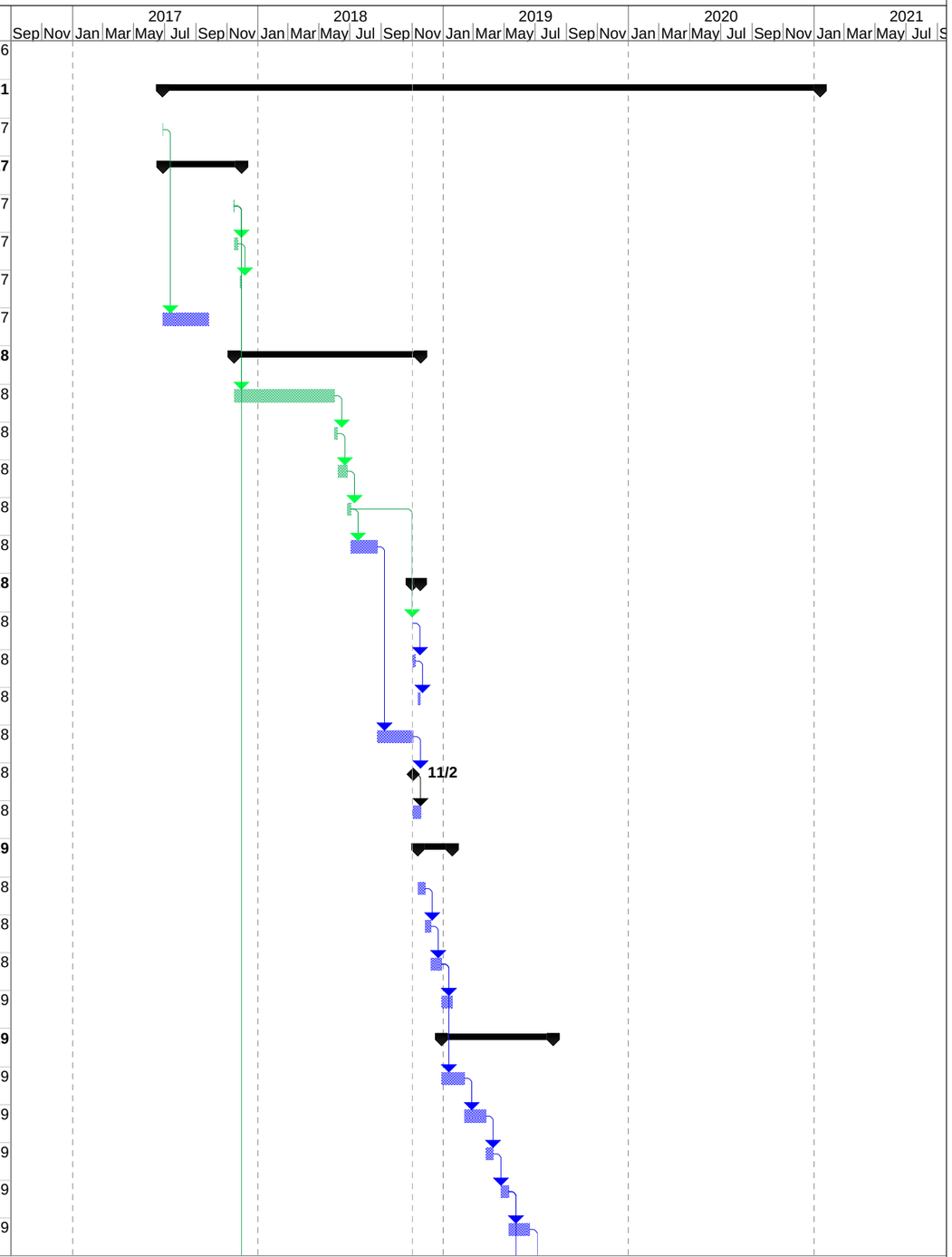
Detailed Project Schedule & Milestones

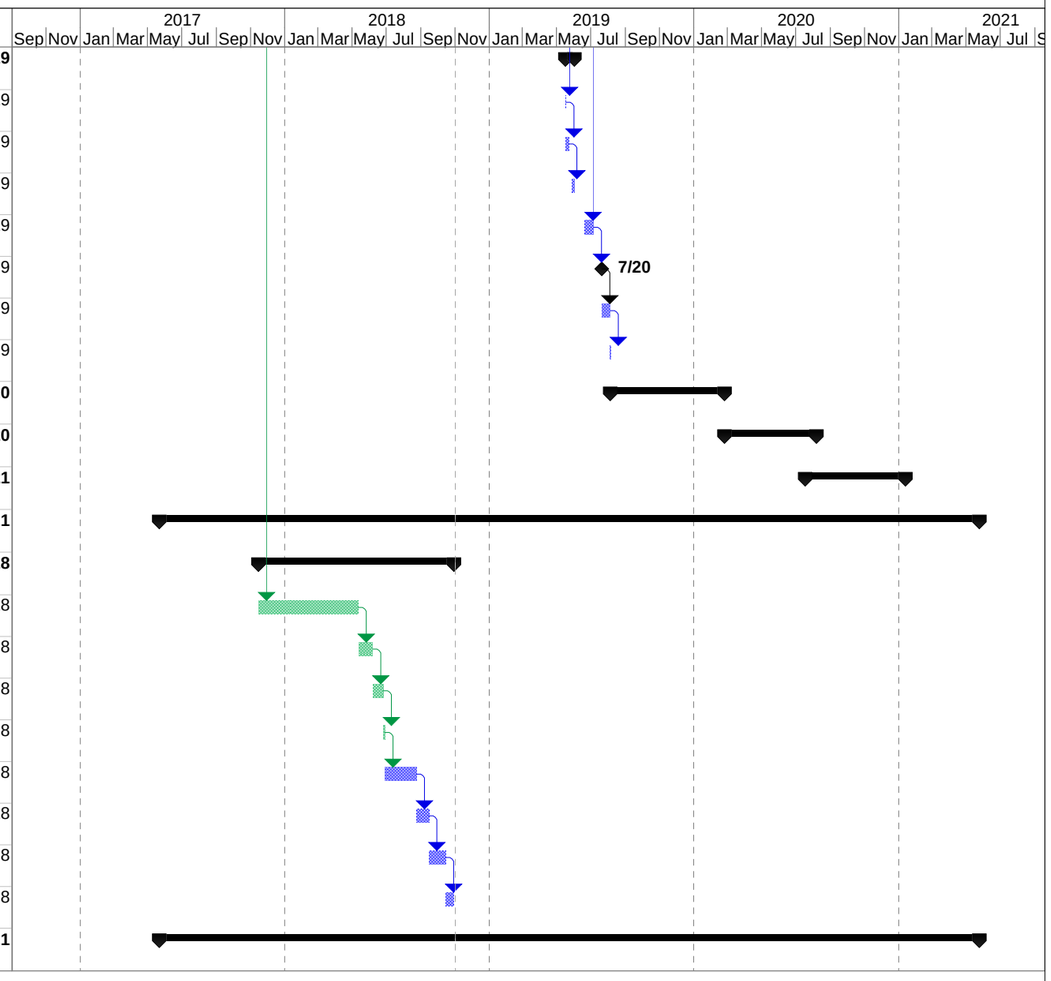
ID	Task Name	Duration	Start	Finish
1	**Notice to Proceed**	1 day	Tue 9/20/16	Tue 9/20/16
2	**Task 6: Remedial Investigation, Feasibility Study, Proposed Plan, and Record of Decision Document for Camp Blauvelt NYHQ-007-R-01**	**1296 days**	**Tue 6/27/17**	**Tue 1/12/21**
3	Notice to Proceed	1 day	Tue 6/27/17	Tue 6/27/17
4	**TPP1/Kick-off Meeting/Site Visit**	**155 days**	**Wed 6/28/17**	**Wed 11/29/17**
5	Kickoff Meeting	1 day	Tue 11/14/17	Tue 11/14/17
6	Prepare and Submit Draft Meeting Notes	7 days	Wed 11/15/17	Tue 11/21/17
7	Prepare and Submit Final Meeting Notes	3 days	Mon 11/27/17	Wed 11/29/17
8	Notify COR that Rights of Entry (ROE) are required and obtain ROEs	90 days	Wed 6/28/17	Mon 9/25/17
9	**Work Plan/UFP-QAPP/SSHP for Camp Blauvelt**	**368 days**	**Wed 11/15/17**	**Sat 11/17/18**
10	Prepare and Submit Draft Work Plan for Camp Blauvelt	198 days	Wed 11/15/17	Thu 5/31/18
11	Army Review	4 days	Fri 6/1/18	Wed 6/6/18
12	Prepare and Submit Responses to Comments on the Draft Work Plan for Camp Blauvelt	19 days	Thu 6/7/18	Mon 6/25/18
13	Prepare and Submit Draft Final Work Plan for Camp Blauvelt	7 days	Tue 6/26/18	Mon 7/2/18
14	Regulatory Agency Review	38 days	Tue 7/3/18	Thu 8/23/18
15	**TPP2 Meeting**	**16 days**	**Thu 11/1/18**	**Fri 11/16/18**
16	TPP2 Meeting	1 day	Thu 11/1/18	Thu 11/1/18
17	Prepare and Submit Draft Meeting Notes	5 days	Fri 11/2/18	Tue 11/6/18
18	Prepare and Submit Final Meeting Notes	5 days	Mon 11/12/18	Fri 11/16/18
19	Prepare and Submit Responses to Comments for Camp Blauvelt (multiple rounds of comments)	71 days	Fri 8/24/18	Fri 11/2/18
20	Prepare and Submit Final Work Plan for Camp Blauvelt	0 days	Fri 11/2/18	Fri 11/2/18
21	Regulatory Agency Approval/Concurrence of Final Work Plan for Camp Blauvelt	15 days	Sat 11/3/18	Sat 11/17/18
22	**Field Investigation**	**68 days**	**Mon 11/12/18**	**Fri 1/18/19**
23	Coordination/Preparation for Field Work	14 days	Mon 11/12/18	Sun 11/25/18
24	Field Work (XRF with discrete and incremental sampling)	12 days	Mon 11/26/18	Fri 12/7/18
25	Laboratory Analysis	21 days	Sat 12/8/18	Fri 12/28/18
26	Data Validation	21 days	Sat 12/29/18	Fri 1/18/19
27	**Remedial Investigation (RI) including MRSPP Update for Camp Blauvelt**	**220 days**	**Sat 12/29/18**	**Mon 8/5/19**
28	Prepare and Submit Draft RI for Camp Blauvelt	45 days	Sat 12/29/18	Mon 2/11/19
29	Army Review	30 days	Tue 2/12/19	Mon 3/25/19
30	Prepare and Submit Responses to Comments for Camp Blauvelt	15 days	Tue 3/26/19	Tue 4/9/19
31	Prepare and Submit Draft Final RI for Camp Blauvelt	15 days	Thu 4/25/19	Thu 5/9/19
32	Regulatory Agency Review	30 days	Fri 5/10/19	Thu 6/20/19



Project: RI-DD Six ARNG NDNODS MMRP Sites | Task | Milestone | Summary | Completed Task

Detailed Project Schedule & Milestones

ID	Task Name	Duration	Start	Finish
33	**TPP3 Meeting**	**16 days**	**Fri 5/17/19**	**Sat 6/1/19**
34	TPP3 Meeting	1 day	Fri 5/17/19	Fri 5/17/19
35	Prepare and Submit Draft Meeting Notes	5 days	Sat 5/18/19	Wed 5/22/19
36	Prepare and Submit Final Meeting Notes	5 days	Tue 5/28/19	Sat 6/1/19
37	Prepare and Submit Responses to Comments on Draft Final for Camp Blauvelt	15 days	Fri 6/21/19	Fri 7/5/19
38	Prepare and Submit Final RI for Camp Blauvelt	0 days	Sat 7/20/19	Sat 7/20/19
39	Regulatory Agency Approval/Concurrence of Final RI for Camp Blauvelt	15 days	Sun 7/21/19	Sun 8/4/19
40	ERIS and SDSFIE Submittals	1 day	Mon 8/5/19	Mon 8/5/19
41	**Feasibility Study (FS) including MRSPP Update (if applicable) for Camp Blauvelt**	**204 days**	**Mon 8/5/19**	**Mon 2/24/20**
54	**Proposed Plan including MRSPP Update (if applicable) for Camp Blauvelt**	**164 days**	**Tue 2/25/20**	**Thu 8/6/20**
65	**Record of Decision including MRSPP Update (if applicable) for Camp Blauvelt**	**179 days**	**Sat 7/18/20**	**Tue 1/12/21**
74	**Task 10: Community Relations Plans (CRP)**	**1464 days**	**Mon 5/22/17**	**Mon 5/24/21**
75	**Camp Blauvelt, NY**	**349 days**	**Wed 11/15/17**	**Mon 10/29/18**
76	Prepare and submit Draft CRP	178 days	Wed 11/15/17	Fri 5/11/18
77	Army Review	18 days	Mon 5/14/18	Wed 6/6/18
78	Prepare and Submit Responses to Comments on Draft CRP	19 days	Thu 6/7/18	Mon 6/25/18
79	Prepare and Submit Draft Final CRP	3 days	Tue 6/26/18	Thu 6/28/18
80	Regulatory Agency Review	56 days	Fri 6/29/18	Thu 8/23/18
81	Prepare and Submit Responses to Comments on Draft Final CRP	22 days	Fri 8/24/18	Fri 9/14/18
82	Prepare and Submit Final CRP	30 days	Sat 9/15/18	Sun 10/14/18
83	Approval/Concurrence of Final CRP	15 days	Mon 10/15/18	Mon 10/29/18
84	**Restoration Advisory Board (RAB) - GENERAL EXAMPLE, Apply to MRS as needed**	**1464 days**	**Mon 5/22/17**	**Mon 5/24/21**



QAPP Worksheet #15 – Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

(UFP-QAPP Manual Section 2.6.2.3; EPA 2106-G-05 Section 2.2.6)

Matrix: Discrete/Incremental Soil
Analytical Method: Metals (Total) by USEPA SW-846 Method 6020B
Concentration Level: Low

Analyte	CAS #	USEPA Residential Soil RSL (mg/kg)[(1)]	NY RP SCO Unrestricted Use (mg/kg)[(2)]	Ecological Soil Screening Value (mg/kg)[(3)]	PAL (mg/kg)	PQL Goal (mg/kg)	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Laboratory-specific DL (mg/kg)	Laboratory-specific LOD (mg/kg)	Laboratory-specific LOQ (mg/kg)
Antimony	7440-36-0	31	-	12	31	3.1	72	124	0.020	0.050	0.10
Copper	7440-50-8	3,100	50	50	50	5.0	84	119	0.071	0.20	0.30
Lead	7439-92-1	400	63	63	63	6.3	84	118	0.0070	0.050	0.10
Zinc	7440-66-6	23,000	109	109	109	10.9	82	119	0.13	0.80	1.0

Screening Level References:
(1) USEPA Residential Soil RSL Value (June 2017), protective of a target hazard quotient of 0.1 and a target cancer risk of $1x10^{-6}$
(2) New York Remedial Program Soil Cleanup Objectives for Unrestricted Use (December 2006)
(3) New York Remedial Program Soil Cleanup Objectives for Restricted Use, Protection of Ecological Resources (December 2006)
- = No soil cleanup objective for Antimony listed

Matrix: TCLP Soil
Analytical Method: TCLP Metals (Lead) by USEPA SW-846 Method 1311/6020B
Concentration Level: Low

Analyte	CAS #	PAL (mg/L)[a]	PQL Goal (mg/L)	LCS Lower Control Limit (%)	LCS Upper Control Limit (%)	Laboratory-specific DL (ug/L)	Laboratory-specific LOD (ug/L)	Laboratory-specific LOQ (ug/L)
Lead	7439-92-1	5.0	5.0	80	120	0.00025	0.0010	0.50

PAL= Project Action Level; LCS = Laboratory Control Spike; LOD = Limit of Detection; LOQ = Limit of Quantitation; PQL = Project Quantitation Limit
[a] 40 CRF 261.24 Toxicity Characteristic Table 7-1

QAPP Worksheet #17 – Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1; EPA 2106-G-05 Section 2.3.1)

The sampling approach of the RI is designed to characterize the nature and extent MC contamination in soil at the firing line and 200-, 300-, 600-, 800-, and 1,000-yard target walls that are associated with historical training activities conducted at Camp Blauvelt MRS. The DQOs for the MC sampling approach are presented in **Worksheet #11**. The sampling design rationale for the MRS is based on historical use, range layout, previous sampling results, and the CSM discussed in **Worksheet #10**. A phased approach that includes assessing the extent of MC contamination in the field using XRF analysis, when feasible, followed by laboratory analysis of soil samples collected using ISM will be used to accomplish project goals.

Based on the findings of the SI and HRR, potential MC are limited small-arms metals (antimony, copper, lead, and zinc). All soil samples collected for laboratory analysis will be sent to Katahdin Analytical Services in Scarborough, Maine, for analysis of target small-arms metals, and/or waste characterization parameters. At the time of collection, the general characteristics of soil samples (XRF, ISM, and discrete subsurface) will be described: grain size, organic content, color, presence of bullets or bullet fragments, and moisture.

Six distinct DUs have been identified as associated with the former firing range (**Figure 17-1**). The firing line DU is approximately 3,920 square feet; 200-yard target wall DU is approximately 0.10 acres; the 300-yard target wall DU is approximately 2,178 square feet; the 600-yard target wall DU is approximately 0.80 acres; the 800-yard target wall DU is approximately 3,920 square feet; and the 1,000-yard target wall DU is 0.41 acres. **Figure 17-2** presents the initial DU and sampling plan for the firing line, **Figure 17-3** presents the initial DU and sampling plan for the 200-yard target wall DU, **Figure 17-4** shows the initial DU and sampling plan for the 300-yard target wall DU, **Figure 17-5** shows the initial DU and sampling plan for the 600-yard target wall DU, **Figure 17-6** depicts the initial DU and sampling plan for the 800-yard target wall, and **Figure17-7** depicts the initial DU and sampling plan for the 1,000-yard target wall DU. The entire MRS covers a 447-acre area.

Step 1 – X-ray Fluorescence Screening:

The initial DUs for the firing line and target walls will be screened for lead in the field using XRF. A grid will be laid out across the DUs and discrete samples will be taken from 0 to 6 inches bgs at each grid node. The initial, or 0-inch, sample collection depth will begin in the soil A horizon after organic matter including detritus, humus, and surface debris has been cleared of the sample location. An approximate 10- by 5-foot grid will be sampled at the firing line DU (approximately 40 samples; **Figure 17-2**). An approximate 16- by 5-foot grid will be sampled at the 200-yard target wall DU (approximately 52 samples; **Figure 17-3**). An approximate 10- by 5-foot grid will be sampled at the 300-yard target wall DU (approximately 42 samples; **Figure 17-4**). An approximate 28- by 20-foot grid will be sampled at the 600-yard target wall DU (approximately 63 samples; **Figure 17-4**). An approximate 20- by 5-foot grid will be sampled at the 800-yard target wall DU (approximately 40 samples; **Figure 17-6**). An approximate 25- by 10-foot grid will be sampled at the 1,000-yard target wall DU (approximately 72 samples; **Figure 17-7**).

Each discrete sample will be collected using a new disposable sampling device, placed in a clear plastic zip-top bag, and disaggregated/homogenized in the field by mechanical methods prior to analysis (**SOP MC-6** and **Section 5.4** of **SOP MC-5 [Attachment A]**). Samples will be analyzed for lead by XRF following the general guidance of USEPA Method 6200 and **SOP MC-5**. Lead concentrations will be recorded as the concentration measured and the error of the reading as given by the XRF analyzer. Field notes will document sample handling and preparation following **Section 3.5.1 of SOP MC-3 (Attachment A)**.

Soil moisture (>20 percent [%]) can potentially interfere with XRF analysis. Sampling will be scheduled during a distinctly dry season. An experienced sampling team will determine the applicability of XRF use in the field with the assistance of a soil moisture probe. If a soil sample has a moisture content of approximately 20% or less, XRF will be used to analyze the sample for lead. If moisture content is greater than 20%, the sample will be dried in the field. Samples to be dried will be placed into disposable aluminum containers and warmed over a low temperature hot plate until moisture is at or below 20%. Dried samples will be placed back into clear plastic zip-top bags and analyzed for lead by XRF.

The results of this analysis will characterize the lateral extent of contamination in surface soil (0 to 6 inches bgs after the removal of surface detritus, humus, and debris). The initial DU boundary will be refined based on the distribution of XRF results for lead that exceed the NY RP SCOs for unrestricted use (**Worksheet #15**). Should samples taken along the boundary of the initial DU (± the error of the reading) exceed the NY RP SCOs for unrestricted use for lead (63 ppm), step-out samples will be taken along the same grid pattern as the DU until exceedances are no longer encountered. This may result in enlarging the DU boundaries, which will be carried forward to Step 2 – ISM Sampling. If no exceedances are found along the initial DU boundaries, the initial DUs will be used during Step 2.

Additionally, a discrete surface soil (0 to 6 inches bgs) sample will be collected from the location with the highest XRF lead result at each DU for waste characterization analysis (i.e., TCLP). These discrete samples will be held at the laboratory and analyzed only if the laboratory results from the respective ISM sample exceed the USEPA RSL for lead (400 ppm). If the respective ISM sample exceeds the USEPA RSL for lead, then the TCLP sample will be analyzed for TCLP lead and pH.. TCLP analysis data will be used in alternative evaluation during the FS, should one be warranted.

Step 2 – ISM Sampling:

Once a DU boundary is confirmed, a 30- to 50-part incremental sample will be collected in triplicate from surface soil (after removing surface detritus, humus, and debris) using ISM and analyzed for metals MC (antimony, copper, lead and zinc) by the laboratory. The location of increments within a respective DU will be determined using a systematic random approach.

Soil increments will be collected from depths of 0 to 6 inches bgs using a standard soil probe. Each increment will be the same volume/mass and contribute to the ISM composite equally. At each DU, incremental samples will be collected in 100 percent triplicate; the number of QC samples will conform to **Worksheet #20**. Sample collection will be in accordance with Interstate Technology Regulatory Council (ITRC) guidance (ITRC, 2012) and **SOP MC-4** (**Attachment A**). All samples collected by ISM will be submitted to the laboratory for analysis as listed in **Worksheet#15**.

During field collection, the general characteristics of soil samples will be described by qualified field personnel using the Unified Soil Classification System to qualitatively document the physical characteristics of soil. This qualitative data will be used in support of potential future remedial alternative evaluation during the FS.

In addition to investigative samples, background reference samples will be collected in 100 percent triplicate using ISM from an area not affected by historical training activities. The sampling area will be representative of undisturbed media and of an appropriate size to adequately characterize background concentrations and be comparable to investigative samples. The proposed location for background reference sample collection is outside of any range-related impacts and shown on **Figure 17-1**. The results of all ISM samples will be used in the risk assessment in the RI report.

Step 3 – Discrete Subsurface Sampling:

The vertical extent of MC contamination will be characterized by collecting up to eight discrete subsurface soil samples from 12 to 18 inches bgs where select surface soil XRF readings (± the error of the reading) exceed the NY RP SCOs for unrestricted use for lead. If no exceedances are found in surface soil, laboratory analysis of subsurface samples will not occur. Sampling locations will be determined in the field and selected to provide the best coverage and resolution of potential subsurface MC contamination. Samples will be collected using a hand auger to expose the 12 to 18 inch bgs zone; once exposed, a new disposable sampling implement will be used to collect a sample from 12 to 18 inches bgs by hand and placed into the appropriate laboratory supplied container.

Subsurface samples will be analyzed by both XRF and laboratory analytical methods for metals MC. The results of the subsurface XRF analysis will be used to inform the sampling team if deeper samples are needed from 24 to 30 inches bgs to delineate the extent of contamination. Should XRF results in the 12 to 18 inches bgs sample exceed the NY RP SCOs for unrestricted use for lead, a contingent sample will be collected from 24 to 30 inches bgs using the same methods. This deeper sample will be held at the laboratory and analyzed only if the laboratory results from the sample above exceed the NY RP SCOs for unrestricted use for MC (antimony, copper, lead, or zinc) and background concentrations. In anticipation of the end use of data (i.e., soil removal volume estimates) it is unlikely that resolution finer than 12 inches vertically within the soil profile is needed as most soil removal equipment will excavate soil in 1-foot lifts. The results of all discrete subsurface samples will be used to confirm the extent of contamination at the MRS and not used in the assessment of risk.

All soil removed will be returned to the level found and the ground surface returned to level. All non-dedicated sampling tools will be decontaminated between samples using biodegradable detergent and distilled water. The volume of water generated during decontamination procedures will be minimized by the use of spray bottles (< 1 liter per DU is anticipated). This minor volume of decontamination water will be discharged to the ground at the respective sampling location (the DU). Investigative derived waste (IDW) is not anticipated to be generated during sampling activities.

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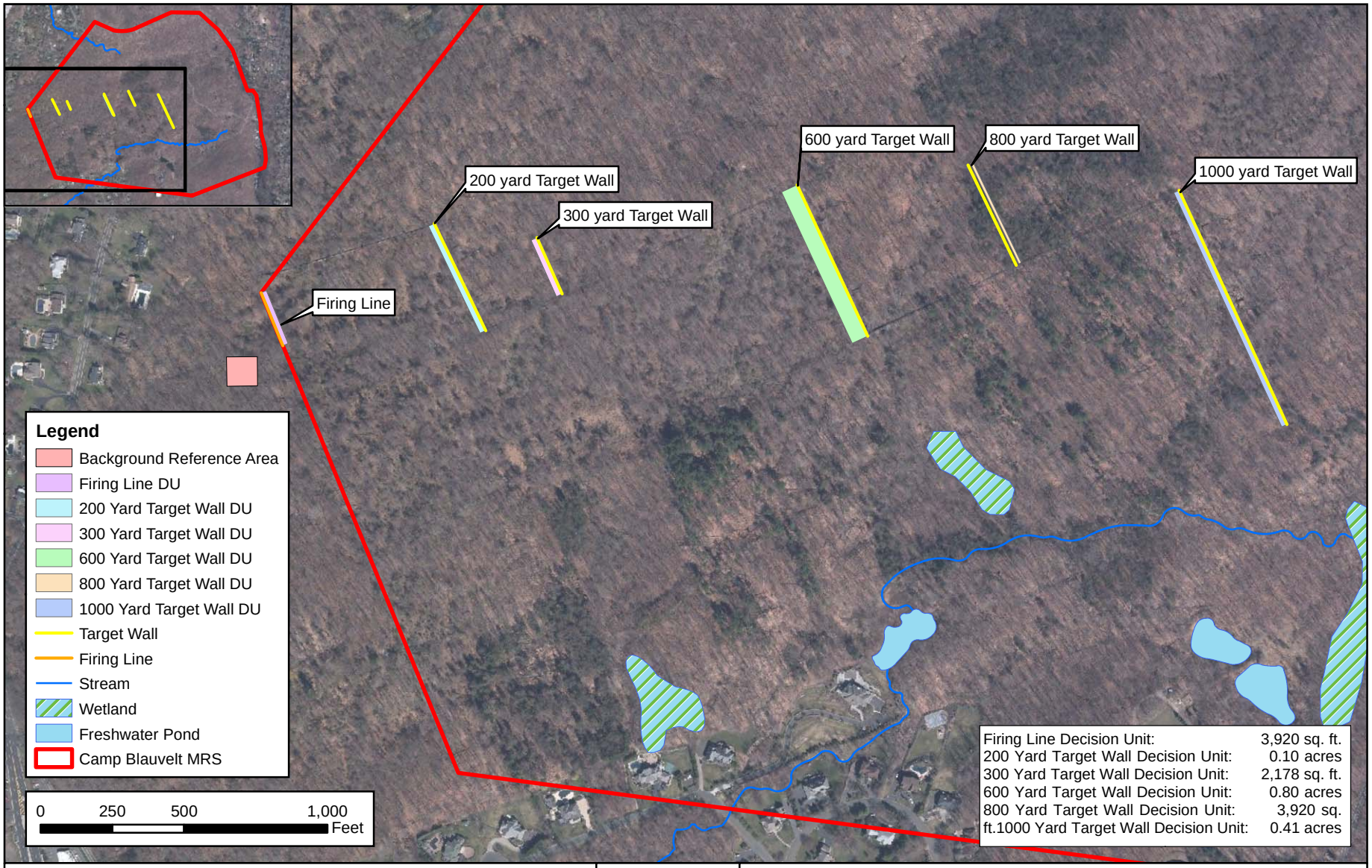

CLIENT	Army National Guard			
PROJECT	RI through DD for Camp Blauvelt, NY MRS			
REVISION NO	0	GIS BY	MS	5/1/2018
SCALE	1:6,000	CHK BY	JW	5/1/2018
SOURCE	New York Statewide Orthoimagery Program, 2016	PM	LS	5/1/2018

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Camp Blauvelt RI Approach

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Figure 17-1

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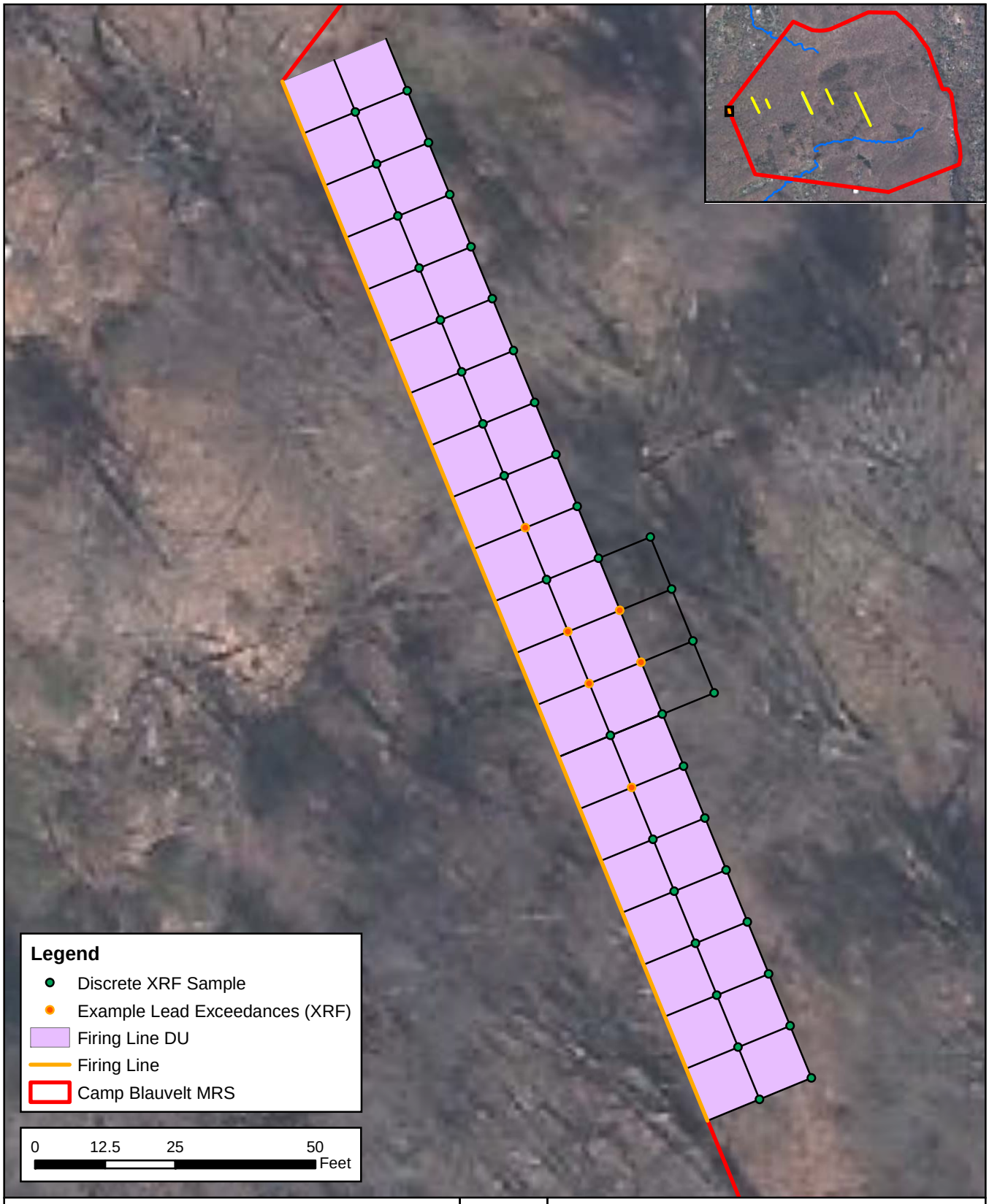

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PROJECT	RI through DD for Camp Blauvelt, NY MRS			
REVISION NO	0	GIS BY	MS	3/26/2018
SCALE	1:300	CHK BY	JW	3/26/2018
New York Statewide Orthoimagery Program, 2016		PM	LS	3/26/2018

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Firing Line DU Sampling Design

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Figure 17-2

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CLIENT	Army National Guard			
PROJECT	RI through DD for Camp Blauvelt, NY MRS			
REVISION NO	0	GIS BY	MS	3/26/2018
SCALE	1:600	CHK BY	JW	3/26/2018
New York Statewide Orthoimagery Program, 2016		PM	LS	3/26/2018

200 yard Target Wall DU Sampling Design

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Figure 17-3

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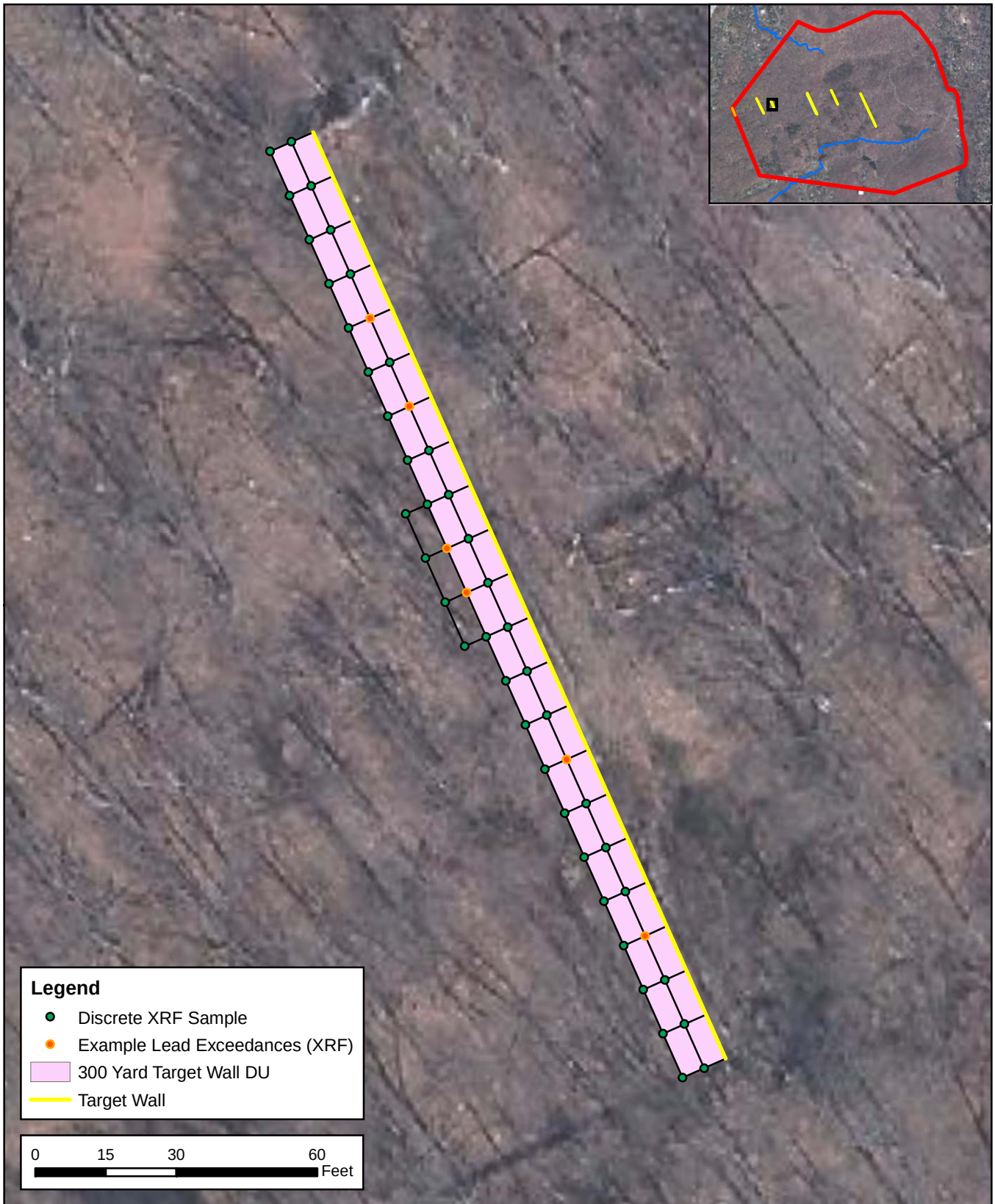

300 yard Target Wall DU Sampling Design

CLIENT	Army National Guard			
PROJECT	RI through DD for Camp Blauvelt, NY MRS			
REVISION NO	0	GIS BY	MS	3/26/2018
SCALE	1:360	CHK BY	JW	3/26/2018
New York Statewide Orthoimagery Program, 2016		PM	LS	3/26/2018

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Figure 17-4

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CLIENT	Army National Guard			
PROJECT	RI through DD for Camp Blauvelt, NY MRS			
REVISION NO	0	GIS BY	MS	3/26/2018
SCALE	1:840	CHK BY	JW	3/26/2018
New York Statewide Orthoimagery Program, 2016		PM	LS	3/26/2018

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600 yard Target Wall DU Sampling Design

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Figure 17-5

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CLIENT	Army National Guard			
PROJECT	RI through DD for Camp Blauvelt, NY MRS			
REVISION NO	0	GIS BY	MS	4/2/2018
SCALE	1:540	CHK BY	JW	4/2/2018
New York Statewide Orthoimagery Program, 2016		PM	LS	4/2/2018

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800 yard Target Wall DU Sampling Design

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Figure 17-6

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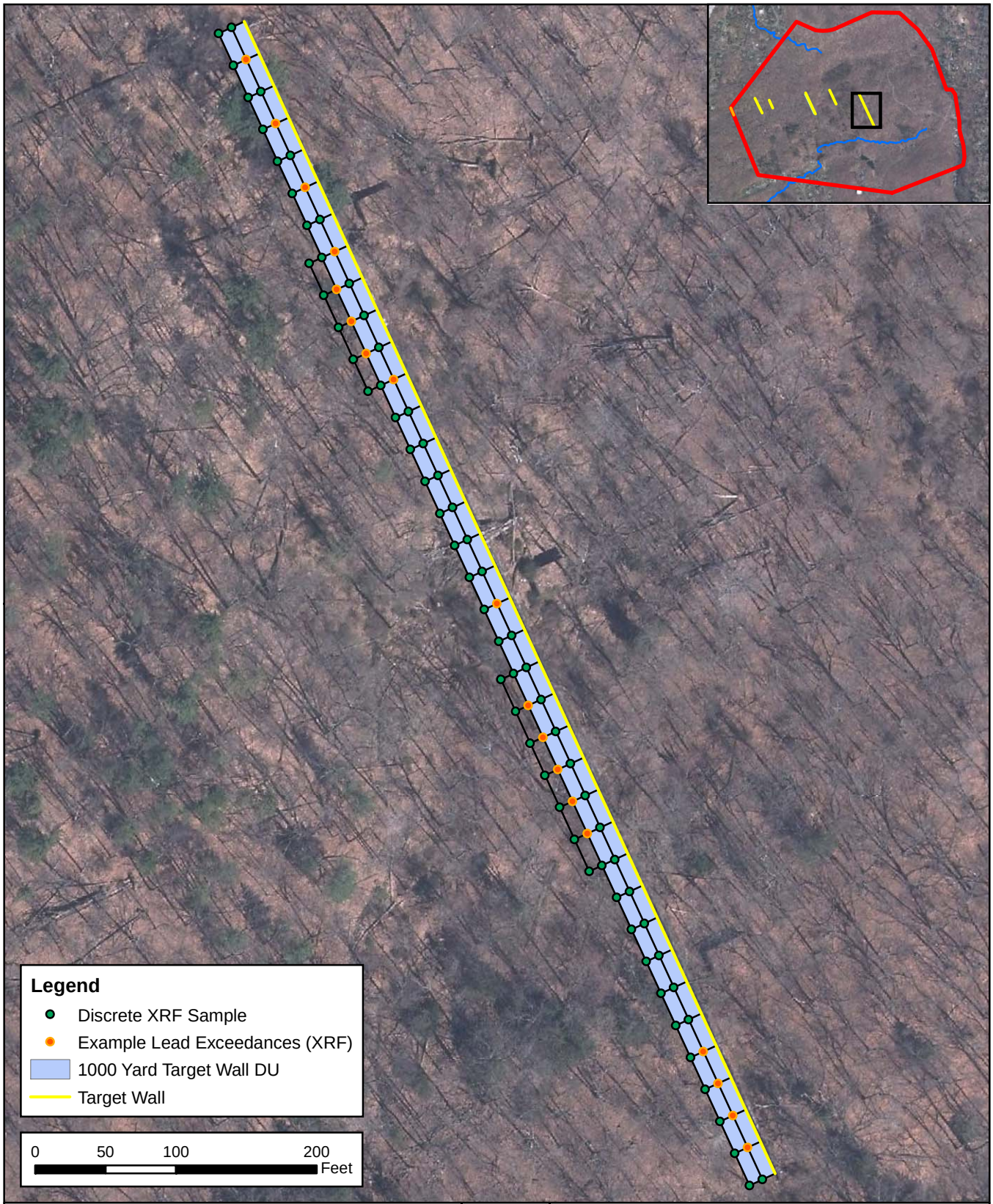

CLIENT	Army National Guard			
PROJECT	RI through DD for Camp Blauvelt, NY MRS			
REVISION NO	0	GIS BY	MS	3/26/2018
SCALE	1:1,200	CHK BY	JW	3/26/2018
New York Statewide Orthoimagery Program, 2016		PM	LS	3/26/2018

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1000 yard Target Wall DU Sampling Design

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Figure 17-7

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QAPP Worksheet #18 – Sampling Locations and Methods

(UFP-QAPP Manual Sections 3.1.1 and 3.1.2; EPA 2106-G-05 Sections 2.3.1 and 2.3.2)

Sample locations will be determined in the field based on XRF results. The type of sample collected will be determined based on the rational presented in **Worksheet #17**. Samples will be analyzed for select target metals (**Worksheet #15**), and select samples will be analyzed for waste characterization parameters (TCLP) if respective ISM sample results exceed the USEPA RSL for lead. Sample identification codes are explained below.

Sample ID [1]	Matrix	Depth (inches bgs)	Analytical Group	Sample Type / Number of Samples	Sampling SOP Reference	Comments
CBT01X01A	Surface soil (after detritus, humus, and surface debris have been removed)	0-6	Lead by XRF	Discrete (XRF) Firing line: approx. 40 200-yard target wall: approx. 52 300-yard target wall: approx. 42 600-yard target wall: approx. 63 800-yard target wall: approx. 40 1,000-yard target wall: approx. 72	Worksheet #21 SOP MC-5	None
			TCLP Lead and pH (Contingent upon respective ISM results)	Discrete: 1		
CBT01IS01	Surface soil (after detritus, humus, and surface debris have been removed)	0-6	Target metals	Incremental in triplicate: 1 incremental sample per DU and background	Worksheet #21 SOP MC-4	None
CBT02DA01A	Subsurface soil	12-18	Target metals	Discrete: 1	Worksheet #21 SOP MC-6	None
CBT01DB01A	Subsurface soil	24-30	Target metals	Discrete: up to 8	Worksheet #21 SOP MC-6	Analysis contingent on 12-18 inches bgs sample results

[1] Sample identification codes are explained on the next page.

Sample Identification Codes:

Discrete Samples:

Example sample identification: CBT01X02A

CBT = *Three-character MRS identifier for the Camp Blauvelt MRS.*

01 = *DU location*; The valid location codes are:

- 01 for the firing line DU
- 02 for the 200-yard target wall DU
- 03 for the 300-yard target wall DU
- 04 for the 600-yard target wall DU
- 05 for the 800-yard target wall DU
- 06 for the 1,000-yard target wall DU

X = *One-character sampling method*: The valid sampling method code is:

- X for XRF soil sample

02 = *Sample location*; The valid sample codes are:

- 01 – 50 for each discrete sample location

A = *XRF replicate reading*; The valid XRF reading codes are:

- A – D for each of four replicate sample readings
  E for discrete TCLP sample

Incremental Soil Samples:

Example sample identification: CBT01IS01

CBT = *Three-character MRS identifier for the Camp Blauvelt MRS.*

01 = *DU location*; The valid location codes are:

- 01 for the firing line DU
- 02 for the 200-yard target wall DU
- 03 for the 300-yard target wall DU
- 04 for the 600-yard target wall DU
- 05 for the 800-yard target wall DU
- 06 for the 1,000-yard target wall DU
- 07 for the background incremental sample

IS = *Two-character sampling method*: The valid sampling method code is:

- IS for incremental surface soil sample

02 = *Sample code*; The valid IS sample codes are:

- 00 = equipment blank
- 01 = primary sample
- 02 = duplicate sample
- 03 = triplicate sample

Discrete Subsurface Samples:

Example sample identification: CBT02DC01A

CBT = *Three-character MRS identifier for the Camp Blauvelt MRS.*

01 = *DU location*; The valid location codes are:

- 01 for the firing line DU
- 02 for the 200-yard target wall DU
- 03 for the 300-yard target wall DU
- 04 for the 600-yard target wall DU
- 05 for the 800-yard target wall DU
- 06 for the 1,000-yard target wall DU

DA = *Two-character sampling depth code*: The valid depth codes are:

- DA = 12-18 inches bgs
- DB = 24-30 inches bgs

02 = *Sample location*; The valid sample location codes are:

- 01 – 08 for each discrete sample location

A = *Discrete QC sample codes*; The valid QC codes are:

- A = primary sample
- B = duplicate sample

Notes:

For MS/MSD analysis, sample labels and COCs will be marked with "Use also for MS/MSD" because additional soil volume is not needed. If IDW is generated, a sample method code of IDW will be used. No dashes will be used in any sample identification codes.

QAPP Worksheets #19 & #30 – Sample Containers, Preservation, and Hold Times

(UFP-QAPP Manual Section 3.1.2.2; EPA 2106-G-05 Section 2.3.2)

Laboratory: Katahdin Analytical Services, Inc.
Required Accreditations / Certifications: ELAP/ DoD
Sample Delivery Method: FedEx

Analyte/ Analyte Group	Matrix	Method/ SOP	ELAP Expiration Date	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
Metals	Discrete soil	EPA 6020B/CA-627	02/01/2019	(1) 4 oz. glass jar	≤6ºC	NA	6 months	28 days
Metals	ISM soil	EPA 6020B/CA-627	02/01/2019	(1) large poly bag	≤6ºC	NA	6 months	28 days
Metals	Water (EQB only)	EPA 6020B/CA-627	02/01/2019	250 ml HDPE	HNO3 to pH <2, ≤6ºC	NA	6 months	28 days
TCLP – Metals Reactivity Flashpoint Corrosivity	Soil	EPA 1311,6020B, 7470A,7471B/ CA-510,CA-608,CA-615 EPA 7.3.3.2/7.3.4.2/ CA-733, CA-734 EPA 1010A/CA-736 EPA 9045D/CA-709	02/01/2019	(1) 16 oz. glass jar	≤6ºC	Metals-28 days for Hg, others 6 months Reactivity-28 days Ignitability/ Corrosivity - NA	Metals - 28 days for Hg, others 6 months Reactivity-28 days Ignitability- None Specified Corrosivity- ASAP	28 days

QAPP Worksheet #20 – Field QC Summary

(UFP-QAPP Manual Sections 3.1.1 and 3.1.2; EPA 2106-G-05 Section 2.3.5)

The number of surface soil samples collected will be determined in the field based XRF results. QC samples (duplicates and field blanks) will be collected at a rate of 10%. Matrix spike and matrix spike duplicate samples will be collected at a rate of once per mobilization. Incremental samples will be collected in triplicate.

Matrix	Analyte/ Analytical Group	Field Samples	Field Duplicates/ Triplicates	Matrix Spikes	Matrix Spike Duplicates	Equipment Blanks	Total # Analyses [a]
XRF surface soil [b]	Lead by XRF	Firing line: approx. 40 200-yard target wall: approx. 52 300-yard target wall: approx. 42 600-yard target wall: approx. 63 800-yard target wall: approx. 40 1,000-yard target wall: approx. 72	Each sample analyzed four times	NA	NA	NA	Firing line: approx. 40 200-yard target wall: approx. 52 300-yard target wall: approx. 42 600-yard target wall: approx. 63 800-yard target wall: approx. 40 1,000-yard target wall: approx. 72
ISM surface soil	Metals	1 incremental sample per DU and background	Incremental: collect 100% in triplicate	5% per mobilization	5% per mobilization	5% per mobilization	≤ 10
Discrete subsurface soil	Metals	≤ 8 per DU	Discrete: 10% per mobilization	5% per mobilization	5% per mobilization	NA	≤ 10

[a] Estimated; does not include potential step outs.

[b] XRF used for screening purposes. No additional field QC planned.

QAPP Worksheet #21 – Field MC Sampling SOPs

(UFP-QAPP Manual Section 3.1.2; EPA 2106-G-05 Section 2.3.2)

The field survey and sampling will be conducted in accordance with AECOM SOPs provided in **Attachment A** of this UFP-QAPP.

SOP	Title, Revision, Date, and URL (if applicable)	Originating Organization	SOP Option or Equipment Type (if SOP provides different options)	Modified for Project? Y/N	Comments
MC-1	Quality Control Process	AECOM	N/A	Y	None
MC-2	Decontamination	AECOM	N/A	N	None
MC-3	Sampling, Handling, Documentation, and Tracking [a]	AECOM	N/A	N	None
MC-4	Incremental Soil Sampling	AECOM	N/A	N	None
MC-5	Field XRF Screening	AECOM	N/A	N	None
MC-6	Surface and Subsurface Sampling	AECOM	N/A	N	None

[a] Example field forms are provided in **Attachment B** of this UFP-QAPP.

QAPP Worksheet #22 – Field Equipment Calibration, Maintenance, Testing, and Inspection

(UFP-QAPP Manual Section 3.1.2.4; EPA 2106-G-05 Section 2.3.6)

Soil sampling will not use field equipment requiring in field calibration. XRF analyzers are factory calibrated. Calibration checks will be performed in the field on certified reference material.

Field Equipment	Activity	SOP Reference	Title or Position of Responsible Person	Frequency	Acceptance Criteria	Corrective Action
XRF analyzer	Soil screening	MC-5	Field Task Leader	Minimum 2x daily	± 10% expected concentration	Obtain replacement unit if repeated calibration check failure.

QAPP Worksheet #23 – Analytical SOPs

(UFP-QAPP Manual Section 3.2.1; EPA 2106-G-05 Section 2.3.4)

SOP	Title, Revision, Date, and URL (if applicable)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	Modified for Project? Y/N
CA-627	Acid Digestion Of Biological Tissues By USEPA Method 200.3 For Total Recoverable Metals Analysis By ICP-AES ICP-MS Spectrometry, 08/16, Revision 2.	Definitive	Water/Metals	ICP-MS	N
		Definitive	Solid/Metals	ICP-MS	N
CA-608	Trace Metals Analysis By ICP-AES Using EPA Method 6010, 07/16, Revision 17.	Definitive	Waste/TCLP Metals	ICP-MS	N
CA-615	Digestion And Analysis Of Aqueous Samples For Mercury By USEPA Method 7470, 06/14, Revision 8	Definitive	Waste/TCLP Mercury	Mercury Analyzer	N
CA-733	Reactive Cyanide SW-846 Chapter Seven, 7.3.3.2, 07/11, Revision 6.	Definitive	Waste/ Reactive Cyanide & Sulfide	Lachet 8000 Series	N
CA-734	Reactive Sulfide SW-846 Chapter Seven, 7.3.4.2, 05/12, Revision 7.				
CA-736	Test Method for Flash Point by Pensky-Martens Closed-Cup Tester, 08/15, Revision 6. (Reviewed 03/16)	Definitive	Waste/EPA 1010A	Herzog HFP-339 Automated Pensky Marten Closed Cup FP Tester	N
CA-709	pH Concentration Measurements In Soil Matrices – SW 846 Method 9045, 07/14, Revision 10.	Definitive	Waste/EPA 9045D	Orion 720A pH Meter	N

QAPP Worksheet #24 – Analytical Instrument Calibration

(UFP-QAPP Manual Section 3.2.2; EPA 2106-G-05 Section 2.3.6)

Instrument	Calibration Range	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for Corrective Action	SOP Reference
ICP-MS; Metals	Linear Dynamic Range (LDR) or High-level Check Standard	Every 6 months and with major maintenance	90-110% recovery	Perform maintenance and/or reanalyze at lower concentration	Analyst, Supervisor	CA-627
ICP-MS; Metals	Tuning	Daily	Resolution < 0.9 amu full at 5% peak height, mass calibration cannot drift more than 0.1 amu; RSD ≤ 5% with 5 replicates	Instrument maintenance, do not continue with calibration	Analyst, Supervisor	CA-627
ICP-MS; Metals	Initial Calibration (ICAL)	Daily ICAL prior to sample analysis.	Correlation coefficient ≥ 0.99	Recalibrate and/or perform necessary equipment maintenance	Analyst, Supervisor	CA-627
ICP-MS; Metals	Initial Calibration Verification (ICV)	Once after each ICAL	All reported analytes within ± 10% of the expected value.	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification	Analyst, Supervisor	CA-627
ICP-MS; Metals	Continuing Calibration Verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All reported analytes within ± 10% of the expected value.	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification	Analyst, Supervisor	CA-627
ICP-MS; Metals	Low-level Calibration Check Standard (Low Level ICV)	Daily following calibration	80-120% recovery	Recalibrate and/or perform necessary equipment maintenance	Analyst, Supervisor	CA-627

Instrument	Calibration Range	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for Corrective Action	SOP Reference
ICP-MS; Metals	Internal Standards (IS)	Every field sample and standard	IS intensity in the samples within 30-120% of intensity of the IS in the ICAL.	Reanalyze all samples with Internal Standard failures. If reanalysis confirms matrix interference, report sample and narrate.	Analyst, Supervisor	CA-627
ICP-MS; Metals	Initial and Continuing Calibration Blank (ICB/CCB)	Once with each ICAL after every 10 samples and at the end of an analytical sequence	Determined concentration ≤ LOD	Determine source of possible contamination, perform maintenance and recalibrate	Analyst, Supervisor	CA-627
Mercury Analyzer	Per EPA 7470A/7471B and Worksheet #28	Prior to analyzing samples per EPA 7470A/7471B	Per calibration criteria per EPA 7470A/7471B and Worksheet #28	Inspect system; correct problem; rerun calibration and affected samples.	Analyst, Supervisor	CA-615
ICP-AES; Metals	Per EPA 6010C and Worksheet #28	Prior to analyzing samples per EPA 6010C	Per calibration criteria per EPA 6010C and Worksheet #28	Inspect system; correct problem; rerun calibration and affected samples.	Analyst, Supervisor	CA-608
ICP-AES; Metals	Initial Calibration (ICAL)	Daily ICAL prior to sample analysis.	Correlation coefficient ≥ 0.99	Recalibrate and/or perform necessary equipment maintenance	Analyst, Supervisor	CA-608
ICP-AES; Metals	Initial Calibration Verification (ICV)	Once after each ICAL	All reported analytes within ± 10% of the expected value.	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification	Analyst, Supervisor	CA-608
ICP-AES; Metals	Continuing Calibration Verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All reported analytes within ± 10% of the expected value.	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification	Analyst, Supervisor	CA-608

Instrument	Calibration Range	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for Corrective Action	SOP Reference
ICP-AES; Metals	Low-level Calibration Check Standard (Low Level ICV)	Daily following calibration	80-120% recovery	Recalibrate and/or perform necessary equipment maintenance	Analyst, Supervisor	CA-608
ICP-AES; Metals	Initial and Continuing Calibration Blank (ICB/CCB)	Once with each ICAL after every 10 samples and at the end of an analytical sequence	Determined concentration ≤ LOD	Determine source of possible contamination, perform maintenance and recalibrate	Analyst, Supervisor	CA-608

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection

(UFP-QAPP Manual Section 3.2.3; EPA 2106-G-05 Section 2.3.6)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/Position Responsible for Corrective Action	SOP Reference
Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)	Change pump tubing, clean nebulizer, change torch, clean sample cone/skimmer cone	Metals - EPA 6020B	Monitor instrument performance via Continuing Calibration Verification and CC Blank	As needed	No maintenance is required as long as instrument QC meets DoD criteria	Change pump tubing, change torch and window, clean filters; recalibrate and reanalyzed affected data	Analyst, Supervisor	CA-627
Mercury Analyzer	Check pump tubing, change sample tubing at least daily. Change reductant, carrier and waste tubing	Mercury – EPA 7470A, 7471B	Monitor instrument performance via Continuing Calibration Verification and Continuing Calibration Blank	As needed	No maintenance is required as long as instrument QC meets DoD criteria	Change pump tubing, recalibrate and reanalyze affected data	Analyst, Supervisor	CA-615

QAPP Worksheets #26 & #27 – Sample Handling, Custody, and Disposal

(UFP-QAPP Manual Section 3.3; EPA 2106-G-05 Section 2.3.3)

Sampling Organization: AECOM
Laboratory: Katahdin
Method of Sample Delivery (shipper/carrier): FedEx and/or courier
Number of Days from Reporting until Sample Disposal: 60 days

Activity	Organization and Title or Position of Person Responsible for the Activity	SOP Reference
Sample labeling	AECOM field team	MC-3
Chain of Custody (COC) form completion	AECOM field team	
Packaging	AECOM field team	
Shipping coordination	AECOM field team	
Sample receipt, inspection, and log-in	Katahdin sample custodians	SD-902, SD-903
Sample custody and storage	Katahdin sample custodians	
Sample disposal	Katahdin sample custodians	

QAPP Worksheet #28 – Analytical Quality Control and Corrective Action

(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6; EPA 2106-G-05 Section 2.3.5)

Matrix: Discrete Soil, ISM Soil, & Aqueous (EQB)
Analytical Group: Metals
Analytical Method: EPA 6020B
SOP Reference: CA-627

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Field Triplicate	1 per sample location	N/A	Use higher value in risk calculations and discuss in uncertainty analysis discussion, if warranted.	J-flag all outside control limits	RSD <30% when detects are ≥5x LOQ, or within ±4x LOQ for results <5x LOQ
Equipment Blank	1 per sampling location or equipment set	N/A	Clean equipment carefully or use disposable sampling equipment where possible.	Per data validation guidelines	No analytes detected > ½ LOQ
Linear Dynamic Range (LDR) or High-level Check Standard	Every 6 months and with major maintenance	90-110% recovery	Perform maintenance and/or reanalyze at lower concentration.	Flagging is not appropriate.	Data cannot be reported above the calibration range without an established/passing high-level check standard.
Tuning	Daily	Resolution < 0.9 amu full at 5% peak height, mass calibration cannot drift more than 0.1 amu; RSD ≤ 5% with 5 replicates	Instrument maintenance, do not continue with calibration.	Flagging is not appropriate.	No samples shall be analyzed without a valid tune.
Initial Calibration (ICAL)	Daily ICAL prior to sample analysis.	Correlation coefficient ≥ 0.99	Recalibrate and/or perform necessary equipment maintenance.	Flagging is not appropriate.	Minimum one high standard and a calibration blank. No samples shall be analyzed until ICAL has passed.
Initial Calibration Verification (ICV)	Once after each ICAL	All reported analytes within ± 10% of the expected value	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification.	Flagging is not appropriate.	No samples shall be analyzed until calibration has been verified with a second source.

Matrix: Discrete Soil, ISM Soil, & Aqueous (EQB)
Analytical Group: Metals
Analytical Method: EPA 6020B
SOP Reference: CA-627

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Continuing Calibration Verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All reported analytes within ± 10% of the expected value	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Results may not be reported without a valid CCV.
Low-level Calibration Check Standard (Low Level ICV)	Daily following calibration	80-120% recovery	Recalibrate and/or perform necessary equipment maintenance.	Flagging is not appropriate.	No samples shall be analyzed without a valid low-level calibration check standard. Low-level calibration check standard should be less than or equal to the LOQ.
Internal Standards (IS)	Every field sample and standard	IS intensity in the samples within 30-120% of intensity of the IS in the ICAL	Reanalyze all samples with Internal Standard failures. If reanalysis confirms matrix interference, report sample and narrate.	Flagging is not appropriate.	Samples suffering from matrix effect should be diluted until criteria are met, or an alternate IS should be selected.
Method Blank (MB)	One per preparatory batch.	No analytes detected > ½ RL or > 1/10 the amount measured in any sample	Correct problem; reanalyzed any sample associated with a blank that fails criteria, except when the sample analysis results in a non-detect.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Results may not be reported without a valid method blank.
Initial and Continuing Calibration Blank (ICB/CCB)	Once with each ICAL after every 10 samples and at the end of an analytical sequence	Determined concentration ≤ LOD	Determine source of possible contamination, perform maintenance and recalibrate	Flagging is not appropriate.	Results may not be reported without a valid calibration blank. For CCB, failures due to carryover may not require an ICAL.

Matrix: Discrete Soil, ISM Soil, & Aqueous (EQB)
Analytical Group: Metals
Analytical Method: EPA 6020B
SOP Reference: CA-627

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Interference Check Solutions (ICS) (also called Spectral Interference Checks) ICS-A and ICS-AB	Daily after ICAL	ICS-A: Absolute value of observed results ≤ LOD for non-spiked project analytes ICS-AB: Within ± 20% of true value	Correct problem; recalibrate instrument	Flagging is not appropriate.	All analytes must be within the LDR.
Laboratory Control Sample (LCS)	One per preparatory batch.	See **Worksheet #15**	Reanalyze and/or re-prep all associated samples unless recoveries are high with no detection of analytes.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Results may not be reported without a valid LCS.
Matrix Spike (MS)	One per preparatory batch per matrix	For matrix evaluation use LCS recovery acceptance criteria.	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Re-prep if sufficient	Flagging is not appropriate.	If MS results are outside the limits, the data shall be evaluated to the source of difference, i.e., matrix effect or analytical error.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch per matrix.	RPD of all analytes **≤** 20%	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Re-prep if sufficient sample is available when appropriate	Flagging is not appropriate.	The data shall be evaluated to determine the source of difference.
Dilution Test	One per preparatory batch	Five-fold dilution must agree within ± 10% of the original measurement for samples with concentrations > 50 x LOQ	Perform Post Digestion Spike	Flagging is not appropriate.	Only applicable for samples with concentrations > 50 X LOQ (prior to dilution). Use along with MS/MSD or PDS data to confirm matrix effects.
Post-Digestion Spike (PDS) Addition	When dilution test fails or analyte concentration in all samples <50 x LOD	Recovery within 80-120%.	Contact the client to determine if additional measures are required	Flagging is not appropriate.	Criteria apply for samples with concentrations < 50 X LOQ prior to dilution.

Matrix: TCLP Soil
Analytical Group: Metals
Analytical Method: EPA 6010C
SOP Reference: CA-608

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Linear Dynamic Range (LDR) or High-level Check Standard	Every 6 months and with major maintenance	90-110% recovery	Perform maintenance and/or reanalyze at lower concentration	Flagging is not appropriate.	Data cannot be reported above the calibration range without an established/passing high-level check standard.
Initial Calibration (ICAL)	Daily ICAL prior to sample analysis.	Correlation coefficient ≥ 0.99	Recalibrate and/or perform necessary equipment maintenance	Flagging is not appropriate.	Minimum one high standard and a calibration blank. No samples shall be analyzed until ICAL has passed.
Initial Calibration Verification (ICV)	Once after each ICAL	All reported analytes within ± 10% of the expected value.	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification	Flagging is not appropriate.	No samples shall be analyzed until calibration has been verified with a second source.
Continuing Calibration Verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All reported analytes within ± 10% of the expected value.	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification	If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Results may not be reported without a valid CCV.
Low-level Calibration Check Standard (Low Level ICV)	Daily following calibration	80-120% recovery	Recalibrate and/or perform necessary equipment maintenance	Flagging is not appropriate.	No samples shall be analyzed without a valid low-level calibration check standard. Low-level calibration check standard should be less than or equal to the LOQ.
Method Blank (MB)	One per preparatory batch.	No analytes detected > ½ RL or > 1/10 the amount measured in any sample	Correct problem; reanalyzed any sample associated with a blank that fails criteria, except when the sample analysis results in a non-detect.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Results may not be reported without a valid method blank.

Matrix: TCLP Soil
Analytical Group: Metals
Analytical Method: EPA 6010C
SOP Reference: CA-608

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Initial and Continuing Calibration Blank (ICB/CCB)	Once with each ICAL after every 10 samples and at the end of an analytical sequence	Determined concentration ≤ LOD	Determine source of possible contamination, perform maintenance and recalibrate	Flagging is not appropriate.	Results may not be reported without a valid calibration blank. For CCB, failures due to carryover may not require an ICAL.
Interference Check Solutions (ICS) (also called Spectral Interference Checks) ICS-A and ICS-AB	Daily after ICAL	ICS-A: Absolute value of observed results ≤ LOD for non-spiked project analytes. ICS-AB: Within ± 20% of true value	Correct problem; recalibrate instrument	Flagging is not appropriate.	All analytes must be within the LDR.
Laboratory Control Sample (LCS)	One per preparatory batch.	QC acceptance criteria specified by DoD QSM 5.0 Tables 5 and 6	Reanalyze and/or re-prep all associated samples unless recoveries are high with no detection of analytes.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Results may not be reported without a valid LCS.
Matrix Spike (MS)	One per preparatory batch per matrix	For matrix evaluation use LCS recovery acceptance criteria.	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Re-prep if sufficient	Flagging is not appropriate.	If MS results are outside the limits, the data shall be evaluated to the source of difference, i.e., matrix effect or analytical error.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch per matrix.	RPD of all analytes ≤ 20%	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Re-prep if sufficient sample is available when appropriate	Flagging is not appropriate.	The data shall be evaluated to determine the source of difference.

Matrix: TCLP Soil
Analytical Group: Metals
Analytical Method: EPA 6010C
SOP Reference: CA-608

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Dilution Test	One per preparatory batch	Five-fold dilution must agree within ± 10% of the original measurement for samples with concentrations > 50 x LOQ	Perform Post Digestion Spike	Flagging is not appropriate.	Only applicable for samples with concentrations > 50 X LOQ (prior to dilution). Use along with MS/MSD or PDS data to confirm matrix effects.
Post-Digestion Spike (PDS) Addition	When dilution test fails or analyte concentration in all samples <50 x LOD	Recovery within 80-120%.	Contact the client to determine if additional measures are required	Flagging is not appropriate.	Criteria apply for samples with concentrations < 50 X LOQ prior to dilution.

Matrix: TCLP Soil
Analytical Group: Mercury
Analytical Method: EPA 7470A/7471B
SOP Reference: CA-615

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Method Blank (MB)	One per preparatory batch	No analytes detected >1/2 RL or 1/10th the amount in any sample	Correct problem; reanalyze any sample associated with a blank that fails criteria, except when the sample analysis resulted in non-detect	If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Results may not be reported without a valid Method Blank
Laboratory Control Sample (LCS)	One LCS per preparatory batch	82-119%	Reanalyze and/or re-prep all associated samples unless recoveries are high with no detection of analytes.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Results may not be reported without a valid LCS
Sample Duplicate or MSD	One per preparatory batch per matrix	RPD ≤ 20%	Evaluate the data to determine if the failed criteria are due to sample matrix or laboratory error. Re-prep if sufficient sample is available when appropriate	Flagging is not appropriate.	The data shall be evaluated to determine the source of difference
Matrix Spike	One per preparatory batch per matrix	For matrix evaluation, use LCS recovery acceptance criteria	Evaluate the date to determine if the failed criteria are due to sample matrix or laboratory error. Re-prep if sufficient sample is available when appropriate	Flagging is not appropriate.	If the MS results are outside the limits, the data shall be evaluated to the source of difference
Continuing Calibration Verification (CCV)	After every 10 samples and at the end of the analytical batch	All analytes within ± 10% of expected value	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Results may not be reported without a valid CCV.
Initial Calibration (ICAL)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.99	Recalibrate and/or perform necessary equipment maintenance.	Flagging is not appropriate	Minimum one high standard and a calibration blank. No samples shall be analyzed until ICAL has passed.

Matrix: TCLP Soil
Analytical Group: Mercury
Analytical Method: EPA 7470A/7471B
SOP Reference: CA-615

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Initial Calibration Verification (ICV)	Once after each initial calibration	All analytes within ± 10% of expected value	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification	Flagging is not appropriate	No samples shall be analyzed until calibration has been verified with a second source.

QAPP Worksheet #29 – Project Documents and Records

(UFP-QAPP Manual Section 3.5.1; EPA 2106-G-05 Section 2.2.8)

Sample Collection and Field Records:

Record	Generation	Verification	Storage location/archival
Field logbook or data collection sheets	Field Task Leader	Project Manager	Project File
Chain-of-Custody Forms	Field Task Leader	Project Manager	Project File
Air Bills	Field Task Leader	Project Manager	Project File
Contractor Daily QC Reports	Field Task Leader	Project Manager	Project File
Deviations	Field Task Leader	Project Manager	Project File
Corrective Action Reports	Field Task Leader	Project Manager	Project File
Correspondence	Field Task Leader	Project Manager	Project File

Project Assessments:

Record	Generation	Verification	Storage location/archival
Field audit checklists	Not Planned	Not Planned	Not Planned
Data verification checklists	Staff Chemist	Project Chemist	Project File
Data validation report	Staff Chemist	Project Chemist	Project File
Data usability assessment report	Staff Chemist	Project Chemist	Project File

Laboratory Records:

Record	Generation	Verification	Storage location/archival
System Audits	NELAP/Laboratory	NELAP/Laboratory	Laboratory QA File
Performance Evaluation	NELAP/Laboratory	NELAP/Laboratory	Laboratory QA File

Laboratory Data Deliverables:

Record	Metals
Narrative	X
COC	X
Summary Results	X
QC Results	X
Chromatograms	X

QAPP Worksheets #31, #32, #33 – Assessments and Corrective Action

(UFP-QAPP Manual Sections 4.1.1 and 4.1.2; EPA 2106-G-05 Sections 2.4 and 2.5.5)

Assessments:

Assessment Type	Responsible Party & Organization	Number/Frequency	Estimated Dates	Assessment Deliverable	Deliverable due date
ELAP Accreditation	A2LA	Annually	NA	Certification	NA
Data Review	Naoum Tavantzis, AECOM	Once	Within 45 days after receipt of data	Validation Report	Within 45 days after receipt of data
External Laboratory Audit	A2LA	Bi-annually	NA	Written Audit Report	NA
Internal Laboratory Audit	Katahdin	Annually	NA	Written Audit Report	NA

Assessment Response and Corrective Action:

Assessment Type	Responsibility for responding to assessment findings	Assessment Response Documentation	Timeframe for Response	Responsibility for Implementing Corrective Action	Responsible for monitoring Corrective Action implementation
Readiness Review	Project Manager	Readiness Review Corrective Action Response	24 hours from receipt of Readiness Review Memorandum	As directed by PM	AECOM QAM
Field Sampling Technical Systems Audit (TSA)	Not Planned	Not Planned	Not Planned	Not Planned	Not Planned
On-site analytical TSA	Not Planned	Not Planned	Not Planned	Not Planned	Not Planned
PT samples	Laboratory QAM	Accreditation	Per Accrediting Authority	Laboratory Technical Director	Laboratory QAM
Management Reviews	AECOM Task Manager	QA Management Response	48 hours from receipt of QA Management Report	As assigned in QA Management Response	AECOM QAM
Field Audit	Not Planned	Not Planned	Not Planned	Not Planned	Not Planned
Laboratory Internal Audit	Laboratory Director or Manager	Corrective Action	48 hours after notification	Laboratory Director, Manager, and/or QA Manager	Laboratory QA Manager

QAPP Worksheet #34 – Data Verification and Validation Inputs

(UFP-QAPP Manual Section 5.2.1 and Table 9; EPA 2106-G-05 Section 2.5.1)

The validation will be based on a graded approach, with additional validation as necessary if problems are identified.

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved QAPP	X	
2	Contract	X	
3	Field SOPs	X	
4	Laboratory SOPs	X	
Field Records			
5	Field logbooks/ Daily Reports	X	X
6	Equipment calibration records (as applicable)	X	X
7	Chain-of-Custody Forms	X	X
8	Sampling diagrams/surveys	X	X
9	Relevant Correspondence	X	X
10	Change orders/deviations	X	X
11	Field audit reports (as applicable)	X	X
12	Photographs	X	X
13	Field corrective action reports	X	X
Analytical Data Package *			
14	Cover sheet (laboratory identifying information)	X	X
15	Case narrative	X	X
16	Internal laboratory chain-of-custody	X	X
17	Sample receipt records	X	X
18	Sample chronology (i.e. dates and times of receipt, preparation, & analysis)	X	
19	Communication records	X	X
20	LOD/LOQ establishment and verification	X	
21	Standards Traceability	X	
22	Instrument calibration records	X	
23	Definition of laboratory qualifiers	X	X
24	Results reporting forms	X	X
25	QC sample results	X	X
26	Corrective action reports	X	X
27	Raw data	X	X
28	Electronic data deliverable	X	X

* Category B Data Package and DUSR format. Compiled in accordance with the applicable sections of:

Department of Defense, 2017. *Quality Systems Manual Version 5.1*. January 2017.

QAPP Worksheet #35 – Data Verification Procedures

(UFP-QAPP Manual Section 5.2.2; EPA 2106-G-05 Section 2.5.1)

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Chain of custody forms and shipping forms	Chain of Custody, Shipping Documents	Chain of custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain of custody should be initialed by the reviewer, a copy of the chain of custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment.	Appropriate field investigation Task Leaders for the individual media
Review of field logbooks	Field Logbooks	Review for completeness and accuracy	Appropriate field investigation Task Leaders
Field sampling TSAs	Technical System Audit Reports	Assessment of field sampling process prior to start of, or as close to the start of sampling as possible. Internal technical reviews of the sampling process are conducted prior to acceptance of the method proposed.	QA Manager or designee
Field data validation TSAs	Technical System Audit Reports	Complete review and assessment of field data. Internal technical reviews and assessments of field data are conducted concurrently with and following data collection.	QA Manager or designee
Fixed laboratory analytical data review	Laboratory Data Package	Data controls are compared to this QAPP and DoD QSM v 5.0 Attachment A in a Three Tiered process using a minimum 100% peer review.	PM or QA Manager
Fixed laboratory TSAs	Laboratory Data Package	ELAP audit and internal quality audits	QA Manager
Fixed laboratory data verification/validation	Data Validation Reports	100% data verification/validation for investigative samples and field QC.	AECOM Project Chemist
Fixed laboratory data validation TSAs	Data Validation Reports	Calculate and assess laboratory DQIs.	QA Manager, or designee

QAPP Worksheet #36 – Data Validation Procedures

(UFP-QAPP Manual Section 5.2.2; EPA 2106-G-05 Section 2.5.1)

Data Validator: AECOM

Analytical Group/Method	Inorganic Data
Data deliverable requirements	Environmental Restoration Information System, .csv
Analytical specifications	WS #28 and Laboratory SOP
Measurement performance criteria	WS #12, WS#15, and WS#28
Percent of data packages to be validated	100%
Percent of raw data reviewed	100%
Percent of results to be recalculated	0
Validation procedure	*National Functional Guidelines for Organic/Inorganic Superfund Data Review* (2017), EPA-540-R-2017-001
Validation code	Per Guidelines
Electronic validation program/version	N/A

QAPP Worksheet #37 – Data Usability Assessment

(UFP-QAPP Manual Section 5.2.3 and Table 12; EPA 2106-G-05 Sections 2.5.2 – 2.5.4)

The Data Usability Assessment (DUA) is an evaluation at the conclusion of data collection activities that uses the results of both data verification and validation in the context of the overall project decisions or objectives. Using both quantitative and qualitative methods, the assessment will determine whether project execution and the resulting data meet project DQOs (**Worksheet #11**). Both sampling and analytical activities will be considered with the ultimate goal to assess whether the final, qualified results support the decisions to be made with the data.

The following personnel are responsible for participating in the DUA:

- AECOM Project Manager: Rosa Gwinn
- AECOM Project Chemist: Naoum Tavantzis
- AECOM Risk Assessor: Gretchen Welshofer
- AECOM Field Task Leader: Joe Witte

The DUA will be documented as a discussion within the RI report and refer to the Data Validation Report that will appear in an appendix of the RI report. The Data Validation Report will follow the specifications given in **Worksheet #36**.

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

Step 1	**Review the project's objectives and sampling design.** The key components established in the DQOs (**Worksheet #11**) will be reviewed to ensure that they are still applicable. Also, the sampling design and how it was implemented in the field will be reviewed for consistency with the stated objectives. For example, at this step in the DUA will: Reevaluate whether comparison criteria (i.e., PALs; **Worksheet #15**) were updated since UFP-QAPP generation and if laboratory quantitation limits (QLs) were sensitive enough for those changes (e.g., QLs remain lower than new criteria). Project data must meet the measurement performance criteria for sensitivity and project QLs specified in **Worksheets #15 & 28**. Discuss the limitations and impact on the use of project data if validation reports indicate that project specific sensitivity goals or QLs were not achieved for a specific sampling or laboratory group, data set or sample delivery group (SDG), matrix, analytical group, or concentration level.
Step 2	**Review the data verification and data validation outputs** All available Quality Assurance (QA) reports, including both field and laboratory generated forms, will be reviewed for deviations from planned activities identified in Step 1 (e.g., number and locations of samples, holding time exceedances, damaged samples, non-compliant PT sample results,

	and SOP deviations) and determine their impacts on the data usability. Validated data will be summarized and/or compiled to identify patterns, trends, and anomalies as they related to the DQIs precision, accuracy/bias, representativeness, comparability, and completeness. Descriptions of each DQI and examples of how each may be incorporated into the usability report follows.
Step 2 (cont.)	**Precision** Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, percent difference, or range, in either absolute or relative terms. QC measures for precision include field duplicates, laboratory duplicates, MSDs, analytical replicates, and surrogates. To meet the needs of the data users, project data must meet the measurement performance criteria for precision specified in **Worksheet #12** of this QAPP. Precision errors may be the result of one or more of the following: field instrument variation, analytical measurement variation, poor sampling technique, sample transport problems, or spatial variation (heterogeneous sample matrices). To identify the cause of imprecision, the field sampling design rationale and sampling techniques will be evaluated by the reviewer, and both field and analytical duplicate/replicate sample results will be compared. For example, if poor precision is indicated in both the field and analytical duplicates/replicates, then the laboratory may be the source of error. If poor precision is limited to the field duplicate/replicate results, then the sampling technique, field instrument variation, sample transport, medium inhomogeneity, or spatial variability may be the source of error. If data validation reports indicate that analytical imprecision exists for a particular data set or SDG, then the impact of that imprecision on usability will be discussed in the usability report.
Step 2 (cont.)	**Accuracy/Bias** Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) due to sampling and analytical operations. Examples of QC measures for accuracy include Matrix Spikes, Laboratory Control Samples, and equipment blanks. A measurement is accurate when the reported value does not differ from the true value or known concentration of the spike or standard. To meet the needs of the data users, project data must meet the measurement performance criteria for accuracy/bias specified in **Worksheet #12** of this QAPP. The usability report will: Discuss and compare data on contamination and accuracy/bias (when bias is observable) for each matrix, analytical group, and concentration level. Describe the limitations on the use of project data if extensive contamination, inaccuracy, or bias exists or when inaccuracy is limited to a specific sampling or laboratory group, data set or SDG, matrix, analytical group, or concentration level. Discuss the impact of any qualitative and quantitative trends in bias on the sample data.
Step 2 (cont.)	**Representativeness** Representativeness is the measure of the degree to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition. It is achieved through a well-designed sampling program and by using standardized sampling strategies, techniques, and analytical procedures. To meet the needs of the data users, project data must meet the measurement performance criteria for sample representativeness specified in **Worksheet #12** of this QAPP. **Worksheet #28 & 35** discusses how the QA/QC activities (e.g., review of sampling design and SOPs, field sampling TSAs, analysis audits, etc.) and QC sample data will be reviewed to assess sample representativeness. For example, if field duplicate precision checks indicate potential spatial variability, additional scoping meetings and subsequent resampling may be needed to collect data that are more representative of a nonhomogeneous site. The usability report will: Discuss the impact of field duplicate and triplicate imprecision on site representativeness. For example, when data variability is high among field replicate data sets (i.e., high relative standard deviation) calculation of the 95% upper confidence limit (UCL) of the population mean is more likely to overestimate the true mean of the DU and therefore achieve better statistical coverage (ITRC, 2012). Discuss the impact of laboratory and field sampling methods on sampling results and how they reflect site conditions. Discuss the effect of site heterogeneity on sampling results in light of sampling methods used. Describe the limitations on the use of project data when sampling results are nonrepresentative for all data or for a specific sampling, group, data set

	or SDG, matrix, analytical group, or concentration level.
Step 2 (cont.)	**Comparability** Comparability is the degree to which different methods, data sets, and decisions agree or can be represented as similar. Comparability describes the confidence (expressed qualitatively or quantitatively) that two data sets can contribute to a common analysis and interpolation. The results of this study will be used as a benchmark for determining comparability for data collected during any future sampling events using the same or similar sampling and analytical SOPs. At this time, data will not be compared to other datasets or data using different sampling or analytical SOPs. To ensure future comparability of data generated for the site, standard sample collection procedures and approved analytical methods will be employed. Sample analyses will be performed by the laboratory using approved methods and procedures. Comparability criteria will be considered met for the project if, based on data reviewed, the sample collection and analytical procedures are determined to have been followed, or defined to show that variations did not affect the values reported. Deviations to sampling scope will be documented in sampling nonconformance reports which may contain some of the discussion of comparability. The usability report will describe the limitations on the use of project data when project-required data comparability is not achieved for the overall project or is limited to a specific sampling or laboratory group, data set or SDG, matrix, analytical group, or concentration level.
Step 2 (cont.)	**Completeness** Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under correct, normal circumstances. To meet the needs of the data users, project data must meet the measurement performance criteria for data completeness. Completeness criteria will be considered met if 90% of planned ISM increments are collected and 100% of all other planned sample data are collected. As applicable, the usability report may also: Describe how the amount of valid data will be determined as a percentage of the number of valid measurements for each matrix, analytical group, and concentration level. Describe how critical data was assessed for completeness when certain sample locations or analytes and matrices are more critical than others in making project decisions. Evaluate the impact of missing information. Ensure that enough information was obtained for the data to be usable to meet the DQOs (**Worksheet #11**).
Step 3	**Verify the assumptions of the selected statistical method** The use of statistical methods for data assessment will likely be limited to estimating a 95% UCL (or mean as appropriate for the analyte) for the assessment of risks. ISM incorporates mechanical methods of achieving appropriate coverage of a DU. By applying an informed field program, ISM is designed to capture the true population distribution. In accordance with ITRC ISM guidance, the 95% UCL will be calculated as either the Student's-t UCL or Chebyshev UCL as appropriate for the observed data. Discretely collected data will be collected to confirm the extent of potential MC contamination at each DU. Statistical analysis will not be used on discrete data.
Step 4	**Implement the statistical method** Where statistical methods are used, the underlying assumptions will be assessed during the DUA. The consequences of selecting the incorrect alternative will be discussed and uncertainty tolerances will be considered.
Step 5	**Document data usability and draw conclusions** The DUA will determine and document whether the data can be used as intended given any deviations and corrective actions that may have occurred. Limitations on data use will be considered and discussed as appropriate and the performance of the sampling design assessed. Conclusions will be drawn taking any data limitations into consideration and documented in the RI report.

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Attachment A

AECOM Standard Operating Procedures

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Field Sampling Standard Operating Procedure (SOP) MC-1
Quality Control Process

1.1 THREE-PHASE CONTROL PROCESS

The Quality Control (QC) personnel are responsible for verifying compliance with project requirements through implementation of the three-phase control process. This process ensures that project activities comply with the approved plans and procedures.

Elements of the three-phase control process are: (1) Preparatory Phase, (2) Initial Phase, and (3) Follow-Up Phase. Each control phase is important for obtaining a quality product. However, the preparatory and initial inspections are particularly valuable in preventing problems. Production work is not to be performed on a definable feature of work until a successful preparatory and initial phase inspection has been completed and documented.

1.1.1 Preparatory Phase

Preparatory phase inspections are performed prior to beginning a definable feature of work. The purpose of the inspection is to review contracts, plans, specifications, standard operating procedures (SOPs), and other applicable documents and to verify that necessary resources (i.e., equipment and personnel), conditions, and controls are in place before work starts. This inspection phase is conducted with the people responsible for performing each definable feature of work to include managers, supervisors, and applicable subcontractors ensuring all involved know what is expected and understand their role. The client is invited to attend but is not required. The Project Manager (PM) is responsible for ensuring that:

- Appropriate plans and procedures are developed, coordinated, and approved
- Personnel required for the activity are identified and positions filled
- Training has been identified and completed
- Preliminary work and coordination have been completed
- Equipment and materials required to perform the activity have been identified and are available
- Reviews have been performed

The QC personnel are responsible for assisting the PM in conducting preparatory phase inspections and verifying the following conditions:

- Appropriate plans and procedures have been developed, approved, reviewed, and are available
- Personnel identified are available and meet the requirements/qualifications for the position or waivers have been obtained
- Required training has been performed, documented and acknowledged
- Preliminary work and coordination have been completed

Deficiencies identified during preparatory phase inspections will be documented and corrective action taken prior to beginning work. The QC personnel will verify that corrective action has been complete and is appropriate before production work begins.

1.1.2 Initial Phase

Initial phase inspections are performed when a work process begins for each crew or team performing the definable feature of work. The purpose of the inspection is to:

- Verify that the work to be performed will be in compliance with procedures and contract specifications
- Verify that equipment and personnel on site meet the requirements established during the preparatory phase
- Review acceptable level of workmanship for site personnel who will be conducting the definable feature of work
- Review preparatory phase inspection report
- Resolve any differences of interpretation

The initial phase is the first documented QC personnel field compliance inspection for a definable feature of work. Initial phase inspections may be repeated when acceptable levels of quality are not demonstrated or at the discretion of the QC personnel.

- Equipment is on-hand, functional, in specification, and appropriate for the job
- Required personnel resources are on site and properly qualified to perform the definable feature of work in accordance with the preparatory phase
- Material and supplies are on-hand and meet contract specifications
- Level of quality expected is understood by workers
- Compliance with procedures and specification;
- Acceptable level of workmanship is being performed
- Corrective action taken during the preparatory phase inspection has resolved the deficiency and prevents recurrence
- Quality issues and any differences of interpretation by workers are resolved
- Briefing on the process improvement program and Field Change Request (FCR) process has been completed

Deficiencies identified during initial phase inspections will be documented and corrective action taken. The QC personnel will verify that corrective action has been completed and is appropriate to prevent recurrence of the condition. When corrective action cannot be completed in a timely manner or the root cause is not known, immediate corrective action that fixes the deficiency may be taken, verified, and work continued pending root cause analysis and more appropriate corrective action.

1.1.3 Follow-up Phase

Follow-up phase inspections are performed after a work process (WP) has begun and periodically throughout the work process. The purpose of the inspection is to evaluate whether the process is being completed in accordance with agreed upon standards and to evaluate whether the level of quality meets QC acceptance criteria. The QC personnel are responsible for monitoring work processes and verifying continued compliance with WP and QC criteria requirements. Follow-up phase inspections are excellent opportunities to observe work processes and identify possible process improvements.

Deficiencies identified during follow-up phase inspections will be documented and corrective action will be taken. The QC personnel will verify that corrective action has been completed and is appropriate to prevent recurrence of the condition. When corrective action cannot be completed in a timely manner or the root cause is not known, immediate corrective action that fixes the deficiency may be taken, verified, and work continued pending root cause analysis and more appropriate corrective action.

1.2 NONCONFORMANCE/CORRECTIVE ACTION

Nonconformances shall be addressed via corrective action in a manner described in this Quality Control Process (QCP) section.

1.2.1 Nonconformance Identification

Circumstances that prevent a work process to control the output from conforming to the contract requirements will be promptly identified, documented, investigated, and corrected appropriately. All project personnel have the responsibility, as part of their normal work duties, to promptly identify and report conditions adverse to quality. The status of non-conformance reports (NCRs) will be maintained in a log and progress of their resolutions shall be documented and reviewed to ensure prompt attention to their conclusion.

1.2.2 Resolution, Corrective Action, and Verification

The appropriate level of management is responsible for evaluating the cause of a NCR and will recommend solutions for correcting the deficiency identified. Actions and technical justifications for an action proposed to resolve the NCR shall be reviewed and approved by personnel responsible for the technical aspect of the work.

Corrective action is the specific action or actions taken to correct the immediate situation and to reduce or prevent the likelihood of future occurrences. Examples of corrective action for the immediate situation include rerunning a portion of a test/operation that was not conducted in accordance with procedures, calibrating test equipment found to be out of calibration, rework of a specific activity, and rerunning any required tests. QC personnel will be responsible for verifying implementation of corrective action, monitoring the effectiveness of preventive action, and reporting any findings to the appropriate management level.

The QC personnel shall maintain an NCR log. The NCR log will be used to track and control each nonconforming condition. At a minimum the log will contain, the date each nonconforming condition was discovered, the NCR tracking number, a brief description of the condition, the location, the department/manager responsible for disposition, the recommended disposition, the NCR closure date, and status of all nonconformance reports. The NCR log status will be maintained in the project files and available on-site.

1.2.3 Material and Equipment Nonconformance

QC personnel ensure that the following requirements are implemented:

- Materials and/or equipment that do not conform to prescribed technical and/or quality requirements are tagged or otherwise identified, documented, and reported as nonconforming. The documentation shall include the following information:

Identification of the technical and quality requirement(s) with which the item is not in compliance

Identification of the current status of the item (i.e., whether the item is on hold or whether its use is conditional)

- Nonconforming materials and equipment are segregated, when possible, from conforming materials and/or equipment to the extent necessary to preclude their inadvertent use and commingling.
- The status of nonconforming material and/or equipment and the progress of their resolution are documented and routinely reviewed to ensure prompt attention to conclusion.

1.2.4 Deficiency Reporting

Deficiencies and nonconforming conditions are very similar and are conditions that, once identified, must be resolved or corrected prior to acceptance of an item or product. A deficiency is a condition that can be corrected quickly by standard methods during the normal course of work. A deficiency usually is not systemic in nature.

It will be the responsibility of all project personnel to identify deficiencies and notify their supervisor or manager as soon as the conditions are identified. Determination of any deficiencies must be supported with objective evidence. Deficiencies will be evaluated, resolved, or corrected and may be considered as opportunities to improve the process (**Section 1.2.7**, Lessons Learned).

1.2.5 Preventive Action

Preventive action is the specific action or actions taken to prevent or reduce the likelihood of future occurrences of nonconformance. Examples of preventive actions are clarifying or refining procedures, allowing for additional training, and/or enhancing monitoring.

Preventive action measures will be selected to prevent or reduce the likelihood of future occurrences and will address root causes to the extent identifiable. Selected measures will be appropriate in relation to the seriousness of the nonconformance and will be realistic in terms of the resources required to implement them. Preventive action measures will be communicated with affected staff, and a record of preventive action taken shall be documented as part of the NCR and maintained for project record.

1.2.6 Trend and Root Cause Analysis

1.2.6.1 Trend Analysis

As necessary, the PM or designee, as a part of a periodic assessment, shall perform a project trend analysis. QC personnel shall verify the implementation of any preventive actions resulting from the trend analysis.

This management assessment shall propose and initiate measures necessary to deal with any problems requiring preventive action. When preventive action necessitates a revision to the project procedures, the PM (or designee) shall issue an administrative FCR describing the necessary change. QC personnel shall verify implementation of the preventive action.

The operations project team reviews results from the following sources and performs a trend analysis, when sufficient information and data are available to ensure that the analysis is meaningful. A trend analysis should be conducted once at least every six months for projects of one year or longer duration.

The trend analysis of QC and/or Quality Assurance (QA) audits, subcontractor/supplier surveillance reports and nonconformance will include the following information:

- Total number of audit findings and observations, surveillance reports, and NCRs for each area of the QCP
- A summary of the root causes for the nonconformance consolidated for each area of the QCP
- Trends that are developing or that have developed

1.2.6.2 Root Cause Analysis

The operations project team appointed by the PM shall determine root cause of a severity level 1 nonconformance. The root cause determination will depend upon project specific factors impacting the product development, product conformity or process performance. The nonconformity may be classified using an event and causal factors following the root cause analysis. The root cause analysis shall identify corrective actions to prevent recurrence. The record of the root cause analysis and corrective action taken shall be maintained on file with QC personnel as a part of the project record.

1.2.6.3 Preventive Action

For the period under review, the project operations team shall determine the root cause(s) of potential repetitive nonconformities and evaluate the need for action to prevent their recurrence. The project operations team shall prepare a report identifying the nonconformities for each area of the project processes/procedures, a consolidated summary of root causes of the nonconformities, and a statement of trends that are developing or have developed, and submit the report to the PM. The PM shall provide appropriate actions to prevent recurrence of the adverse trends. The project team and QC personnel shall verify implementation of the preventive actions and report the results to the PM. The record of trend analysis and preventive action taken shall be maintained on file by QC personnel as a part of the project record.

1.2.7 Lessons Learned

During the course of field activities, data or information may be discovered that could eliminate or reduce challenges and/or offer opportunities for quality and productivity improvements through value engineering. Lessons learned are documented and communicated as soon as possible to allow access by project personnel. These lessons learned are considered valuable tools in updating plans and procedures for subsequent field activities. Lessons learned will be reviewed and distributed by the AECOM Project Quality Manager (PQM) to other applicable AECOM project locations.

1.2.8 Field Change Request Form Process

An FCR form is to be completed for initiating changes to an approved, documented process. Any field team member assigned to perform or supervise a task that recognizes the necessity for a change in the task is responsible for initiating, completing, and submitting the FCR for review and approval of appropriate field changes. The FCR process includes review and approval of the recommended change by the Field Team Lead, PQM, Health & Safety Officer (as appropriate), PM and appropriate client representatives prior to process alteration in the field and incorporation into a revised work plan element. The client may ask that the FCR be reviewed by appropriate regulatory personnel if it is deemed to be a significant change to a process or overall scope of work. When an FCR is approved, changes to procedures will be reviewed with project personnel during the morning meeting/safety briefing prior to implementation. FCRs will be numbered sequentially and will be maintained in the project files on-site. FCRs will be included as an appendix to the Final Report Supplement.

FCRs should be approved or disapproved in no more than one week.

Field Sampling Standard Operating Procedure (SOP) MC-2

Decontamination

2.1 PURPOSE AND SCOPE

This document defines the standard operating procedure (SOP) for decontamination. This procedure is to be used together with the Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) and the other SOPs. Health and safety procedures and equipment for the investigation are detailed in the Site Safety and Health Plan (SSHP). Applicable SOPs are listed below:

- SOP MC-4 Incremental Sampling
- SOP MC-5 Field XRF Screening
- SOP MC-6 Surface and Subsurface Soil Sampling

2.1.1 Site and/or Sample Cross-Contamination

The overall objective of a multimedia sampling program is to obtain samples that accurately depict the chemical, physical, and/or biological conditions at the sampling site. Extraneous contaminants can be brought onto the sampling location and/or introduced into the medium of interest during the sampling program (e.g., using sampling equipment that is not properly or fully decontaminated). Trace quantities of contaminants can consequently be captured in a sample and lead to false positive analytical results and, ultimately, to an incorrect assessment of the contaminant conditions associated with the site. Decontamination of sampling equipment (e.g., all non-disposable equipment that will come in direct contact with samples) and field support equipment (e.g., vehicles) is, therefore, required prior to, between, and after uses to ensure that sampling cross-contamination is prevented and that on-site contaminants are not carried off-site.

2.2 EQUIPMENT DECONTAMINATION PROCEDURES

The following sections present equipment decontamination procedures and necessary equipment.

2.2.1 Equipment List

The following is a list of equipment that may be needed to perform decontamination:

- Brushes
- Wash tubs
- Buckets
- Scrapers, flat bladed
- Hot water - high-pressure sprayer
- Sponges or paper towels
- Alconox detergent (or equivalent)
- Potable tap water

- Laboratory-grade de-ionized water
- Garden-type water sprayers
- Appropriate health and safety equipment (i.e., nitrile gloves, safety glasses, etc.)
- Appropriate Investigative derived waste (IDW) containers

2.2.2 Decontamination

This section presents the procedures for decontamination of equipment.

2.2.2.1 Sampling Equipment

The following steps will be used to decontaminate sampling equipment:

1. Personnel will dress in suitable safety equipment to reduce personal exposure as required by the SSHP.
2. Gross contamination on equipment will be scraped off at the sampling or construction site.
3. Equipment that cannot be damaged by water will be placed in a wash tub containing Alconox or low-sudsing non-phosphate detergent along with potable water and scrubbed with a bristle brush or similar utensil. Equipment will be rinsed with tap water in a second wash tub followed by a de-ionized water rinse.
4. Equipment that may be damaged by water will be carefully wiped clean using a sponge and detergent water and rinsed with de-ionized water. Care will be taken to prevent equipment damage.

Following decontamination, equipment will be placed in a clean area or on clean plastic sheeting to prevent contact with contaminated soil. If the equipment is not used immediately after decontamination, the equipment will be covered or wrapped in plastic sheeting, foil, or heavy-duty trash bags to minimize potential contact with contaminants.

2.2.2.2 Equipment Leaving the Site

Vehicles used for activities in non-contaminated areas shall be cleaned on an as-needed basis, as determined by the site safety officer, using soap and water on the outside and vacuuming the inside. On-site cleaning will be required for very dirty vehicles leaving the area.

2.2.2.3 Decontamination Solutions

A decontamination solution should be capable of removing, or converting to a harmless substance, the contaminant of concern without harming the object being decontaminated. The preferred solution is a mixture of detergent and water, which is a relatively safe option compared to chemical decontaminants. A solution recommended for decontaminating consists of 1 to 1.5 tablespoons of Alconox per gallon of warm water. Skin surfaces should be decontaminated by washing with hand soap and water. The decontamination solution must be changed when it

no longer foams or when it becomes extremely dirty. Rinse water must be changed when it becomes discolored, begins to foam, or when the decontamination solution cannot be removed.

2.2.2.4 Responsible Authority

Decontamination operations at each hazardous waste site shall be supervised by the site safety officer. The site safety officer is responsible for ensuring that all personnel follow decontamination procedures and that all contaminated equipment is adequately decontaminated. The site safety officer is also responsible for maintaining the decontamination zone and managing the wastes generated from the decontamination process.

Site activities should be conducted with the general goal of preventing the contamination of people and equipment. Bagging monitoring instruments, avoiding contact with obvious contamination, and employing dust suppression methods are all procedures that would reduce the probability of equipment becoming contaminated and, therefore, reduce the need for and extent of decontamination. However, some type of decontamination will always be required on site. A sample personnel decontamination set-up guideline and a sample decontamination equipment and supplies list are included in the SSHP.

The Occupational Safety and Health Administration (OSHA) requires that proper personal protective equipment (PPE) must be worn when operating steam or pressure washing equipment. A rain suit, boots, hard hat, and a face shield are recommended to be worn. All personnel must be kept out of the path of steam or water spray.

2.2.2.5 Wastewater

Liquid wastewater from decontamination may be containerized, labeled, and stored for later disposal as required by project specific requirements. Liquid wastewater from decontamination may be discharged to ground on a project specific basis following acceptance from the project team and stakeholders.

2.2.3 Emergency Decontamination

Hazardous waste facilities should also have in place emergency decontamination procedures, in order to prevent the loss of life or severe injury to site personnel. In the case of threat to life, decontamination should be delayed until the victim is stabilized; however, decontamination should always be performed first, when practical, if it can be done without interfering with essential lifesaving techniques or first aid, or if a worker has been contaminated with an extremely toxic or corrosive material that could cause severe injury or loss of life. During an emergency, provisions must also be made for protecting medical personnel and disposing of contaminated clothing or equipment.

2.2.4 Documentation

Sampling personnel will be responsible for documenting the decontamination of sampling and drilling equipment. The documentation will be recorded with waterproof ink in the sampler's

field notebook with consecutively numbered pages. The information entered in the field book concerning decontamination should include the following:

- Decontamination personnel
- Date and start and end times
- Decontamination observations
- Weather conditions
- IDW handling

Field Sampling Standard Operating Procedure (SOP) MC-3

Sampling, Handling, Documentation, and Tracking

3.1 PURPOSE

This document defines the SOP for sample handling, documentation, and tracking. This procedure is intended to be used together with the UFP-QAPP and other SOPs. Health and safety procedures and equipment for the investigation are detailed in the Accident Prevention Plan/Site Safety and Health Plan (APP/SSHP). Applicable SOPs are listed below:

- SOP MC-4 Incremental Sampling
- SOP MC-5 Field XRF Screening
- SOP MC-6 Surface and Subsurface Soil Sampling

3.2 SAMPLE IDENTIFICATION

Samples collected during site activities will have discrete sample identification numbers. These numbers are necessary to identify and track each of the many samples collected for analysis during the life of this project. In addition, the sample identification numbers will be used in the database to identify and retrieve the analytical results received from the laboratory.

Each sample is identified by a unique code that indicates the site name, sample matrix/method, sample location, sample unit, and sequential sample number (for duplicate, triplicate, and equipment blanks). Sample identification codes are found in UFP-QAPP Worksheet #18.

The sampling locations, sample type, and sample sequence identifiers are established prior to field activities for each sample to be collected. On-site personnel will obtain assistance in defining any special sampling requirements from the Project Manager.

3.3 SAMPLE LABELING

Sample labels are filled out as completely as possible by a designated member of the sampling team prior to beginning field sampling activities each day. All sample labels are filled out using waterproof ink. At a minimum, each label will contain the following information:

- Sampler's company affiliation
- Site location
- Sample identification code (i.e., FPIS01)
- Date and time of sample collection
- Analyses required
- Method of preservation (if any) used
- Sample matrix (i.e., soil)
- Sampler's signature or initials

3.4 SAMPLE HANDLING

This section discusses proper sample containers, preservatives, and handling and shipping procedures. The UFP-QAPP summarizes the information contained in this section and also includes the sample holding times for each analyte.

3.4.1 Sample Containers

Certified, commercially clean sample containers are obtained from the contract analytical lab. The contract laboratory will label the bottles to indicate the type of sample to be collected. Required preservatives are prepared and placed in the bottles at the laboratory prior to shipment to the site. Appropriate sample containers for the specific analyses required are listed in the UFP-QAPP.

3.4.2 Sample Preservation

Sample preservation efforts will commence at the time of sample collection and will continue until analyses are performed. Samples will be stored on ice at 4°C in coolers immediately following collection. The ice will be double bagged in plastic storage bags. Additional sample preservation requirements are listed in the UFP-QAPP. Chemical preservatives, if necessary, will be added to the sample containers by the laboratory prior to shipment to the field, unless otherwise specified in the UFP-QAPP.

3.4.3 Sample Handling and Shipping

The sample containers are wiped clean of all sample residue and then wrapped in protective packing material (bubble wrap) and taped. Samples will then be placed right side up in a cooler and surrounded with ice (double bagged using plastic bags). Additional protective packing material is used around the upright samples as necessary. A temperature blank provided by the contract laboratory is placed in each sample cooler shipped.

A chain of custody (COC) form will accompany each cooler. The COC is put in a plastic bag and attached to the inside lid of the cooler. The cooler lid is taped closed with a custody seal for delivery to the laboratory. Once the cooler has been packed and the COC has been secured inside the cooler, the cooler is sealed on both ends using several wraps of reinforced strapping tape. The tape should be applied from the back of the cooler and over the top of the cooler to pull the front of the cooler lid down. The wraps of strapping tape should cover the hinges of the cooler lid.

Once the strapping tape has been applied, two signed and dated custody seals will be place on two corners of the cooler. One custody seal will be placed on top of the strapping tape on one end of the cooler across the seam of the cooler and the cooler lid, on the front of the cooler. The other custody seal will be placed on top of the strapping tape across the seam between the cooler and cooler lid on the other end of the cooler, on the back of the cooler. The custody seals will be covered with one complete wrap of clear tape.

All water drain valves on the sample coolers will be sealed using duct tape to prevent leakage of any fluids from the cooler during shipment. Samples will be hand delivered or shipped by overnight express carrier for delivery to the analytical laboratory. All samples must be shipped for laboratory receipt and analyses within specific holding times. This may require daily shipment of samples with short holding times. The temperature of all coolers will be measured upon receipt at the laboratory.

3.4.4 Holding Times and Analyses

The holding time is specified as the maximum allowable time between sample collection and analysis and/or extraction, based on the analyte of interest and stability factors, and preservative (if any) used. Allowable holding times are listed in the UFP-QAPP. Chemical constituents that will be analyzed and other parameters to be measured during field investigations are identified in the UFP-QAPP.

3.5 SAMPLE DOCUMENTATION AND TRACKING

This section describes documentation required in the field notes, on the sample collection field sheets (SCFSs), on the daily quality control reports (DQCRs), and on the sample COC forms.

3.5.1 Field Notes

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded using pens with permanent waterproof ink in a permanently bound weatherproof field log book containing consecutively numbered pages.

The information in the field log book will include the following as a minimum:

- Project name
- Location of sample
- Sampler's printed name and signature
- Date and time of sample collection
- Sample identification code
- Description of samples (matrix sampled)
- Sample depth (if applicable)
- Number and volume of samples
- Sampling methods or reference to the appropriate SOP
- Sample handling, including filtration and preservation, as appropriate for separate sample aliquots
- Analytes of interest
- Field observations

- Results of any field measurements, such as depth to water, pH, temperature, and conductivity
- Personnel present
- Level of PPE used during sampling

Changes or deletions in the field book should be lined out with a single strike mark, initialed, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the sampler's memory.

Each page in the field books will be signed by the person making the entry at the end of the day, as well as on the bottom of each page. Anyone making entries in another person's field book will sign and date those entries.

3.5.2 Sample Collection Field Sheets (SCFS)

An SCFS for soil will be completed at each sampling location. The data sheet will be completely filled in. If items on the sheet do not apply to a specific location, the item will be labeled as not applicable or not required. The information on the data sheet includes the following:

- Sample location number
- Date and time of sampling
- Person performing sampling
- Type of sample
- Number of samples taken
- Sample identification number
- Preservation of samples
- Record of any QC samples from site
- Any irregularities or problems which may have a bearing on sampling quality

3.5.3 Daily Quality Control Report (DQCR)

Each sampling crew will also maintain DQCRs to supplement the information recorded in the field logbook. DQCRs will be maintained by members of the field sampling team and cross-checked for completeness at the end of each day by the sampling team members and/or Field Manager. They will be signed and dated by individuals making entries and initials by the reviewer upon completion. Copies of the DQCR will be forwarded to the Quality Assurance Officer for review. The DQCR will include the following information:

- Project name
- Project number
- Personnel on site

- Visitor on site
- Subcontractors on site
- Equipment on site
- Weather conditions
- Field work performed
- Quality control and health and safety activities
- Problem, down time, and standby time
- Name and title of person completing the DQCR

3.5.4 Sample Chain of Custody (COC)

During field sampling activities, traceability of the sample must be maintained from the time that the samples are collected until laboratory data are issued. Initial information concerning collection of the samples will be recorded in the field log book as described above. Information on the custody, transfer, handling, and shipping of samples will be recorded on a COC form. The COC is a three-part carbonless form.

The sampler will be responsible for initiating and filling out the COC form. The sampler will sign the COC when the sampler relinquishes the samples to anyone else. One COC form will be completed for each cooler of samples collected daily. The COC will contain the following information:

- Sampler's signature and affiliation
- Project number
- Date and time of collection
- Sample identification number
- Sample type
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times
- Method of shipment
- Shipping air bill number (if appropriate)

The person responsible for delivery of the samples to the laboratory will sign the COC form, retain the last copy of the three-part COC form, document the method of shipment, and send the original and the second copy of the COC form with the samples. Upon receipt at the laboratory, the person receiving the samples will sign the COC form and return the second copy to the Project Manager. Copies of the COC forms documenting custody changes and all custody

documentation will be received and kept in the central files. The original COC forms will remain with the samples until final disposition of the samples by the laboratory. The analytical laboratory will dispose of the samples in an appropriate manner 60 to 90 days after data reporting. After sample disposal, a copy of the original COC will be sent to the Project Manager by the analytical laboratory to be incorporated into the central files.

Field Sampling Standard Operating Procedure (SOP) MC-4

Incremental Soil Sampling

For incremental composite sampling, multiple grab samples are collected over an area of interest or a decision unit (DU) and composited into a single large volume sample. Samples are collected randomly over the DU and these sample increments are composited to obtain an approximately 1 kilogram (kg) sample. The benefit of incremental sampling is that it yields a better estimate of an average concentration of analyzed parameters than would mathematical averaging of discrete samples. A limitation is that it does not provide location-specific concentrations that might be used for determining volume of soil in a remedial action such as excavation or treatment.

This SOP provides descriptions of equipment, field procedures, and QA/QC procedures to be implemented for using incremental sampling (IS) to collect samples. Specific sample locations will be determined in the field and frequency of collection is presented in the UFP-QAPP. The procedures in this SOP are to be used with the UFP-QAPP and other appropriate SOPs. Applicable SOPs referenced by this SOP are listed below:

- SOP MC-2 Decontamination
- SOP MC-3 Sample Handling, Documentation, and Tracking
- SOP MC-6 Surface and Subsurface Soil Sampling

4.1 INCREMENTAL SAMPLING DESCRIPTION

The following sections detail the equipment needed and the procedures to be followed to implement IS.

4.2 EQUIPMENT LIST

The following general list of equipment will be needed to collect IS soil samples:

- Volumetric soil sampler (i.e., soil probe, hand auger, or 5-gram Terra Core®)
- Magnetic locator (if required)
- Surveyor's flags
- Tape rule marked in 0.01-foot increments
- Field books/field log sheets
- Stainless-steel knives and bowls
- 1-gallon zip sealing bags
- Sample bottle labels
- Label tape (clear)
- Paper towels
- Camera

- Waterproof and permanent marking pens
- Grease pencil or paint pen
- Plastic sheeting
- Nitrile gloves (several boxes, appropriate sizes)
- Handheld global positioning system (GPS) unit
- Handheld pushbutton counter
- Location data and/or figure for sample areas
- Plastic trash bags
- Appropriate health and safety equipment, as specified in the SSHP
- Appropriate decontamination supplies, as specified in SOP MC-2
- Cooler with ice

4.3 DECONTAMINATION

Before any sampling begins, the sampling equipment will be decontaminated according to the procedures contained in SOP MC-2. Sampling equipment will be decontaminated between sampling activities for different Decision Units (DU), but decontamination of sampling equipment will not be required between collecting soil increments within one DU or Sampling Unit (SU).

4.4 INCREMENTAL SAMPLING PROCEDURES

IS will be completed using a systematic-random sampling approach. The DU boundary is typically determined by considering the investigative objectives, soil type, and analytes of concern. The illustrations depict the typical DU configuration for a small-arms range (**Figure 4-1**). If more detail is required a DU can be further subdivided into SUs (**Figure 4-2**).

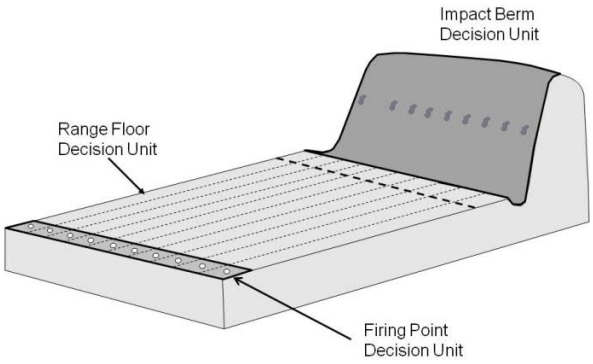

Figure 4-1
Typical DU

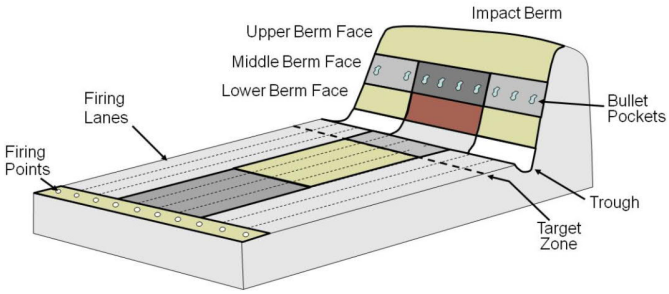

Figure 4-2
DU Subdivided into SUs

The first step will be to mark the boundaries of the DU(s) or SU(s). After the boundaries have been marked, soil samples consistent with systematic-random sampling design IS protocol (**Figure 4-3**) will be collected by a soil sampling person accompanied by a munitions and explosives of concern (MEC) avoidance technician. The MEC avoidance technician will use a magnetic locator to assist with identifying potential MEC at sampling locations. After each sampling location has been cleared, a soil aliquot will be collected. Sampling locations will be adjusted if anomalies are detected. This process will be repeated until all aliquots within a DU/SU have been collected.

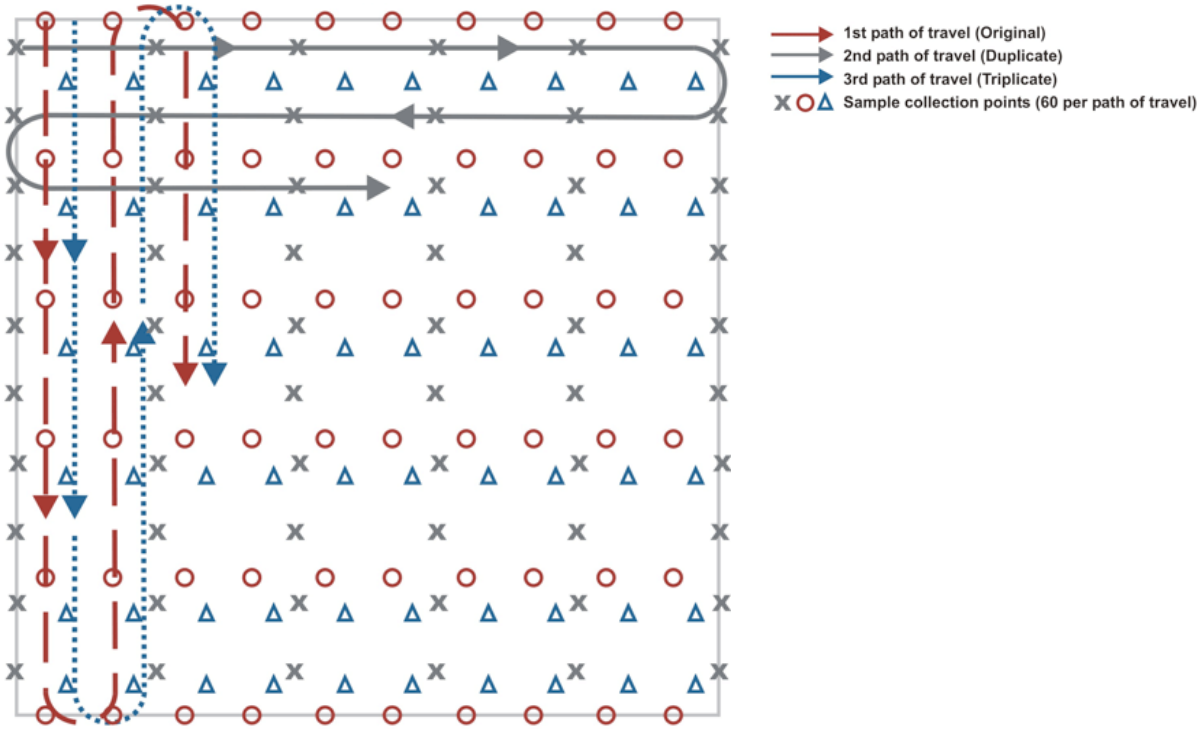

Figure 4-3
Systematic-Random Sampling Design
(ITRC, 2012)

4.4.1 Marking of DUs/SUs and Sampling Locations

The boundaries of each DU/SU will be marked prior to sampling. The boundaries will be marked in such a way that field personnel will not collect any samples outside the DU/SU boundaries. The following procedures will be used by the field crews to locate and mark the DU/SUs in the field:

1. The list of geo-referenced corner coordinates of the DU/SU will be provided to the field crew.

2. The field crew will locate the corners of the DU/SU at a given AOC/site by using a GPS with sub-meter accuracy.
3. Once located in the field, the DU/SU corners will be marked by placing a surveyor's flag into the ground. The DU/SU corners will be clearly marked on the flags with a grease pencil or paint pen to denote the site name and DU/SU.
4. Once the DU/SU corners are flagged, colored twine or cord will be stretched between corners to visibly mark DU/SU boundaries. This will ensure the soil aliquots are collected within the boundary.
5. Once the boundaries of a DU/SU have been marked, a soil sampler (accompanied by a MEC avoidance technician) will choose, access, and collect soil samples from the sampling locations.

4.4.2 Sample Collection

For the planned IS as part of this RI, stainless steel hand tools (either an auger or soil probe) will be used. Incremental samples will be collected from the 0 to 0.5-foot interval using the following procedure:

1. The MEC avoidance technician will clear each sampling location immediately prior to sampling and will offset the sample location as necessary to avoid any metallic anomalies.
2. Collect the aliquot using a soil probe or hand auger.
3. Using a 5-gram sampler, collect 5 grams of soil from the 0.5 foot interval. Add the sample to the bag. Increments shall be collected with the same sampling device in order to target a fixed volume per increment and achieve the desired sample mass.
4. Label the sample containers and place on ice, complete the COC, and pack the cooler(s) for shipment.

4.4.3 Sample Processing and Analysis

All collected IS soil samples will be processed by the laboratory following similar methods to those described in Appendix A of EPA Method 8330B. A copy of the contract analytical laboratory's SOP for IS sample processing under Method 8330B is contained in the UFP-QAPP. Required analyses for each collected IS sample are specified in the UFP-QAPP.

4.4.4 Field QA/QC Procedures and Samples

Duplicate and triplicate samples will be collected as specified in the UFP-QAPP to evaluate IS sampling variability in a similar manner as the primary sample. The duplicate and triplicate samples will require the same number of aliquots as the primary sample. Appropriate sample volumes will be collected for laboratory matrix spike/matrix spike duplicates (MS/MSD) analysis on identified primary samples (**Section 4.4.4.1** below). Equipment blank samples will also be collected from decontaminated non-disposable sampling equipment. No other IS QA/QC samples are planned for the RI.

4.4.4.1 Matrix Spike and Matrix Spike Duplicates (MS/MSD)

MS/MSD are used to assess the potential for matrix effects. Samples will be designated for MS/MSD analysis on the COC form and on the bottles. For IS sampling, the laboratory will use soil from the processed IS samples for the MS/MSD.

4.4.5 Sample Identification, Handling, and Documentation

Samples will be identified, handled, and recorded as described in this SOP and SOP MC-3. The parameters for analysis and preservation are specified in tables contained in the UFP-QAPP.

4.4.6 Documentation

Each field activity must be properly documented to facilitate a timely and accurate reconstruction of events in the field (see SOP MC-3). A SCFS will be completed for each IS soil sample submitted for chemical analysis.

4.4.6.1 Field Logbook

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation and not documented on the boring log will be recorded in a bound logbook with consecutively numbered pages. All entries in logbooks will be made in waterproof ink and corrections will consist of line-out deletions that are initialed and dated. Entries in the logbook will include the following, as applicable:

- Project name and number
- Sampler's name
- Date and time of sample collection
- SU grid layout, quadrant sampling locations, and increment collection locations and depths
- Sample number, location, and depth
- Sampling method
- Observations at the sampling site
- Unusual conditions
- Information concerning drilling decisions
- Decontamination observations
- Weather conditions
- Names and addresses of field contacts
- Names and responsibilities of field crew members
- Names and titles of any site visitors

- Location, description, and log of photographs (if taken)
- References for all maps and photographs
- Information concerning sampling changes, scheduling modifications, and change orders
- A detailed description of IS sampling activities including increment and grid information
- Summary of daily tasks and documentation on any scope of work changes required by field conditions
- Signature and date by personnel responsible for observations

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook for a particular site. A site-specific logging procedure will be developed to include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel. The logbooks will be kept in the field team member's possession or in a secure place during the investigation. Following the investigation, the logbooks will become a part of the project file.

4.4.7 Sample Collection Field Sheets (SCFS)

An SCFS will be completed at each SU. The data sheet will be completely filled in. If items on the sheet do not apply to a specific location, the item will be labeled as not applicable or not required. Sheets will not be completed for each aliquot, just for the final composite sample. The information on the data sheet includes the following:

- Sample location number
- Date and time of sampling
- Person(s) completing sampling
- Type of sample
- Number of samples taken
- Sample identification number
- Preservation of samples
- Record of any QC samples from site
- Any irregularities or problems which may have a bearing on sampling quality

4.5 REFERENCES

Interstate Technology Regulatory Council (ITRC). 2012. *Incremental Sampling Methodology.* Technical and Regulatory Guidance. February.

United States Army Corps of Engineers. 2009. Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program. Environmental and Munitions Response Center of Expertise. Interim Guidance 09-02.

United States Army Corps of Engineers. 2013. Incremental Sampling Methodology (ISM) Implementation of Incremental Sampling (IS) for Metallic Residues. Engineer Research Development Center, ERDC TR-13-5. August.

Field Sampling Standard Operating Procedure (SOP) MC-5

Field X-ray Fluorescence Screening

5.1 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for the operation of a field x-ray fluorescence (XRF) instrument for measuring metals concentrations in soil.

5.2 MATERIAL

The following general list of equipment will be needed to conduct field XRF screening:

- Work Plan
- Personal protective equipment (PPE)
- Field logbook
- XRF instrument and manual
- 1-gallon clear plastic bags or 8-ounce clear glass jars
- Mylar (or similar) plastic sheeting
- Standard reference materials (SRM)

5.3 CALIBRATION

The following procedures should be used to calibrate the XRF instrument:

1. Prepare standard samples by filling XRF sample cups with SRMs and covering with Mylar (or similar) plastic sheeting. SRMs should span both below and above the expected range of sample concentration.
2. Check XRF equipment factory calibration by analyzing each SRM. Each SRM reading should be within 10% of the certified value for analytes of concern. Retain or copy supplier's calibration document in project file.
3. Calibration checks will occur before and after sampling and at least once every 4 hours of operation. All calibration checks will be documented in the field logbook.
4. SRMs will also be analyzed by reading concentrations through the same plastic bags being used for sampling. Document to show that reading through the plastic bag shows no analytical bias or interference.

5.4 FIELD OPERATIONS

The following procedures should be used when conducting field XRF screening:

1. Fill a 1-gallon plastic bag ½ to ¾ full or an 8 oz. glass jar completely full with the soil sample using hand auger, trowel, or by hand.
2. Thoroughly mix contents of sample bag being sure to break up aggregates of soil and discarding material >2mm in diameter. If necessary, run sample through 60-mesh sieve to

segregate and remove all large grains or use a rubber mallet to disaggregate sample within bag.

3. Per XRF instrument manufacturers specifications, ensure the sample collection time is set between 15 and 30 seconds per reading.
4. During XRF instrument use, when the radiation shutter is open:
    - do not place hands, feet, or other body parts in the radiation field
    - do not measure samples on a table or raised surface, radiation can travel through non-metal surfaces to objects/body parts below
    - do not look into the beam path
    - do not point the instrument at anyone
    - do not hold the instrument from the front
5. Collect, at minimum, four readings per sample by shooting XRF analyzer through the clear plastic bag. Ensure neither sample nor instrument moves during sample collection duration. The four reading locations should be randomly chosen to gather data representative of the entire sample.
6. The sample reading (metal concentration) and internal standard deviation (error) will be recorded for each reading and sample in the field logbook.
7. Co-located duplicate readings will be taken once every 10 samples.
8. After all XRF analyses, the soil samples will be returned to their initial field sampling locations.
9. Plastic sample bags will not be reused for multiple samples and will be disposed of as municipal waste.

5.5 PRECAUTIONS

The following precautions should be considered when conducting field XRF screening:

- If the sample taken has a moisture content >20%, the XRF readings may lose accuracy as the moisture within the sample can interfere with the incoming or outgoing x-rays. It is highly recommended that the sample be dried before collecting readings. Drying can occur in a warm ambient air environment or by heating with a toaster or conventional oven.
- The XRF instrument has a radioactive source and when in operation actively emits high energy x-rays. The instrument should always be used per the manufacturer's recommendations. Never point the instrument at another person or anything other than the sample in question during operation
- Radiation monitoring equipment should be used when handling or operating the XRF instrument. Radiation monitors or badges should be worn by all working with or near the instrument with the understanding that the maximum permissible whole-body dose of

occupational exposure is 5 Roentgen Equivalent Man (REMs) per year.

5.6 SAFETY

The U.S. Department of Agriculture's (USDA) Office of Homeland Security & Emergency Coordination, Radiation Safety Division has guidelines for the use and possession of portable X-ray fluorescence analyzers (XFAs). In addition to following the all recommendations for use outlined in the manufacturer's user manual, field personnel will conform to the following as specified by the USDA (USDA, 2017):

- All servicing or cleaning of an XFA involving exposure of the radioactive sources must be performed by the manufacturer or by an authorized representative of the manufacturer. Before removing the XFA from its place of storage, make sure it is locked in the transport case. When transporting the XFA in a vehicle, block and brace it to prevent shifting or movement, and lock the XRA in the vehicle when it is unoccupied. When the indicator light is flashing, and the shutter is open, the primary x-ray beam is on and radiation is being emitted from the front of the XFA.
- After completing each measurement, immediately close the radiation shutter. Always maintain the XFA under constant view and immediate control when it is not in storage. At job sites, do not walk away from the XFA when it is left on the ground. When the XFA is not in use at a temporary job site, it must be securely locked in the operator's vehicle (or other appropriate locked storage location). Return the XFA to its proper locked storage location at the end of the work shift.

5.7 REFERENCES

EPA Method 6200 – Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment

U.S. Department of Agriculture, Office of Homeland Security & Emergency Coordination Radiation Safety Division. Portable X-Ray Fluorescence Analyzer. https://www.dm.usda.gov/ohsec/rsd/xfa.htm, accessed January 2017.

Olympus Delta™ Family: Handheld XRF Analyzers (model DS2000) User Manual (shipped with equipment from supplier; see **Attachment A** for table of contents)

Attachment A

Olympus Delta™ Family: Handheld XRF Analyzers User Manual Table of Contents

CONTENTS - Page 1 of 3

CONTENTS - Page 2 of 3

CONTENTS - Page 3 of 3

Field Sampling Standard Operating Procedure (SOP) MC-6
Surface and Subsurface Sampling

6.1 PURPOSE AND SCOPE

This document defines the SOP for collecting surface soil samples. This SOP provides descriptions of equipment, field procedures, and QA/QC procedures implemented for the collection of surface soil samples. Specific sample locations and frequency of collection are presented in the UFP-QAPP. This procedure is intended to be used together with the UFP-QAPP and other SOPs. Health and safety procedures and equipment for the investigation are detailed in the SSHP. Applicable SOPs are listed below:

- SOP MC-3 – Sample Handling, Documentation, and Tracking
- SOP MC-2 – Decontamination

6.1.1 Reference Standards

Wherever an American Society for Testing and Materials (ASTM) designation is cited in this document, it shall mean the ASTM Standard Specification of that designation appearing in the "1994 Annual Book of ASTM Standards," published by the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania. "EM 1110-2-1906" refers to United States Department of the Army, "Engineering and Design, Laboratory Soil Testing," 30 December 1970.

6.2 PROCEDURES FOR SOIL SAMPLING

Surface soil samples will be collected using stainless-steel hand utensils or, for drilling rig borings, a stainless-steel split-spoon sampler. Surface soil samples will be collected from 0 to 0.5 feet below ground surface (bgs).

6.2.1 Equipment List

The following list of equipment will be needed to collect surface soil samples with hand utensils:

- Stainless-steel spoon or trowel
- Surveyor's stakes and flags
- Ruler marked in 0.1-foot increments
- Field books/field sheets
- Stainless-steel knife and bowl
- Sample bottles provided by the laboratory
- Sample bottle labels
- Label tape (clear)
- Paper towels

- Camera
- Waterproof and permanent marking pens
- Plastic sheeting
- Plastic bags
- Appropriate health and safety equipment, as specified in the SSHP
- Appropriate decontamination supplies, as specified in SOP MC-2
- Ice chest with ice

6.2.2 Decontamination

Before drilling or sampling begins, the drilling and sampling equipment will be decontaminated according to the procedures contained in SOP MC-2. Drilling and sampling equipment will be decontaminated between boring and sampling locations. Sampling equipment will also be decontaminated between collections of samples from different depths at the same location.

6.2.3 Surface Soil Sampling Procedures

This method of soil sample collection is to be used in situations where the bedrock is shallow or other conditions will not permit the use of auger or drilling methods. The following procedure should be used to collect shallow soil samples using hand utensils:

1. Decontaminate sampling equipment according to SOP MC-2.
2. Record the sample location on a site map and in the field logbook.
3. Don a clean pair of nitrile gloves.
4. Clear and remove vegetation and any surface debris such as rocks, as necessary.
5. Using a decontaminated spoon or trowel, remove soil from a 1 square foot area until the specified sampling depth is reached. Removed soil should be placed on plastic sheeting.
6. Collect the soil for the analytical parameters from the specified depth using a decontaminated stainless-steel sampling spoon. If more soil is necessary to fill the remaining sample jars, the area is to be expanded without increasing the depth.
7. Composite the soil by thoroughly mixing the soil from the sampling point in a decontaminated stainless-steel bowl with the sampling spoon. Fill the jar for the specified analysis. The required analyses and appropriate containers are listed in the UFP-QAPP.
8. Label, store and document sample according to SOP MC-3.
9. Record applicable information on the Sample Collection Field Sheet.
10. Identify the location for future reference using surveying stakes and flags.

6.2.4 Subsurface Soil Sampling Procedures (Direct Push)

Direct push samples will be collected using a dual tube sampling system. The outer rods in this system remain in the ground while the inner rod and sample liner are extracted to retrieve a soil sample from the desired interval. Soil samples may be collected continuously throughout the depth of the direct push boring or from discrete intervals. The direct push rods will be decontaminated between boring locations, but not between samples at the same boring since a new acetate liner is used for each sample.

At each sampling location, the assembled inner and outer rods will be advanced by a combination of hydraulic down pressure and percussion hammering. After the target depth is reached, the inner rod will be withdrawn and the liner filled with the soil sample will be retrieved.

The following procedures will be followed after the soil sample has been retrieved:

1. Don a clean pair of nitrile gloves.
2. Cut the acetate liner along the length of the sample and measure the recovery. Record the sampling interval and recovery on the drilling log.
3. Determine and identify the size of the recovered sample. This will be for soil classification and stratigraphic logging and may be used for chemical analysis.
4. Examine the soil sample and record the soil description on the drilling log in accordance with the Unified Soil Classification System (USCS).
5. Homogenize an approximate 1-foot interval of the soil sample by thoroughly mixing it in a stainless-steel bowl. Use the homogenized soil to fill the appropriate sample containers. Record the sample interval and analysis requested on the drilling log.
6. Label, store, transport, and document the samples according SOP MC-3.
7. Complete photographic documentation.
8. If no other samples will be collected from the boring, abandon the boring by backfilling the hole with hydrated granular bentonite. Pour the granular bentonite down the hole in approximate 1-foot to 2-foot lifts, and then pour approximately ½ gallon of potable water down the hole to hydrate the bentonite. Continue this from the bottom of the hole to the ground surface.

6.2.5 Subsurface Soil Sampling Procedures (Hand Auger)

Soil collected using a hand auger will be collected at 6-inch depth intervals using a stainless-steel hand auger. Procedures are listed below:

1. Decontaminate the hand auger and other sampling equipment according to SOP MC-2.
2. Don a clean pair of nitrile gloves.
3. Using a decontaminated hand auger handle and bucket, advance a borehole to the specified sampling depth. Place the recovered soil on plastic sheeting.

4. Record the sample interval, soil description (USCS), and required analysis on the drilling log.
5. Fill the sample containers with the soil sample from the appropriate depth interval.
6. If no other samples will be collected from the boring, abandon the boring by backfilling the hole with hydrated granular bentonite. Pour the granular bentonite down the hole in approximate 1-foot to 2-foot lifts, and then pour approximately ½ gallon of potable water down the hole to hydrate the bentonite. Continue this from the bottom of the hole to the ground surface.

6.2.6 Field Quality Assurance/Quality Control Procedures and Samples

Field Quality Assurance/Quality Control samples are designed to help identify potential sources of external sample contamination and to evaluate potential error introduced by sample collection and handling. All QA/QC samples are labeled with QA/QC identification numbers and sent to the laboratory with the other samples for analyses.

6.2.6.1 Duplicate Samples

Duplicate samples are samples collected to assess precision of sampling and analysis. For the soil sampling, a duplicate sample will be collected at the same time as the initial sample. The initial sample containers for a particular parameter or set of parameters will be filled first, and then the duplicate sample bottles for the same parameter(s), and so on until all necessary sample bottles for both the initial sample and the duplicate sample have been filled. The duplicate soil sample will be handled in the same manner as the primary sample. The duplicate sample will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory on the day it is collected. Duplicate samples will be collected for all parameters. The soil will be divided evenly and then homogenized separately. Duplicate samples will be blind to the laboratory.

6.2.6.2 Matrix Spikes and Matrix Spike Duplicates

Matrix spikes (MS) and matrix spike duplicates (MSD) are used to assess the potential for matrix effects. Samples will be designated for MS/MSD analysis on the chain of custody form and on the bottles. It may be necessary to increase the sample volume for samples where this designation is to be made.

6.2.7 Sample Identification, Handling, and Documentation

Samples will be identified, handled and recorded as described in this SOP and SOP MC-3. The parameters for analysis and preservation will be specified in the UFP-QAPP.

6.2.8 Documentation

Each field activity must be properly documented to facilitate a timely and accurate reconstruction of events in the field (see SOP MC-3). Sample Collection Field Sheets will be completed for all soil samples submitted for chemical analysis.

6.2.8.1 Field Logbook

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation and not documented on the boring log will be recorded in a bound logbook with consecutively numbered pages. All entries in logbooks will be made in waterproof ink and corrections will consist of line-out deletions that are initialed and dated. Entries in the logbook will include the following, as applicable:

- Project name and number
- Sampler's name
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Observations at the sampling site
- Unusual conditions
- Information concerning drilling decisions
- Decontamination observations
- Weather conditions
- Names and addresses of field contacts
- Names and responsibilities of field crew members
- Names and titles of any site visitors
- Location, description, and log of photographs (if taken)
- References for all maps and photographs
- Information concerning sampling changes, scheduling modifications, and change orders
- Summary of daily tasks (including costs) and documentation on any cost or scope of work changes required by field conditions
- Signature and date by personnel responsible for observations

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook for a particular site. A site-specific logging procedure will be developed to include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel. The logbooks will be kept in the field team

member's possession or in a secure place during the investigation. Following the investigation, the logbooks will become a part of the final project file.

Attachment B

AECOM Field Forms

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AECOM

Americas

Daily Tailgate Meeting

S3AM-209-FM5

Instructions: Conduct meeting prior to sending crews to individual tasks. Require attendance of all AECOM employees and subcontractors. Invite personnel from simultaneous operations for coordination purposes. Review scope of work and briefly discuss required and applicable topics**. This meeting is a daily refresher, not a full orientation**. Task-specific discussions associated with Task Hazard Assessment (THA) follow this meeting at the task location immediately before individual task is started.

AECOM Supervisor Name: **Phone Number:**	
AECOM SH&E Rep. Name: **Phone Number:**	
Meeting Leader:	

Date:	**Project Name/Location:**	**Project Number:**
Today's Scope of Work:		

Muster Point Location:	**First Aid Kit Location:**	**Fire Extinguisher Location:**	**Spill Kit Location:**

1. Required Topics	**2. Discuss if Applicable to Today's Work**
☐ Fitness for Duty requirements, all sign in / sign out	☑ ■ **Check ☑ as reviewed or mark ■ as not applicable**
☐ Required training (incl. task specific) completed and current	☐ ☐ Biological/ Chemical / Electrical Hazards
☐ SH&E Plan onsite - understood, reviewed, signed by all (incl. scope, hazards, controls, procedures, requirements, etc.)	☐ ☐ Ergonomics - Lifting, Body Position
☐ Pre-Job Hazard Assessments (JHA/JSAs) available and understood	☐ ☐ Lock Out/ Tag Out
☐ Task Hazard Assessments (THAs) are to be completed for each task immediately prior to conducting	☐ ☐ Short Service Employees - visual identifier and mentor/ oversight assignment
☐ STOP WORK Right & Responsibility- all task changes/changed conditions re-assess with THA	☐ ☐ Simultaneous/ Neighbouring Operations
☐ Requirement to report to supervisor any injury, illness, damage, near miss, unsafe act / condition	☐ ☐ Slip/ Trip/ Fall Hazards
☐ Emergency Response Plan – including muster point, first aid kit, fire extinguisher, clinic/hospital location	☐ ☐ Specialized PPE Needs
☐ Personal Protective Equipment (PPE) - Required items per hazard assessments in good condition / in use by all	☐ ☐ Traffic Control
☐ Equipment/machinery inspected (documented as required) and in good condition - operators properly trained/certified	☐ ☐ Waste Management/ Decontamination
☐ Work area set up and demarcation/ barricades in place to protect workers, site staff, and the public	☐ ☐ Weather Hazards / Heat Stress / Cold Stress
☐ Required checklists/records available, understood (describe):	☐ ☐ Subcontractor Requirements (e.g., JHAs, THAs, procedures, reporting, etc.)
☐ Lessons Learned / SH&E improvements (describe):	☐ ☐ Work Permits / Plans required (e.g., Fall Protection, Confined Space, Hot Work, Critical Lifts, etc.); in place, understood (identify/attach):
	☐ ☐ Other Topics (describe/attach):
	☐ ☐ Client specific requirements (describe):

3. Daily Check Out by Site Supervisor	
Describe incidents, near misses, observations or Stop Work interventions from today:	Describe Lessons Learned/ Improvement Areas from today:

The site is being left in a safe condition and work crew checked out as fit unless otherwise specified as above.

Site Supervisor Name	**Signature**	**Date** **Time** **(at end of day / shift)**

Worker Acknowledgement / Sign In Sign Out sheets applicable to this meeting are on reverse and, if applicable, attached.

All employees:

- **STOP WORK if concerned / uncertain about safety / hazard or additional precaution is not recorded on the THA.**
- **Be alert and communicate any changes in personnel or conditions at the worksite to the supervisor.**
- **Reassess task, hazards, & mitigations on an ongoing basis; amend the THA if needed.**

SITE WORKERS (including AECOM Contractors and Subcontractors): Your signature below means that you understand:

* The requirement to participate in creating, reviewing, & updating hazard assessments (THA) applicable to your task(s).
* The hazards & control measures associated with each task you are about to perform.
* The permit to work requirements applicable to the work you are about to perform (if it includes permitted activities).
* That no tasks or work is to be performed without a hazard assessment.
* Your authority & obligation to "Stop Work" intervene, speak up/ listen up.

Your initials (right columns) certify that you arrived & departed fit for duty, & have reported all incidents/near misses; meaning:

* You are physically and mentally fit for duty.
* You are not under the influence of any type of medication, drugs, or alcohol that could affect your ability to work safely.
* You are aware of your responsibility to immediately report any illness, injury (regardless of where or when it occurred), or impairment/fatigue issue to the AECOM Supervisor.
* You signed out as fit / uninjured unless you have otherwise informed the AECOM Supervisor.

Print Name & Company	Signature	Initials & Sign In Time	Initials & Sign Out Time
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit

(Attach additional Site Worker sign-in/out sheets if needed) Identify number of attached sheets: _____

SITE VISITOR / SITE REPRESENTATIVE

Name	Company Name	Arrival Time	Departure Time	Signature

AECOM

Americas

Task Hazard Assessment

S3AM-209-FM6

Customer	**Permit No.**
Location	**Job No.**
Description of Task	**Date**

Basic Task Steps (explain how the task will be carried out)	**Hazards** (identify all hazards and potential hazards)	**Risk** (initial)	**Precautions** (describe how that hazard will be controlled)	**Risk** (final)	**Initials**
			Highest Risk Index		

Review and attach to Tailgate Meeting as required. Number and attach additional pages if necessary.

Worker/Visitor acknowledgement and review of this content on back of this document.

Risk Matrix on Reverse

Originator _____ (Print Name) _____ (Signature)

Supervisor _____ (Print Name) _____ (Signature)

THIS FORM IS TO BE KEPT ON JOB SITE.

AECOM

WORKER SIGN ON

NAME (Please Print) SIGNATURE

I participated in the development and understand the content of this Task Hazard Assessment.

VISITOR SIGN ON

NAME (Please Print) SIGNATURE TIME

Risk Rating Matrix

Probability	Severity				
	5 - Catastrophic	4 – Critical	3 – Major	2 – Moderate	1 - Minor
5 – Frequent	25	20	15	10	5
4 – Probable	20	16	12	8	4
3 – Occasional	15	12	9	6	3
2 – Remote	10	8	6	4	2
1 - Improbable	5	4	3	2	1

Risk Rating (Probability x Severity)	Risk Acceptance Authority
1 to 4 (Low)	Risk is tolerable, manage at local level
5 to 9 (Medium)	Risk requires approval by Operations Lead/Supervisor & Safety Manager
10 to 25 (High)	Risk requires the approval of the Operations Manager & Safety Director

Severity – Potential Consequences				
	People	Property Damage	Environmental Impact	Public Image/Reputation
Catastrophic	Fatality, Multiple Major Incidents	>$1M USD, Structural collapse	Offsite impact requiring remediation	Government intervention
Critical	Permanent impairment, Long term injury/illness	>$250K to $1M USD	Onsite impact requiring remediation	Media intervention
Major	Lost/Restricted Work	> $10K to $250K USD	Release at/above reportable limit	Owner intervention
Moderate	Medical Treatment	> $1K to $10K USD	Release below reportable limit	Community or local attention
Minor	First Aid	</=$1K USD	Small chemical release contained onsite	Individual complaint

Probability		
Frequent	Expected to occur during task/activity	9/10
Probable	Likely to occur during task/activity	1/10
Occasional	May occur during the task/activity	1/100
Remote	Unlikely to occur during task/activity	1/1,000
Improbable	Highly unlikely to occur, but possible during task/activity	1/10,000

Task Hazard Assessment Follow-Up/Review.

First Break **Initial**

Lunch Break **Initial**

Second Break **Initial**

Emergency Meeting / Assembly Area

Emergency Contact #

Emergency Radio Channel

Area is safe and housekeeping completed at the end of task/shift.

Supervisor (print name)

Signature

Date: _____

AECOM Technical Services Inc.

DAILY QUALITY CONTROL REPORT

Report Number: _____
Project Title: _____
Location: _____
Contract/DO Number: _____

WEATHER	BRIGHT SUN	CLEAR	OVERCAST	RAIN	SNOW
TEMPERATURE	< 32	32 - 50	50 - 70	70-85	>85
WIND	STILL	MODERATE	HIGH		
HUMIDITY	DRY	MODERATE	HUMID		

Personnel \ Site Visitors On-Site

No.	Name	Hrs.	Affiliation	Location/Description of Work
a.				
b.				
c.				
d.				
e.				
f.				
g.				

Sampling equipment on site:

Type	Serial Number	Calibration Verification	Time	Parameter	Standard	Reading

Field Changes: YES_____ NO_____

If yes, filed Nonconformance and Corrective Action Report number (NCR No.):_____

Health & Safety (Briefing held, PPE, injuries, near misses, etc.)	
Work Performed (including sampling)	
QA Activities	**Daily Report**_____ **Review of COC**_____ **Track Progress Report against QAPP**_____
QC Activities	**# Duplicates**_____ **Equipment calibrated complete to standards**_____ **# Equipment Blanks**_____ **# MS/MSD**_____ **# Field Blanks**_____
Problems Encountered Resolved	
Additional Information	
Activities Scheduled for the Next Day	

Contractor Verification: On behalf of the contractor, AECOM, I certify 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, to the best of my knowledge, except as may be noted above.

_____ _____

Signature Date

Date:_____

AECOM Technical Services Inc.
Nonconformance and Corrective Action Report

Report Number:_____ **Location:**_____

Project Title:_____ **Contract Number:**_____

Description of Nonconformance and Cause:	
Proposed Disposition:	

Submitted by: _____ **Date:** _____

Approved by: _____

Actual Disposition approved by Project Manager:	
Implementation of Disposition assigned to:	

Completed by: _____ **Date:** _____

Verified by: _____ **Date:** _____

AECOM

Site ID: _____
Arrival Time: _____
Departure Time:_____

Soil Sample Collection Log

Site Name/Location: _____ Date: _____

On-Site Personnel: _____ Log Preparer: _____

Sample ID: _____

Soil Sample Characterization

Grain Size (%)	
Silt/Clay (<0.06 mm)	
Sand (0.06 – 2 mm)	
Gravel (2.64 mm)	
Cobble (64 – 256 mm)	
Organic Content	LOW / MED / HIGH
Color	
Moisture (%)	
Bullets or Bullet Fragments?	YES / NO

Sample Collection Tools Used: _____

Sample Types

☐ Incremental (always taken Triplicate)– No. of Increments: _____

☐Discrete – Depth interval: _____

XRF Result: _____

XRF Error: _____

Quality Control Samples

☐Duplicate ☐MS/MSDs ☐Field Blank ☐Equipment Blank ☐N/A

Notes:

_____

_____

_____

_____

_____

_____

AECOM

PHOTOGRAPHIC RECORD

Client Name:	**Site Location:**	**Project No.**
Army National Guard	Williston Local Training Area, North Dakota	60520956

Photo No. 1	
Location of Photo:	
Description:	

Photo No. 2	
Location of Photo:	
Description:	

Attachment C

Analytical Laboratory ELAP Certification and Standard Operating Procedures

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KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

SOP Number: CA-627
Revision History
Cover Page
Page 1

TITLE: TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020

Prepared By: George Brewer Date: 03/01

Approved By:

Group Supervisor: George Brewer Date: 04/02/01

Operations Manager: Jol C Butler Date: 3/29/01

QA Officer: Deborah J. Nadeau Date: 03.27.01

General Manager: Dennis P. Hurley Date: 04/03/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Changed acid solution conc. changed Run ID Naming convention added data reduction and reporting procedures updated standards tables (4-8) Updated Table 10 in include ISIS configuration	LAD	02-16-05	02-16-05
02	Sect. 4.2 - changed tebing size sect. 5 - changed acid conc.'s Sect. 7 - major changes to reflect current practises including reporting data in the metals database. Sect. 8 - major changes updating acceptance criteria. Updated Tables 1, 3 - 8, 10 & 11	LAD	04/06	04/06
03	Updated Tables 4, 5 and 6 with current standards. Updated Table 1 with serial dilution, Post Digestion Matrix spike, MSA, ICS-A, ICS-AB and IDL minimum frequency or criteria. Updated Sect. 8 regarding client specific requirements.	LAD	07/07	07/07
04	Section 7.18 - changed instrument identifier to reflect new instrument; section 8 - changed acceptance criteria and ICSAB analyte list; Table 1 - updated acceptance criteria and corrective action for QC. Table 3 - added all analytes to list - removed "for information only" list.	LAD	04/08	04/08
05	Updates to reflect changes from 6020 to 6020A. Added Hardness by calculation attachment. Added LLOQC requirement and criteria to Sect 8 and Table 1. Added criteria to analyze PQL Std. at beginning and END of run.	LAD	02/09	02/09

TITLE: TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
06	Sect. 8 and QC Tables - Added DoD QSM references and criteria. Section 10 - Added references. Tables 4 → 7 - Added information pertaining to CCV conc. change	LAD	08/09	08/09
07	Added Table 2 with DoD QSM ver. 4.1 QC requirements. Updated Section 4.1, Table 10 and Table 11 with new autosampler information.	LAD	04/10	04/10
08	Sect. 1.1 - Added definitions. Sect. 5.4.1, 4.2, 5.2 7.9, 7.10, 7.1, 7.16 and 9 8.7 - minor changes to reflect current practice. Sect. 9 - added MDL, LOD and LOQ information. Sect 10 - Added, ~~edited references~~. Updated Tables 1, 5, 6, 7, 8 and 9 edited references LAD 042512	LAD	04/12	04/12
09	Sect. 7 - Added reference to autosampler software, added printing calibration and removed printing of run summary	LAD	08/13	08/13
10	Sect. 7 - Updated for changes made in the Metals database for importing and handling data. Sect. 10 - updated and added references. Added Table 3 - DoD QSM 5.0 QC Requirements	LAD	06/14	06/14
11	Sect. 7, Table 1, 2, 3, 6, 8 & 11 - Updated to reflect change from 5 pt. to 2 pt. calibration. Table 7, 8 & 9 - Updated to reflect change in Aluminum PQL	LAD	04/16	04/16
12	Change title of Section 5.0. Update method referenced for NELAC + DoD. Minor additions/corrections to sections 3.0, 4.2, 7.3.5 and table 5.	LAD	09/17	09/17

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-627-12**, titled **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**
.

Recipient: _____ Date: _____

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-627-12**, titled **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

Recipient: _____ Date: _____

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

1.0 SCOPE AND APPLICATION

Inductively coupled plasma-mass spectrometry (ICP-MS) is applicable to the determination of sub-ppb (ug/L) concentrations of a large number of elements in water samples and in waste extracts or digests. When dissolved constituents are required, samples must be filtered and acid-preserved prior to analysis. No digestion is required prior to analysis for dissolved elements in water samples. Acid digestion prior to filtration and analysis is required for groundwater, aqueous samples, industrial wastes, soils, sludges, sediments, and other solid wastes for which total (acid-leachable) elements are required.

ICP-MS has been applied to the determination of over 60 elements in various matrices. Analytes for which EPA has demonstrated the acceptability Method 6020 in a multi-laboratory study on solid wastes are listed as “analytes” in Table 4. Instrument detection limits, sensitivities, and linear ranges will vary with the matrices, and operating conditions. If Method 6020 is used to determine any analyte not listed in Table 4, it is the responsibility of the analyst to demonstrate the accuracy and precision of the method in the waste to be analyzed. The analyst is always required to monitor potential sources of interferences and take appropriate action to ensure data of known quality.

An appropriate internal standard is required for each analyte determined by ICP-MS. Recommended internal standards are ^{6}Li, ^{45}Sc, ^{89}Y, ^{103}Rh, ^{115}In, ^{159}Tb, ^{165}Ho, and ^{209}Bi. The lithium internal standard should have an enriched abundance of ^{6}Li, so that interference from lithium native to the sample is minimized. Other elements may need to be used as internal standards when samples contain significant amounts of the recommended internal standards.

1.1 Definitions:

CCB - Continuing Calibration Blank - An analyte-free solution consisting of acidified reagent water used to verify calibration accuracy periodically during analysis.

CCV - Continuing Calibration Verification - A midrange standard used to verify calibration accuracy periodically during analysis.

Duplicate - A second aliquot of a sample that is prepared and analyzed in the same way as the original sample in order to determine the precision of the method.

ICB - Initial Calibration Blank - An analyte-free solution consisting of acidified reagent water used to verify calibration accuracy.

ICP-MS - Inductively Coupled Plasma Mass Spectrometry.

ICS - Interference Check Samples - Two standards (ICS-A and ICS-AB) used to verify the effectiveness of interference correction equations. Solution ICS-A contains only interferents (Al, Ca, Fe, Mg, Na, K, P, S, Mo, Ti, C, Cl) at high

concentrations; solution ICS-AB contains interferents at the same concentrations as well as analytes at low (20 ug/L) concentrations.

ICV - Initial Calibration Verification - A standard made from a source independent from the calibration standards and with analyte concentrations different from those in the CCV; used to verify the accuracy of the instrument calibration.

IDL - Instrument Detection Limit - The lowest concentration of an analyte that can be determined with 95% confidence.

Internal Standard - Pure analytes added to a sample, extract, or standard solution in known amounts and used to measure the relative responses of other method analytes that are components of the same sample or solution. Internal standards must be analytes that are not native to the sample.

LCS - Laboratory Control Sample - A standard or solid reference material that has been brought through the sample preparation process.

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

LOD – Limit of Detection – An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix-specific and is used for DoD QSM acceptance criteria.
LOQ – Limit of Quantitation.- The minimum concentration of a target analyte that produces a quantitative result within specified limits of precision and bias.

PB - Preparation Blank - Reagent water that has been brought through the sample preparation process.

Post-Digestion Spike - An aliquot of a sample to which a known amount of analyte has been added before analysis and after digestion, if digestion is required.

PQL - Practical Quantitation Limit - The lowest concentration of an analyte that is routinely reported by the laboratory; nominally three to five times the IDL.

Matrix Spike - An aliquot of a sample to which a known amount of analyte has been added before digestion.

Serial Dilution - The dilution of a sample by a factor of five. When corrected by the dilution factor, the measured analyte concentrations of the diluted sample should agree with those of the original undiluted sample within specified limits. Serial dilution may reflect the influence of interferents.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of, analysts experienced in ICP-MS analysis by USEPA Method 6020 who are knowledgeable in the recognition and in the correction of spectral, chemical, and physical interferences in ICP-MS. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, "Personnel Training & Documentation of Capability".

It is the responsibility of all Katahdin technical personnel involved in ICP-MS analysis by USEPA Method 6020 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented, and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

Samples, sample digestates, standards, and other reagents used in ICP analysis may contain high concentrations of acids and toxic metals. Spilled samples and reagents should be cleaned up from instrument and laboratory surfaces immediately.

Liquid argon represents a potential cryogenic and suffocation hazard and safe handling procedures should be employed at all times when handling liquid argon

tanks and fittings. Safety glasses and cryogenic-resistant gloves should be worn when changing or adjusting argon tanks.

The Agilent 7500 ICP-MS spectrometer is safety-interlocked to prevent user exposure to harmful electrical voltages, radio frequency emissions, ultraviolet radiation, high temperatures, and other hazards. At no time should the operator attempt to disable these interlocks or operate the instrument if any safety interlock is suspected to be disabled

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention and waste minimization techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Samples, sample digestates, standards, and other reagents used in ICP-MS spectrometry may contain high concentrations of acids and toxic metals. They should be disposed of in a manner appropriate to the types of hazards they present. All digested samples and excess reagents and standards should be disposed of in the satellite waste container for corrosive wastes (labeled “Waste Stream A”) that is located in the Metals Instrument lab. Further information regarding waste classification and disposal may be obtained by consulting Katahdin Analytical Environmental Health and Safety Manual and the Department Manager.

2.0 SUMMARY OF METHOD

2.1 Prior to analysis, samples that require total (“acid-leachable”) values must be digested using appropriate sample preparation methods (such as USEPA Methods 3005 - 3051).

2.2 USEPA Method 6020 describes the multi-elemental determination of analytes by ICP-MS. The method measures ions produced by a radio-frequency inductively coupled argon plasma. Analyte species originating in a liquid are nebulized and the resulting aerosol transported by argon gas into the plasma torch. The ions produced are entrained in the plasma gas and introduced, by means of a vacuum interface, into a mass spectrometer. The ions produced in the plasma are sorted according to their mass-to-charge ratios and quantified with a channel electron multiplier. Interferences must be assessed and valid corrections applied or the data flagged to indicate problems. Interference correction must include compensation for background ions contributed by the plasma gas, reagents, and constituents of the sample matrix.

3.0 INTERFERENCES

Isobaric elemental interferences in ICP-MS are caused by isotopes of different elements forming atomic ions with the same nominal mass-to-charge ratio (m/z). The Agilent 7500 ChemStation data system is used to correct for these interferences. This involves determining the signal for another isotope of the interfering element and subtracting the appropriate signal from the analyte isotope signal. Isobaric molecular and doubly-charged ion interferences in ICP-MS are caused by ions consisting of more than one atom or charge, respectively. Most isobaric interferences which could affect ICP-MS determinations have been identified. Examples include $ArCl^+$ ions on the As signal and MoO^+ ions on the cadmium isotopes. While the approach used to correct for molecular isobaric interferences is demonstrated below using the natural isotopic abundances from the literature, the most precise coefficients for an instrument must be determined from the ratio of the net isotope signals observed for a standard solution at a concentration providing suitable (<1 percent) counting statistics. Because the ^{35}Cl natural abundance of 75.77 percent is 3.13 times the ^{37}Cl abundance of 24.23 percent, the chloride correction for arsenic can be calculated (approximately) as follows (where the $^{38}Ar^{37}Cl^+$ contribution at m/z 75 is a negligible 0.06 percent of the $^{40}Ar\ ^{35}Cl^+$ signal):

Corrected ^{75}As signal (using natural isotopic abundances for coefficient approximations) = (m/z 75 signal) - (2.95) (m/z 77 signal) + (2.548) (m/z 82 signal) – (2.571) (m/z 83 signal), where the final term adjusts for any selenium contribution at 77 m/z.

NOTE: Arsenic values can be biased high by this type of equation when the net signal at m/z 82 is caused by ions other than $^{82}Se^+$, (e.g., $^{81}BrH^+$ from bromine wastes or ^{82}Kr from krypton contamination in the Ar).

Similarly:
Corrected ^{114}Cd signal (using natural isotopic abundances for coefficient approximations) = (m/z 114 signal) - (0.027) (m/z 118 signal) - (1.84)(m/z 108 signal),

where last 2 terms adjust for any tin or MoO^+ contributions at m/z 114.

NOTE: Cadmium values will be biased low by this type of equation when $^{92}ZrO^+$ ions contribute at m/z 108. Also, use of m/z 111 for Cd is even subject to direct ($^{92}ZrOH^+$) ions and indirect ($^{90}ZrO^+$) additive interferences when Zr is present.

NOTE: As for the arsenic equation above, the coefficients in the Cd equation are only illustrative. The most appropriate coefficients for an instrument can be determined from the ratio of the net isotope signals observed for a standard solution at a concentration providing suitable (<l percent) counting precision.

The interference correction equations that are used by this laboratory in performing USEPA Method 6020 are listed in Table 5. The accuracy of these types of equations is based upon the constancy of the observed isotopic ratios for the interfering species. Corrections that presume a constant fraction of a molecular ion relative to the “parent” ion have not been

found to be reliable, e.g., oxide levels can vary. If a correction for an oxide ion is based upon the ratio of parent-to-oxide ion intensities, the correction must be adjusted for the degree of oxide formation by the use of an appropriate oxide internal standard previously demonstrated to form a similar level of oxide as the interferent. This type of correction has been reported for oxide-ion corrections using ThO^+/Th^+ for the determination of rare earth elements. The use of aerosol desolvation and/or mixed plasmas have been shown to greatly reduce molecular interferences (the Agilent 7500 ICP-MS spectrometer employs spray chamber cooling to effect aerosol desolvation). These techniques can be used provided that method detection limit, accuracy, and precision requirements for analysis of the samples can be met.

3.1 Physical interferences are associated with the sample nebulization and transport processes as well as with ion-transmission efficiencies. Nebulization and transport processes can be affected if a matrix component causes a change in surface tension or viscosity. Changes in matrix composition can cause significant signal suppression or enhancement. Dissolved solids can deposit on the nebulizer tip of a pneumatic nebulizer and on the interface skimmers (reducing the orifice size and the instrument performance). Total solid levels below 0.2% (2,000 mg/L) are recommended to minimize solid deposition. An internal standard can be used to correct for physical interferences, if it is carefully matched to the analyte so that the two elements are similarly affected by matrix changes. The internal standard used should differ from the analyte of interest by no more than 50 amu. See Table 15 for a list of internal standards used. When the intensity level of an internal standard is less than 70 percent or greater than 120 percent of the intensity of the first standard used during calibration, the sample must be reanalyzed after a fivefold (1+4) or greater dilution has been performed.

3.2 Memory interferences can occur when there are large concentration differences between samples or standards that are analyzed sequentially. Sample deposition on the sampler and skimmer cones, spray chamber design, and the type of nebulizer affect the extent of the memory interferences that are observed. The rinse period between samples must be long enough to eliminate significant memory interference.

4.0 APPARATUS AND MATERIALS

4.1 Agilent 7500 ICP-MS system, consisting of the Agilent 7500 ICP-mass spectrometer and its controlling computer data station. The spectrometer is capable of providing resolution better than or equal to unit resolution at 10% peak height. The Agilent 7500 mass range of 2-260 amu exceeds the method requirement of 2- 240 amu. The Agilent 7500 ChemStation software allows automatic corrections for isobaric interferences and correction for internal standard responses as required by the method. All critical argon flows including nebulizer argon are under mass flow controller control and a peristaltic pump is used for sample introduction. Peripheral equipment includes a Elemental Scientific SC-4 PX

Fast Autosampler and Sample Introduction system, and Bullzip PDF printer set to print to file ICPMS_CP.pdf located in folder PDF_PRINTS on the desktop.

4.2 Peristaltic pump tubing – 3-stop ESI PVC flared black-black (0.76 mm ID) and orange-green-orange (0.38 mm ID). 2-stop ESI PVC flared red-red (1.14 mm ID).

4.3 15 ml 17x100 mm polypropylene or polystyrene disposable test tubes for samples and 50 ml polypropylene centrifuge tubes for standards.

4.4 Automatic adjustable-volume pipetters of suitable precision and accuracy. Calibrated Eppendorf Reference pipets and Finn digital pipets are appropriate.

4.5 Trace metal grade pipette tips.

4.6 Volumetric glassware or plasticware of suitable precision and accuracy.

4.7 Talc free vinyl gloves.

4.8 Argon gas supply (high purity grade gas or liquid, 99.99%).

4.9 For the determination of trace levels of elements, contamination and loss are of prime consideration. Potential contamination sources include improperly cleaned laboratory apparatus and general contamination within the laboratory environment from dust etc. A clean laboratory work area, designed for trace element sample handling must be used. Standards, samples and blanks should be exposed to the laboratory environment as little as possible. The use of preparation blanks and spikes should be used to verify the absence of sources of contamination and loss. If necessary, polypropylene sample tubes should be rinsed and stored in dilute acid prior to use.

NOTE: Chromic acid must not be used for cleaning glassware for trace metals analysis.

5.0 REAGENTS AND STANDARDS

5.1 Acids used in the preparation of standards and for sample processing must be of high purity. Redistilled acids are recommended because of the high sensitivity of ICP-MS. Mallincrodt/Baker “Instra-Analyzed” trace-metals grade acids are appropriate. It is important to match the acid concentration in standards and samples. Concentrations of antimony and silver between 50-500 ug/L require 1% (v/v) HCl for stability; for concentrations above 500 ug/L additional HCl will be needed. For this reason, it is recommended that antimony and silver concentrations in samples and standards be maintained below 500 ppb wherever possible. Acids are received in poly-coated glass bottles, and are stored under the hood in the Metals sample preparation laboratory at room temperature until use. All

acids are considered to have a shelf life of three years from date of receipt unless otherwise indicated by the vendor. Refer to the current revision of Katahdin SOP CA-105, Reagent and Solvent Handling, for further details.

5.2 Laboratory reagent grade water, trace metals free, equivalent to ASTM Type 1 (ASTM D 1193), >18 Megohm/centimeter resistivity.

5.3 Single element and multielement stock standard solutions – purchased standards prepared from high purity salts or metals, and supplied by the vendors with certificates of purity and analysis. Refer to Tables 6 and 7 for a listing of stock standards required, and to Table 8 for element concentrations in stock standards. Purchased stock standards are received in polyethylene containers and are stored in their original containers at room temperature in the Metals Standards Preparation Laboratory. All purchased stock standards are given an expiration date as indicated by the manufacturer. Refer to the current revision of Katahdin SOP CA-106, Standard Preparation, Documentation and Traceability, for further details.

5.4 Intermediate standard solutions – laboratory-prepared multielement standards that are used in the subsequent preparation of working standards. Refer to Table 7 for a listing of intermediate standards required and for preparation instructions. Refer to Table 8 for element concentrations in intermediate standards. Intermediate standards are stored at room temperature in acid-washed polyethylene containers in the Metals Standards Preparation Laboratory. Intermediate standards are assigned an expiration date of three months from the date of preparation, or the earliest expiration date of a component standard, whichever comes first. Refer to the current revision of Katahdin SOP CA-106, Standard Preparation, Documentation and Traceability, for further details.

5.5 Working standard solutions – laboratory-prepared multielement standards that are used to calibrate the instrument, to provide internal standardization through on-line addition, and to perform all necessary QC checks. Refer to Table 6 for a listing of working standards and for preparation instructions. Refer to Table 8 for element concentrations in working standards. Working standards are stored at room temperature in acid-washed polyethylene containers in the Metals Standards Preparation Laboratory. All working standards except the ICSA and ICSAB solutions are assigned an expiration date of three months from the date of preparation, or the earliest expiration date of a component standard, whichever comes first. The ICSA and ICSAB solutions are assigned an expiration date of one week from the date of preparation, or the earliest expiration date of a component standard, whichever comes first. Refer to the current revision of Katahdin SOP CA-106, Standard Preparation, Documentation and Traceability, for further details.

5.6 Blanks: Three types of blanks are required for the analysis. The calibration blank is used in establishing the calibration curve. The preparation blank is used to monitor for possible contamination resulting from the sample preparation procedure. The rinse blank is used to flush the system between all samples and standards.

5.6.1 The calibration blank consists of the same concentrations of the same acid(s) used to prepare the final dilution of the analyte calibration solutions (currently 1% HNO_3 and 0.5% HCl, v/v, in laboratory reagent grade water). Use of HCl for antimony and silver is cited in Section 5.1.

5.6.2 The preparation blank must be carried through the complete preparation procedure and contain the same volumes of reagents as the associated digested sample solutions.

5.6.3 The rinse blank consists of 4% HNO_3 and 0.5% HCl,v/v, in reagent water. Prepare a sufficient quantity to flush the system between standards and samples.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Samples to be analyzed for trace metals by ICP-MS should be collected and preserved as described in the following table.

Matrix	Container[1]	Collection Volume/ Weight	Preservation/ Treatment	Holding Time
Aqueous (total)	P, G	250 mL	HNO_3 to pH < 2	6 months
Aqueous (dissolved)	P, G	250 mL	Filter, HNO_3 to pH < 2	6 months
Solid	P, G	10 g	Cool, 4°C	6 months

[1] P = polyethylene or, G = glass

7.0 PROCEDURES

7.1 Instrument control and data acquisition are completely automated through the use of the Agilent Chemstation software. The main Chemstation screen is accessed by double-clicking the “ICP-MS Top” icon on the Windows desktop. Autosampler tables are edited by selecting “Edit Sample Log Table” from the Sequence menu in the Agilent Chemstation software. In the following discussion, software menu items that are to be selected are printed in boldface. The instrument operating conditions, acquisition parameters, acquisition masses, and internal standards for analysis USEPA Method 6020 are detailed in Table 12.

7.2 Turn on the argon supply at the tank and set the pressure to >700 kPa.

7.3 Turn on the water chiller/recirculator.

7.4 Verify that the exhaust hood is in operation.

7.5 Ensure that the internal standard solution bottle is adequately full. Consumption is approximately 2.5 mL/hour.

7.6 Verify that the rinse station reservoir has an adequate supply of reagent water.

7.7 Verify that the drain reservoir has adequate room to accept the day's drain waste. Empty the reservoir as necessary into an appropriate waste container (Waste Stream A) located in the Hazardous Waste Storage Area.

7.8 Inspect the peristaltic pump tubes for signs of flattening and wear, and replace them as necessary. Clamp the peristaltic pump tubes into the peristaltic pump.

7.9 Open ESI autosampler software by double-clicking the "ESI SC" icon. Open the Chemstation software by double-clicking the "ICP-MS Top" icon. Initiate the plasma by selecting **Instrument>>Instrument Control>>Plasma>>Plasma On** and allow the instrument to aspirate calibration blank solution for at least 45 minutes. During this warm-up, select **Tune>>Sensitivity>>Start** to start the instrument scanning the mass range. Verify that the flow of sample and internal standard solutions through the uptake lines and into the nebulizer is free from pulsations by introducing an air bubble into each line and observing its progress. Adjust the pump clamp tension on each line to obtain a constant, pulse-free flow.

7.10 After the 45 minute warm-up, check the responses of masses 82 and 83 to insure minimal krypton intereference with selenium. Mass 83 response should be < 2000 counts per second. Then aspirate the Instrument Tune Solution (10 ppb Li, Y, Ce, Tl) and check the responses and RSDs at masses 7, 89, and 205.

7.11 Generate a tune report by selecting **Tune>>File>>Generate Report**. Evaluate the tune report against the tune specifications listed in Table 12. If the tune passes all specifications, proceed to step 7.14.

7.12 If the tune report indicates unacceptable instrument performance for any parameter, initiate an autotune by selecting **Tune>>Autotune>>Run**. The Chemstation software will attempt to tune the instrument to meet the tune specifications, and will generate a new tune report after autotuning. Evaluate the new tune report against the tune specifications listed in Table 13.

7.13 Repeat step 7.12 until all tune specifications have been met. File the final tune report.

7.14 Aspirate the P/A tuning solution (see Table6) and run a P/A auto tune by selecting **Tune>>Tune>>P/A Factor>>Run**. This will calibrate the pulse and analog modes of the detector. File the P/A report with the Tune report.

7.15 Load the instrument analytical method and calibrations table for USEPA Method 6020 into memory by selecting:

Methods>>Load>>K1PTCAL16.M>>K1PTCAL16.C.

7.16 Edit the sequence template "K6020.S" to create an analytical sequence table listing all of the samples to be analyzed. To do this, select "Edit Sample Log Table" from the **Sequence** menu in the Agilent Chemstation software. Double-click **SMPL** from the menu at the top left. Fill in the sample table with sample IDs, vial numbers, analytical method (K1PTCAL16.M for all samples), dilution factors, and failure actions. When the sample table is complete, select **Print** to print this table. Close the "Edit Sample Log Table" window. Save the sample log table under a new name by selecting **Save** under the **Sequence** menu and then typing the name.

7.17 Load the autosampler racks according to the analytical sequence printout.

7.18 Select **Sequence>>Load and Run Sequence**, and select the appropriate autosampler sequence table from the displayed list. Enter the analyst's initials in the Operator box. Change data file name to appropriate designation. The protocol for naming data files is as follows: the 1st character is a letter that identifies the instrument ("J" for the Agilent 75000 ICP-MS), the 2nd character is a letter that identifies the year of the run ("G" for 2013, "H" for 2014, etc.), the 3rd character is a letter that identifies the month of the run ("A" for January, "B" for February, etc.), the 4th and 5th characters are numbers that identify the date of the run ("01" for the first day of the month, etc.), and the 6th character is a letter that sequentially identifies the run ("A" for the first run of the day on that instrument, "B" for the second run, etc.). For example, the run identified as "JGA16A" is the first run of the day that was performed on January 16, 2013, using the Agilent 7500 ICP-MS. Select **Run**. The instrument will analyze all samples in the order listed in the table. Analysis must proceed in the sequence described in Table 11 to ensure that all necessary quality control samples are analyzed at the appropriate frequencies. A minimum of three replicate scans is required for all standards and samples. Analysis always begins with the analysis of a calibration blank followed by at least one multielement calibration standard to calibrate the instrument. The system is flushed with rinse blank between each sample and standard, and each sample and standard is aspirated for at least one minute prior to the beginning of mass scanning.

7.19 Analysis continues with analysis of the initial calibration verification standard (ICV) and the initial calibration blank (ICB) to verify the accuracy of the calibration. Refer to Section 8 and Table 1 for additional information.

7.20 A practical quantitation limit standard (PQL) is analyzed at the beginning of the run to verify calibration accuracy at the reporting limit. Refer to Section 8 and Table 1 for additional information.

7.21 A continuing calibration verification standard (CCV) and a continuing calibration blank (CCB) must be analyzed at the beginning of the run, after every ten samples, and at the end of the run to verify the continued accuracy of the calibration. Refer to Section 8 and Table 1 for additional information.

7.22 Interference check standard solutions ICS-A and ICS-AB must be analyzed at the beginning of each run and every 12 hours to verify the adequacy of interference corrections. Refer to Section 8 and Table 1 for additional information.

7.23 All sample analytical results for a particular element that are bracketed (preceded or followed) by failing results in a calibration verification sample (ICV, ICB, CCV, or CCB) for that element must not be reported, except as noted in Sections 8.5, 8.6, and 8.9. The sample must be reanalyzed for the element in question.

7.24 All samples that exceed the linear dynamic range must be diluted and reanalyzed.

7.25 If dilutions of digested samples are performed, the measured element concentrations must be multiplied by the dilution factor prior to reporting. This is accomplished automatically by entering the dilution factor in the sample log table prior to initiation of analysis.

7.26 If an element has more than one monitored isotope, examination of the concentration calculated for each isotope, or the isotope ratios, will provide useful information for the analyst in detecting a possible spectral interference. Consideration should therefore be given to both primary and secondary isotopes in the evaluation of the element concentration. In some cases, secondary isotopes may be less sensitive or more prone to interferences than the primary recommended isotopes, therefore differences between the results do not necessarily indicate a problem with data calculated for the primary isotopes. In the case of Pb, quantitation is based on the sum of isotopes 206, 207 and 208 to compensate for any variation in naturally occurring isotope ratios. This is accomplished through the use of the interference correction equation for lead.

7.27 Calculations, aqueous samples: Final element concentrations for aqueous samples are reported in units of micrograms per liter (ug/L). The reported concentrations are calculated from measured digestate concentrations as follows:

$$\text{Concentration (ug/L)} = \frac{MC \times DF \times FV}{IV}$$

where: MC = Measured digestate concentration (ug/L)
DF = Instrument dilution factor
FV = Final digestate volume (L)
IV = Digested sample volume (L)

7.28 Calculations, solid samples: Final element concentrations for solid samples are reported in units of milligrams per kilogram (mg/kg) on a dry weight basis. The reported concentrations are calculated from measured digestate concentrations as follows:

$$\text{Concentration (mg/kg dry weight)} = \frac{MC \times DF \times FV \times 100}{W \times S}$$

where: MC = Measured digestate concentration (ug/L)
DF = Instrument dilution factor
FV = Final digestate volume (L)
W = Weight of digested wet sample (g)
S = Percent solids

DATA REDUCTION AND REPORTING

7.29 Follow these steps to create the data import file: Open the FileView program using the "FIVIEW" icon on the Windows Desktop. Select "Data" in left window. Select the data file of interest and double click to move the required samples into the "Process List". Make sure the "Corrected Data" box is checked. Click the "Process" button. The data will be displayed in a spreadsheet format.

7.30 Select "Configure" from the top menu and "Sublists" from the displayed options. Select "Load Sublist" and then select "K2008.sbl" from this list of options and click "open." Make sure the "Enable Sublist" box is checked. Click the "OK" button. This will display only the analyte masses in the spreadsheet.

7.31 Select "Quant Info" from the top menu and select "Quant Results" from the displayed options. This will display the data in concentration units.

7.32 Select the "Transpose" from the menu. Click on "file" within the chart to highlight the data.

7.33 Select "Tools" from the top menu and "Copy Selected Data to CSV File" from this list of options. Set the name to the file as "FileName.CSV", e.g., "JGA28A.CSV". Save the file to the ICP-MS DATA folder on metals on server_a.

7.34 Rename the pdf file to the appropriate file name in the PDF_Prints window and save to J-ICMS-Data file in My Network Places. Right click on ICPMS_CP.pdf icon to copy and paste blank file into PDF_Prints window for the next run.

To import data into the Metals Database:

7.35 Open the data file from metals on Server_a. Replace dashes in Cal Blank line with zeros. Replace dashes in Cal Std 1 line with 50 for most all elements. Change aluminum and silicon with 1000 and change sodium, magnesium, potassium, calcium, and iron with 10,000. All cells under metals with ###, replace with 999999. Save file in ICP-MS Data folder on Metals on Server a. Select the "ICPMS Import" icon from the Windows Desktop, the ICPMS Import window will appear. Enter the datafile name without extension, (e.g., "JGA28A") and click "ok."

7.36 When the “Import finished” message appears, close the ICPMS Import window and select the “KIMS_METALS” icon from the Windows Desktop. The Metals Database Main Menu will appear. Select Additional Data Handling and then select Accept Samples by Element. Type in file name and reject any items that fail run QC.

7.37 Select the “Reporting Menu” button. From the Reporting Menu screen select the Batch QC Menu button and then the “Calculate Batch QC” button.

7.38 From the resulting list of QC results, deselect any items that fail run QC. Click on the “Accept Selected Batch QC” button.

7.39 From the Metals Main Menu, select the “Additional Data Handling” button. The Data Menu will appear. Select the “Report Added Compounds” button.

7.40 From the resulting list of sample results, deselect any items that fail run QC. Click on the “Accept Data” button.

7.41 Once all associated data from an analysis run have been processed, go to the RUNLOG INFO table of the metals database. Sort for the file of interest. Add lines for the 6020 and 200.8 Method Tunes. Change the time column accordingly. Go to the Generate Coverage portion of the Export Menu and print the Run Log and Logbook Page for the analysis run.

7.42 To extract Tune Reports and P/A Factor Tuning Report click on metpdf on Imageserver icon. Select J-ICPMS Data folder and select file on interest. Select Document drop down menu>pages>extract>select page numbers and click ok. Close document and save in metdpdf on “imageserver (P:) in J-ICP-MS-INST Tune folder as Filename+Tune.

7.43 Remove “blanks” and “rinses” from pdf file by selecting Document drop down menu>pages>delete>select appropriate pages at the beginning and end of report. Save document with ”RAW” added to the end of the file name. Save in the “ICPMS DATA” section of the “METPDF” directory on the IMAGESERVER.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

USEPA Method 6020 requires the laboratory to perform specific quality control checks to assess laboratory performance and data quality. Minimum frequencies, acceptance criteria, and corrective actions for these control checks are tabulated in Table 1 and are described below. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific

judgments. These decisions are based on holding time considerations and client and project specific Data Quality Objectives. The Department Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

INITIAL DEMONSTRATION OF PERFORMANCE

8.1 Instrument detection limits (IDL) are determined quarterly for each analyte analyzed on each instrument. This determination requires seven replicate analyses of a reagent blank, performed on three non-consecutive days. The standard deviation of the 21 analyses is multiplied by three to obtain the IDL. For more information on performing IDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.2 Method detection limits (MDL) are determined annually for each analyte analyzed by each method on each instrument. This determination requires at least seven replicate digestions and analyses of reagent water spiked at 3-5 times the anticipated MDL for each analyte. MDLs differ from IDLs in that the seven replicates are digested prior to analysis, and they may be analyzed on a single day. The standard deviation of the 7 (or more) replicate analyses is multiplied by the Student's t-value to obtain the MDL. For more information on performing MDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.3 A Lower Limit of Quantitation Check (LLQC) sample must be prepared and analyzed annually or on an as-needed basis to confirm the laboratory's Practical Quantitation Limits (PQLs). The LLQC sample is equivalent to the PQL standard (Section 8.9) but is carried through the entire sample preparation and analysis process. Element recoveries for the LLQC sample must fall within 70% to 130% of the expected concentrations to confirm the previously established PQLs.

ANALYTICAL RUN QC SAMPLES

8.4 Initial instrument calibration: The instrument is calibrated by running a calibration blank and at least one multielement calibration standard. For each element,

calibration is performed fitting a single order equation to the calibration data, as follows:

$$Y=aX + [Blank]$$

where: Y = Concentration (ug/L)
X = Measured signal intensity (counts per second)
a = Slope of the calibration line
[Blank] = Measured signal intensity of the calibration blank

8.5 The intensities of all internal standards must be monitored for every analysis. When the intensity of any internal standard fails to fall between 70 and 120 percent of the intensity of that internal standard in the initial calibration standard, the following procedure is followed. The sample must be diluted fivefold (1+4) and reanalyzed with the addition of appropriate amounts of internal standards. This procedure must be repeated until the internal standard intensities fall within the prescribed window. The intensity levels of the internal standards for the calibration blanks (ICB and CCBs) and calibration verification standards (ICV and CCVs) must agree within ± 20 percent of the intensity level of the internal standard of the original calibration solution. If they do not agree, terminate the analysis, correct the problem, recalibrate, verify the new calibration, and reanalyze the affected samples.

8.6 An Initial Calibration Verification (ICV) solution is analyzed after the initial calibration to check calibration accuracy. The ICV solution is prepared by combining compatible elements from standard sources different than those of the calibration standards and at concentrations within the linear working range of the instrument. The results of the ICV must fall within 90% to 110% of the expected values. If the ICV fails, result for the failing elements may not be reported from the run, unless the ICV recovery is greater than 110% and the sample result is less than the PQL.

8.7 Continuing Calibration Verification (CCV) solutions are analyzed after the initial calibration, after every ten samples, and at the end of the analytical run. The CCV solution is prepared using the same standards used for calibration at concentrations near the mid-point of the calibration curve. Results of the CCVs must fall within 90% to 110% of the expected values. If a CCV fails, results for the failing elements in samples bracketed by the failing CCV may not be reported, unless the CCV recovery is greater that 110% and the sample result is less that the PQL. For DoD analyses, results may not be reported without a valid CCV or report flagged results if reanalysis is not possible.

8.8 A Practical Quantitation Limit (PQL) Check Standard or low level continuing calibration verification (LLCCV) is analyzed at the beginning of each run (after the ICV and ICB samples) and at the end of each run. Element concentrations in this solution are one-fifth the laboratory's practical quantitation limit (assuming a 5-fold dilution of all digestates during analysis). Element recoveries for the PQL Check Standard must fall within 70% to 130% of the expected values (unless the samples

analyzed are for the Department of Defense (80% to 120% recovery limits) or other client-specific limits are imposed). If the PQL Check Standard fails, results for the failing elements may not be reported from the run, unless the PQL Check Standard recovery is greater than the high limit and the sample result is less than the PQL.

8.9 A calibration blank solution is analyzed after each ICV and CCV. A calibration blank that is analyzed after the ICV is called an Initial Calibration Blank (ICB). A calibration blank that is analyzed after a CCV is called a Continuing Calibration Blank (CCB). The absolute values of results of ICBs and CCBs must be less than the applicable reporting limit (or PQL) for each element. The reporting limit should be determined on a project specific basis, taking into account the data quality objectives for the project. This information must be communicated through a project QAPP and through the Katahdin project manager. When no project specific reporting limit is specified, the laboratory PQL shall be used. Some project specific limits may require reporting down to the MDL or IDL and taking corrective action based on these levels. Results that fall between the PQL and the IDL or MDL must always be flagged as “estimated” with a “J”.

8.10 If an ICB or a CCB fails the acceptance criteria of less than the reporting limit, results for the failing elements may not be reported from the run until the problem is corrected and a passing ICB or CCB has been analyzed, with the following exception. If the result for an ICB or CCB is greater than the PQL (or reporting limit), sample results that are less than the PQL (or reporting limit) or that are greater than or equal to ten times the measured ICB or CCB concentration may be reported. Also, for failing elements, all samples analyzed after the last passing CCB must be reanalyzed, with the exception noted above.

8.11 To obtain analyte data of known quality, it is necessary to measure more than the analytes of interest in order to apply corrections or to determine whether interference corrections are necessary. If the concentrations of interference sources (such as C, Cl, Mo, Zr, W) are such that, at the correction factor, the analyte is less than the limit of quantitation and the concentration of interferents are insignificant, then the data may go uncorrected. Note that monitoring the interference sources does not necessarily require monitoring the interferent itself, but that a molecular species may be monitored to indicate the presence of the interferent. When correction equations are used, all QC criteria must also be met. Extensive QC for interference corrections are required at all times. The monitored masses must include those elements whose hydrogen, oxygen, hydroxyl, chlorine, nitrogen, carbon and sulfur molecular ions could impact the analytes of interest. Interference check solutions ICS-A and ICS-AB are analyzed at the beginning of each run and at least every 12 hours during the run to verify the effectiveness of interference corrections. Solution ICS-A contains high concentrations of interferents (Al, Ca, Fe, Mg, Na, P, K, S, C, Cl, Mo, and Ti) only. These should recover between 80% and 120% of the true value. The measured concentrations of other elements in this solution should be very low, indicating that interfering mass correction equations are adequate. Solution ICS-AB contains interferents at the same high

concentrations, and all other analytes at 20 ug/L. Measured recoveries for all analytes should be within 80% to 120% of the true values.

PREPARATION BATCH QC SAMPLES

8.12 Each digestion batch of twenty or fewer samples will contain a preparation blank and a laboratory control sample. Each batch will also contain one or more of the following QC samples: laboratory control sample duplicate, sample duplicate, matrix spiked sample, or matrix spiked sample duplicate.

8.12.1 A preparation blank (PBW or PBS), consisting of reagent water carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. The results of preparation blanks must be less than the Practical Quantitation Level (PQL) (or project specific reporting limit, if applicable) for each element. If a preparation blank fails, results for the failing elements may not be reported from the digestion batch, and all associated samples must be redigested, with the following exception. If the result for a preparation blank is greater than the PQL or reporting limit, associated sample results that are less than the PQL or reporting limit or that are greater than or equal to ten times the measured preparation blank concentration may be reported.

8.12.2 A laboratory control sample (LCSW, LCSO, or LCSS), consisting of spiked reagent water or a solid reference material carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. Results for laboratory control samples must fall within 80% to 120% of the expected value, unless vendor-supplied limits (for solid reference materials) or laboratory-generated statistical limits are available. If a laboratory control sample fails, results for the failing elements may not be reported from the digestion batch, and all associated samples must be redigested, with the following exception. If the recovery of a laboratory control sample is greater than 120%, associated sample results that are less than the PQL or reporting limit may be reported.

SAMPLE MATRIX QC SAMPLES

8.13 The relative percent difference (RPD) between matrix duplicate, matrix spike duplicate, or laboratory control duplicate sample results is calculated as follows:

$$RPD\ (\%) = \frac{|D_1 - D_2|}{(|D_1 + D_2|)/2} \times 100$$

where: D_1 = First sample or LCS result
D_2= Second (duplicate) sample or LCS result

A control limit of 20% RPD is applied to duplicate analysis, if the result is greater than 100 times the instrument detection limit. If the matrix duplicate analysis fails, the associated sample result must be flagged on the report of analysis.

8.14 The recovery for each element in a spiked sample must fall within 75% to 125% of the actual value if the result for the unspiked sample is less than four times the amount of spike added. If a recovery fails, the associated sample result must be flagged on the report of analysis. The spike recovery should be calculated as follows:

$$\text{Recovery (\%)} = \frac{S-U}{SA} * 100\%$$

where: S = Measured concentration of spiked aliquot
U = Measured concentration of unspiked aliquot
SA = Amount of spike added

8.15 A serial dilution is analyzed to check for chemical or physical interferences. If the analyte concentration of a sample is sufficiently high (minimally, 50 x IDL), the measured concentration of a five-fold dilution (1:5 dilution) of the sample should agree within 90% to 110% of the original determination. The percent difference between the original sample and the serial dilution should be calculated as follows:

$$\text{Difference (\%)} = \frac{|L-S|}{S} * 100\%$$

where: L = Serial dilution result (corrected for dilution)
S = Original sample result

If the serial dilution analysis fails, a matrix interference should be suspected. The action taken is dependent upon project requirements. The associated sample result may be flagged on the report of analysis, the sample may be reanalyzed at dilution to eliminate the interference, or a post-digestion spike may be performed (see section 8.16).

8.16 An analyte spike that is added to an aliquot of a prepared sample, or its dilution, should be recovered within 80% to 120% of the known value if the result for the unspiked aliquot is less than four times the amount of spike added. If the post-digestion spike is not recovered within these limits, the sample should be diluted and reanalyzed to compensate for the matrix interference or the method standard additions may be employed.

9.0 METHOD PERFORMANCE

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 value is above zero. The MDLs shall be determined and verified one time per type of instrument unless otherwise required by the method.

A Limit of Detection (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent. LODs must be determined for all parameters for which the laboratory is accredited under the DoD Environmental Laboratory Accreditation Program. LOD's must be verified for every preparation and analytical method combination and on every applicable instrument on a quarterly basis.

The Limit of Quantitation (LOQ) is the minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ shall be set at the lowest point in the calibration curve for all analyses utilizing an initial calibration. LOQ's must be verified quarterly for every preparation and analytical method combination and on every applicable instrument on a quarterly basis for all parameters included in the DoD Scope of Accreditation. The LOQ must be verified at least once annually if the analysis is not included in the DoD Scope of Accreditation.

MDLs are filed with the Organic Department Manager and then with the QAO. LOD and LOQ verifications are filed with the QAO. Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revisions of USEPA Method 6020 for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA SW846, 3rd Edition, Final Updates I, II, IIA, IIB, III, IIIA, IIIB and IV, February 2007, Method 6020A.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.1, January, 2017.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

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Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision

Agilent 7500 ICP-MS ChemStation Operator's Manual, Agilent Technologies, Inc., 2000.

List of Tables

TABLE 1

QC REQUIREMENTS

QC Sample	Minimum Frequency	Acceptance Criteria	Corrective Action
Initial Calibration, minimum 1 point plus a calibration blank.	Daily prior to sample analysis.	If more than 1 caibration std is used, correlation coefficient (r) $\geq$ 0.998	Recalibrate
Initial Calibration Verification (ICV),	Before beginning a sample run.	Recovery within $\pm$ 10% of true value.	Do not use results for failing elements, unless ICV >110% and

TABLE 1

QC REQUIREMENTS

QC Sample	Minimum Frequency	Acceptance Criteria	Corrective Action
prepared from a second source.			sample result < PQL/reporting limit.
Initial Calibration Blank (ICB)	Immediately after the ICV.	Absolute value of ICB < PQL or project specific reporting limit.	Do not use results if sample ≥ PQL/reporting limit and < 10x ICB level.
PQL Standard or LLCCV	At beginning and end of run	70-130% of true value	Do not use results for failing elements, unless PQL rec.> upper limit and sample result < PQL/reporting limit.
Continuing Calibration Verification (CCV)	At beginning of run, after every 10 samples, and at end of run.	Recovery within ± 10% of true value.	1) Do not use bracketed sample results for failing elements, unless CCV >110% and sample result < PQL/reporting limit. 2) Investigate and correct problem.
Continuing Calibration Blank (CCB)	Immediately after every CCV	Absolute value of CCB < PQL or project specific reporting limit.	Do not use sample results if ≥ PQL/reporting limit and < 10x CCB level.
Interference Check Solution A (ICS-A)	Before analyzing samples, and every 12 hours during a run.	Interferents: Recovery within ± 20% of true value. Analytes: No criteria established (Project specific criteria may apply)	Do not use sample results for failing elements.
Interference Check Solution AB (ICS-AB)	Before analyzing samples, and every 12 hours during a run.	Recovery within ± 20% of true value.	Do not use sample results for failing elements, unless ICSAB >120% and sample result < PQL/reporting limit.
Preparation Blank (PBW/PBS)	One per digestion batch of 20 or fewer samples.	Less than PQL (standard practice), or based on the project specific guidelines.	1) Investigate source of contamination. 2) Redigest and reanalyze all associated samples if sample concentration ≥ PQL and <10x the blank conc.
Laboratory Control Sample (LCSW/LCSS/LCSO)	At least one per digestion batch of 20 or fewer samples.	Recovery within ± 20% of true value, unless vendor-supplied or statistical limits have been established.	1) Investigate source of problem. 2) Redigest and reanalyze all associated samples, unless LCS >120% and sample result < PQL.
Duplicate Sample (D), Matrix Spike Duplicate (P), or LCS Duplicate (LC2W/LC2S/LC2O)	See section 8.11	1) RPD ≤ 20%, if sample > 100x IDL.	Flag results

TABLE 1

QC REQUIREMENTS

QC Sample	Minimum Frequency	Acceptance Criteria	Corrective Action
Post-Digestion Matrix Spike (A)	When serial dilution fails and analyte concentration < 100 x MDL.	Recovery ± 20% of true value, if sample < 4x spike added.	Flag results and/or analyze sample by method of standard additions.
Serial Dilution (L)	1 per digestion batch	If original sample result is at least 50x IDL, 5-fold dilution must agree within ± 10% of the original result.	Flag result or dilute and reanalyze sample to eliminate interference.
Internal Standard (IS)	Appropriate IS required for all analytes in all samples. Mass of IS must be <50 amu different from that of analyte.	1) For each sample, IS intensity within 70%-120% of that of initial calib. blank. 2) For ICV, ICB, CCV, and CCB, IS intensity within 80%-120% of that in initial calib. blank.	Do not use results for failing elements.
Instrument Detection Limit (IDL) Study	Quarterly.	IDL < MDL PQL at least 2-3x IDL	1) Repeat IDL study. 2) Raise PQL.
Method Detection Limit (MDL) Study	Refer to KAS SOP QA-806, "Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications", current revision.		
Lower Limit of Quantitation Check (LLQC) Sample	Digest and analyze annually or as needed to confirm PQLs	70% - 130% of true value	Reevaluate PQLs
Method of Standard Additions	When matrix interference is suspected	r ≥ 0.995	Dilute and reanalyze sample to eliminate interference.

TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate	Prior to using	QC acceptance criteria	Recalculate results;	NA.	This is a demonstration of

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TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
acceptable analytical capability	any test method and at any time there is a change in instrument type, personnel, test method, or sample matrix.	published by DoD, if available; otherwise method-specified criteria.	locate and fix problem, then rerun demonstration for those analytes that did not meet criteria.		analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD determination and verification	Refer to current revision of SOP QA-806				
LOQ establishment and verification	Refer to current revision of SOP QA-806				
Instrument detection limit (IDL) study	At initial set-up and after significant change in instrument type, personnel, test method, or sample matrix.	IDLs shall be ≤ LOD.	NA.	NA.	Samples may not be analyzed without a valid IDL.
Tuning	Prior to ICAL.	Mass calibration ≤ 0.1 amu from the true value; Resolution < 0.9 amu full width at 10% peak height; For stability, RSD ≤ 5% for at least four replicate analyses.	Retune instrument then reanalyze tuning solutions.	Flagging criteria are not appropriate.	No analysis shall be performed without a valid MS tune.
Initial calibration (ICAL) for all analytes (minimum one high standard and a calibration blank)	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, r ≥ 0.995.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed.
Second source calibration verification	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analytes within ± 10% of true value.	Verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All analytes within ± 10% of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Low-level	Daily, after one-	Within ± 20% of true	Correct problem, then	Flagging criteria are not	No samples may be

TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
calibration check standard	point ICAL.	value.	reanalyze.	appropriate.	analyzed without a valid low-level calibration check standard. Low-level calibration check standard should be less than or equal to the reporting limit.
Linear dynamic range or high-level check standard	Every 6 months.	Within ±10% of true value.	NA.	NA.	
Method blank	One per preparatory batch.	No analytes detected > ½ RL (> RL for common lab contaminants) and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). For negative blanks, absolute value < LOD. Blank result must not otherwise affect sample results.	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Calibration blank	Before beginning a sample run, after every 10 samples, and at end of the analysis sequence.	No analytes detected > LOD. For negative blanks, absolute value < LOD.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.	Apply B-flag to all results for specific analyte(s) in all samples associated with the blank.	
Interference check solutions (ICS-A and ICS-AB)	At the beginning of an analytical run and every 12 hours.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ± 20% of true value. May use < LOD for some projects.	Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples.	If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	
LCS containing all analytes to be reported	One per preparatory batch.	Water: Recovery must be within + 20% of the true value Soil: Recovery must be within vendor supplied limits (varies by lot).	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix spike (MS)	One per preparatory batch per matrix	For matrix evaluation, use recovery must be within + 20% of the true value.	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of

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TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
			control tests (dilution test and post-digestion spike addition) are required to evaluate matrix effects.		difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate (MSD) or sample duplicate	One per preparatory batch per matrix.	MSD: For matrix evaluation use recovery must be within + 20% of the true value. MSD or sample duplicate: RPD < 20% (between MS and MSD or sample and sample duplicate).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Dilution test	One per preparatory batch.	For samples with concentrations > 50 x LOQ then five-fold dilution must agree within ± 10% of the original measurement.	Perform post-digestion spike addition.	Flagging criteria are not appropriate.	Only applicable for samples with concentrations > 50 x LOQ.
Post digestion spike addition	When dilution test fails or analyte concentration for all samples < 50 x LOD.	Recovery within 75-125%	Run all associated samples in the preparatory batch by method of standard additions (MSA) or see flagging criteria.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Spike addition should produce a concentration of 10 – 100 x LOQ.
Method of standard additions (MSA)	When matrix interference is confirmed.	NA.	NA.	NA.	Document use of MSA in the case narrative.
Internal standards (IS)	Every sample.	IS intensity within 30-120% of intensity of the IS in the ICAL.	Flagging criteria are not appropriate.	Reanalyze sample at 5-fold dilution with addition of appropriate amounts of internal standards.	
Results reported between DL and LOQ	NA.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

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TABLE 3

DoD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Linear Dynamic Range (LDR) or High-level Check Standard	Daily.	Within ±10% of true value.	Dilute samples within the calibration range, or re-establish/verify the LDR.	Flagging is not appropriate.	Data cannot be reported above the calibration range without an established/passing high-level check standard.
Tuning	Prior to ICAL.	Mass calibration = 0.1 amu from the true value; Resolution < 0.9 amu full width at 10% peak height.	Retune instrument and verify.	Flagging is not appropriate.	No samples shall be analyzed without a valid tune.
Initial Calibration (ICAL) for All Analytes	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, r2 = 0.99.	Correct problem, then repeat ICAL.	Flagging is not appropriate.	Minimum one high standard and a calibration blank. No samples shall be analyzed until ICALhas passed.
Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes, within ± 10% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed until calibration has been verified with a second source.
Continuing Calibration Verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All reported analytes within ± 10% of the true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable CCV.	Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Low-level Calibration Check Standard (Low Level ICV)	Daily.	All reported analytes within ± 20% of the true value.	Correct problem and repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed without a valid low-level calibration check standard. Low-level calibration check standard should be less than or equal to the LOQ.
Internal Standards (IS)	Every field sample, standard and QC sample.	IS intensity in the samples within 30-120% of intensity of the IS in the ICAL blank.	If recoveries are acceptable for QC samples, but not field samples, the field samples may be considered to suffer from a matrix effect. Reanalyze sample at 5-fold dilutions until criteria is met. For failed QC samples,	Flagging is not appropriate.	Samples suffering from matrix effect should be diluted until criteria are met, or an alternate IS should be selected.

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TABLE 3

DoD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
			correct problem, and rerun all associated failed field samples.		
Method Blank (MB)	One per preparatory batch.	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Initial and Continuing Calibration Blank (ICB/CCB)	Before beginning a sample run, after every 10 field samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed. Flagging is not appropriate.	Results may not be reported without a valid calibration blank.	For CCB, failures due to carryover may not require an ICAL.
Interference Check Solutions (ICS) (also called Spectral Interference Checks)	After ICAL and prior to sample analysis.	ICS-A: Absolute value of concentration for all non-spiked project analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ± 20% of true value.	Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples.	If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the failed ICS.	All analytes must be within the LDR. ICS-AB is not needed if instrument can read negative responses.
Laboratory Control Sample (LCS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Correct problem, then re-prep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Must contain all reported analytes. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference, i.e., matrix effect or analytical error.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	The data shall be evaluated to determine the source of difference.

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TABLE 3

DoD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
		limits are not specified. MSD or MD: RPD of all analytes = 20% (between MS and MSD or sample and MD).			
Dilution Test	One per preparatory batch if MS or MSD fails.	Five-fold dilution must agree within ± 10% of the original measurement.	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	Only applicable for samples with concentrations > 50 X LOQ (prior to dilution). Use along with MS/MSD or PDS data to confirm matrix effects.
Post Digestion Spike (PDS) Addition	One per preparatory batch if MS or MSD fails (using the same sample as used for the MS/MSD if possible).	Recovery within 80-120%	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	Criteria apply for samples with concentrations < 50 X LOQ prior to dilution.
Method of Standard Additions (MSA)	When dilution or post digestion spike fails and if the required by project.	NA.	NA.	NA.	Document use of MSA in the case narrative.

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

TABLE 4

SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-627-11	METHOD 6020, current revision
Apparatus/Materials		
Reagents		
Sample preservation/ handling		
Procedures		
QC - Spikes		
QC - LCS		
QC - Accuracy/Precision		
QC - MDL		
QC - Calibration Blanks	Acceptance criteria employed for 6020: ± PQL	Acceptance criteria stated in 6020: <10% of PQL

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

TABLE 5

ISOTOPES MONITORED AND CORRECTION EQUATIONS USED FOR USEPA METHOD 6020

Element Class	Element	Sym-bol	Isotopes Monitored	Correction Equations [See note 1]
Analytes	Aluminum	Al	27	
	Antimony	Sb	121, 123	
	Arsenic	As	75	$^{75}As = (75)*1 - (77)*2.95 + (82)*2.548 – (83)*2.571$ [See note 2]
	Barium	Ba	135, 137	
	Beryllium	Be	9	
	Boron	B	11	
	Cadmium	Cd	106, 108, 111, 114	$^{111}Cd = (111)*1 – (108)*1.073 + (106)*0.764$ [See note 3] $^{114}Cd = (114)*1 – (118)*0.0268 – (108)*1.84$ [See note 4]
	Calcium	Ca	44	$^{44}Ca = (44)*1 – (88)*0.0169$ [See note 7]
	Chromium	Cr	52, 53	
	Cobalt	Co	59	
	Copper	Cu	63, 65	
	Iron	Fe	54, 56, 57	$^{54}Fe = (54)*1 – (52)*0.0282$ [See note 8] $^{57}Fe = (57)*1 – (43)*0.03$ [See note 9]
	Lead	Pb	206, 207, 208	$^{208}Pb = (208)*1 + (206)*1 + (207)*1$ [See note 5]
	Magnesium	Mg	25	
	Manganese	Mn	55	
	Molybdenum	Mo	98	$^{98}Mo = (98)*1 – (99)*0.146$ [See note 10]
	Nickel	Ni	60, 61	
	Potassium	K	39	
	Selenium	Se	82	$^{82}Se = (82)*1 – (83)*1.009$ [See note 11]
	Silver	Ag	107, 109	
	Sodium	Na	23	
	Strontium	Sr	88	
	Thallium	Tl	203, 205	
	Thorium	Th	232	
	Tin	Sn	118, 120	
	Tungsten	W	182	
	Uranium	U	238	
	Vanadium	V	51	$^{51}V = (51)*1 – (53)*2.95 + (52)*0.378$ [See note 12]
	Zinc	Zn	66, 67, 68	
Internal Stan-dards.	Bismuth	Bi	209	
	Germanium	Ge	72	
	Indium	In	115	$^{115}In = (115)*1 – (118)*0.016$ [See note 6]
	Lithium	Li	6	
	Scandium	Sc	45	
	Terbium	Tb	159	
	Yttrium	Y	89	

TABLE 5 (continued)

ISOTOPES MONITORED AND CORRECTION EQUATIONS USED FOR USEPA METHOD 6020

Notes:

1) Numbers in parentheses, e.g "(51)", indicate measured counts at the indicated mass.
2) Corrects for ArCl interference, taking into account secondary interferences from Se and Kr
3) Corrects for MoO interference, taking into account secondary interference from ^{108}Cd
4) Corrects for Sn interference
5) Corrects for variations in isotopic composition of lead
6) Corrects for Sn interference
7) Corrects for interference from $^{88}Sr^{2+}$
8) Corrects for Cr interference
9) Corrects for Ca interference
10) Corrects for Ru interference
11) Corrects for Kr interference
12) Corrects for ClO, taking into account secondary interference from Cr

TABLE 6

PREPARATION OF CALIBRATION AND QUALITY CONTROL STANDARDS

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
Continuing Calibration Verification CCV (1.0% HNO_3 / 0.5% HCl)	CL-CAL-3	Spex Industries	0.25
	ICP-MS-MIX-Z	Lab Prepared	0.50
	ICP-MS CAL 1	Lab Prepared	1.25
Calibration Standard (1.0% HNO_3 / 0.5% HCl)	CL-CAL-3	Spex Industries	0.50
	ICP-MS-MIX-Z	Lab Prepared	1.0
	ICP-MS CAL 1	Lab Prepared	2.5
Initial Calibration Verification (ICV) (1.0% HNO_3 / 0.5% HCl)	CL-ICS-1,CL-ICS-4, CL-ICS-5	Spex Industries	0.20 of each
	CL-ICS-3	Spex Industries	2.0
	1000 mg/L Si	Inorganic Ventures	0.040
	1000 mg/L Al	Inorganic Ventures	0.038
	1000 mg/L B, W Solution (0.5mL each per 50mL and use same day only)	Inorganic Ventures	0.200
Practical Quantitation Limit Solution (PQL) (1.0% HNO_3 / 0.5% HCl)	ICP-MS PQL Intermediate	Lab Prepared	0.1
Interference Check Solution A (ICS-A) (1.0% HNO_3 / 0.5% HCl)	6020ICS-0A	Inorganic Ventures	10.0
Interference Check Solution AB (ICS-AB) (1.0% HNO_3 / 0.5% HCl)	6020ICS-0A	Inorganic Ventures	10.0
	ICP-MS-CAL 1	Lab Prepared	1.0
	ICP-MS ICSAB Intermediate	Lab Prepared	1.0
P/A Tuning Solution (1.0% HNO_3 / 0.5% HCl)	1000 mg/L Co, Cr, Mo, Mn, Pb, Sb, Sr, U, V	High Purity Standards	0.02
	10,000 mg/L Al, K, Na	High Purity Standards	0.002
Instrument Tuning Solution (1.0% HNO_3 / 0.5% HCl)	ICP-MS-TS-2	High Purity Standards	0.10
	Conc. HNO_2	Baker Instra Analyzed	4
Internal Standard Solution (5.0% HNO_3 / 0.5% HCl)	Internal Standard Mix	Spex Industries	10

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

TABLE 6

PREPARATION OF CALIBRATION AND QUALITY CONTROL STANDARDS

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
Method Tuning Solution (1.0% HNO_3 / 0.5% HCl)	ICP-MS Method Tune Intermediate	Lab Prepared	1.0
	Internal Standard Mix 1	Spex Industries	1.0

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

TABLE 7

PREPARATION OF INTERMEDIATE STANDARDS

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
ICP-MS PQL Intermediate (5% HNO_2/5%HCL)	10,000 mg/L K, Na	High Purity Standards or Inorganic Ventures	2.0 of each
	10,000 mg/L Si	High Purity Standards or Inorganic Ventures	1.0
	1000 mg/L B	High Purity Standards or Inorganic Ventures	0.40
	10,000 mg/L Al, Ca, Fe, Mg 1000 mg/L Zn	High Purity Standards	0.20 of each
	1000 mg/L As, Se, V, W, Sr, Sn, Mo, Cr	High Purity Standards or Inorganic Ventures	0.10 of each
	1000 mg/L Cu	High Purity Standards	0.06
	1000 mg/L Ba, Mn, Ni	High Purity Standards	0.04 of each
	1000 mg/L U, Be, Cd, Co, Ag, Th, Tl, Pb, Sb	High Purity Standards	0.02 of each
ICP-MS CAL 1 -(5% HNO_2/5%HCL)	1000 mg/L Ag, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, Sb, Se, Th, Tl, U, V, Zn	High Purity Standards	0.2 of each
	10,000 mg/L Al	High Purity Standards or Inorganic Ventures	0.02
	Conc. HCL	Baker Instra Analyzed	2
ICP-MS-MIX-Z (1.0% HNO_3 / 0.5% HCl)	10,000 mg/L K, Na, Fe, Mg, Ca	High Purity Standards or Inorganic Ventures	5.0 of each
	10,000 mg/L Si	High Purity Standards or Inorganic Ventures	1.0
	10,000 mg/L Al	High Purity Standards or Inorganic Ventures	0.95
	1000 mg/L B, Sn, Sr, W	High Purity Standards or Inorganic Ventures	0.50 of each
ICP-MS-MIX-Y (1.0% HNO3/ 0.5% HCl)	10,000 mg/L Al	High Purity Standards or Inorganic Ventures	0.030
	1000 mg/L As, Ba, Cr, Cu, Mn, Mo, Ni, Pb, Se, Sb, V, Zn	High Purity Standards or Inorganic Ventures	0.30 of each
ICP-MS ICSAB Intermediate (1.0% HNO_3 / 0.5% HCl)	10,000 mg/L Si	High Purity	0.50
	1,000 mg/L B, Sn, Sr, W	High Purity or Inorganic Ventures	0.20 each

TABLE 7

PREPARATION OF INTERMEDIATE STANDARDS

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
ICP-MS Method Tune Intermediate (1.0% HNO_3 / 0.5% HCl)	1000 mg/L Be, Co, Tl 10,000 mg/L Mg	High Purity Standards or Inorganic Ventures	0.1 of each
	1000mg/L Pb		0.30

TABLE 8

ELEMENT CONCENTRATIONS IN WORKING STANDARDS

Element	CONCENTRATION IN SOLUTION, ug/L				
	CCV	Cal. Std.	ICV	PQL	P/A Tune Soln.
Aluminum	500.0	1000.0	400.0	20.0	200
Antimony	25.0	50.0	20.0	0.2	200
Arsenic	25.0	50.0	20.0	1.0	
Barium	25.0	50.0	20.0	0.4	
Beryllium	25.0	50.0	20.0	0.2	
Boron	25.0	50.0	20.0	4.0	
Cadmium	25.0	50.0	20.0	0.2	
Calcium	5000.0	10000.0	4000.0	20.0	
Chromium	25.0	50.0	20.0	1.0	200
Cobalt	25.0	50.0	20.0	0.2	200
Copper	25.0	50.0	20.0	0.6	
Iron	5000.0	10000.0	4000.0	20.0	
Lead	25.0	50.0	20.0	0.2	200
Magnesium	5000.0	10000.0	4000.0	20.0	
Manganese	25.0	50.0	20.0	0.4	200
Molybdenum	25.0	50.0	40.0	1.0	200
Nickel	25.0	50.0	20.0	0.4	
Potassium	5000.0	10000.0	4000.0	200.0	200
Selenium	25.0	50.0	20.0	1.0	
Silicon	500.0	1000.0	400.0	100.0	
Silver	25.0	50.0	20.0	0.2	
Sodium	5000.0	10000.0	4000.0	200.0	200
Strontium	25.0	50.0	20.0	1.0	200
Thallium	25.0	50.0	20.0	0.2	
Tin	25.0	50.0	20.0	1.0	
Tungsten	25.0	50.0	20.0	1.0	
Uranium	25.0	50.0	20.0	0.2	200
Vanadium	25.0	50.0	20.0	1.0	200
Zinc	25.0	50.0	20.0	2.0	

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

TABLE 8 (continued)

ELEMENT CONCENTRATIONS IN WORKING STANDARDS

Element	CONCENTRATION IN SOLUTION, ug/L				
	ICSA[1]	ICSAB[1]	Internal Std Solution	Method Tune Solution	Instrument Tuning Solution
Aluminum	100000	100000			
Antimony		20			
Arsenic		20			
Barium		20		10	
Beryllium		20			
Boron		20			
Cadmium		20			
Calcium	100000	100000			
Chromium		20			
Cobalt		20		10	
Copper		20			
Iron	100000	100000			
Lead		20		10	
Magnesium	100000	100000		100	
Manganese		20			
Molybdenum	2000	2000			
Nickel		20			
Potassium	100000	100000			
Selenium		20			
Silver		20			
Sodium	100000	100000			
Strontium		20			
Thallium		20		10	10.0
Tin		20			
Tungsten		20			
Uranium		20			
Vanadium		20			
Zinc		20			
Bismuth			1000.0	10	
Germanium			1000.0	10	
Indium				10	
Lithium (^{6}Li)			1000.0	10	
Scandium			1000.0	10	
Terbium			1000.0	10	
Yttrium			1000.0	10	10.0

TABLE 8 (continued)

ELEMENT CONCENTRATIONS IN WORKING STANDARDS

Element	CONCENTRATION IN SOLUTION, ug/L				
	ICSA[1]	ICSAB[1]	Internal Std Solution	Method Tune Solution	Instrument Tuning Solution
Cerium					10.0
Lithium					10.0

1) Solution also contains 1000 mg/L Chloride, 200 mg/L Carbon, and 100 mg/L Phosphorus and Sulfur, and 2mg/L Titanium.

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

TABLE 9

ELEMENT CONCENTRATIONS IN INTERMEDIATE STANDARDS

ELEMENT	CONCENTRATION IN SOLUTION, mg/L					
	MS-MIX-Z	ICP-MS PQL Intermediate	ICP-MS-MIX-Y	ICP-MS Method Tune Intermediate	ICP-MS CAL 1	ICP-MS ICSAB Intermediate
Aluminum	95.0	2.0	3.0		0.2	
Antimony		0.02	3.0		0.2	
Arsenic		0.10	3.0		0.2	
Barium		0.04	3.0		0.2	
Beryllium		0.02		1.0	0.2	
Boron	5.0	4.0				0.2
Cadmium		0.02			0.2	
Calcium	500	2.0				
Chromium		0.10	3.0		0.2	
Cobalt		0.02		1.0	0.2	
Copper		0.06	3.0		0.2	
Iron	500	2.0				
Lead		0.02	3.0	3.0	0.2	
Magnesium	500	2.0		10.0		
Manganese		0.04	3.0		0.2	
Molybdenum		0.10	3.0		0.2	
Nickel		0.04	3.0		0.2	
Potassium	500	20.0				
Selenium		0.10	3.0		0.2	
Silicon	100	10.0				5.0
Silver		0.02			0.2	
Sodium	500	20.0				
Strontium	5.0	0.10				0.2
Thallium		0.02		1.0	0.2	
Tin	5.0	0.10				0.2
Thorium		0.02			0.2	
Tungsten	5.0	0.10				0.2
Uranium		0.02			0.2	
Vanadium		0.10	3.0		0.2	
Zinc		0.20	3.0		0.2	

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

TABLE 10

ELEMENT CONCENTRATIONS IN STOCK STANDARDS

Element	CONCENTRATION IN SOLUTION, mg/L				
	Instrument Calibration Standard 3 (Spex)	CL-ICS-1 (Spex)	CL-ICS-3 (Spex)	CL-ICS-4 (Spex)	CL-ICS-5 (Spex)
Aluminum		10.0			
Antimony		10.0			
Arsenic		10.0			
Barium		10.0			
Beryllium		10.0			
Boron					
Cadmium		10.0			
Calcium	1000		200.0		
Chromium		10.0			
Cobalt		10.0			
Copper		10.0			
Iron	1000		200.0		
Lead		10.0			
Magnesium	1000		200.0		
Manganese		10.0			
Molybdenum				10.0	10.0
Nickel		10.0			
Potassium	1000		200.0		
Selenium		10.0			
Silver		10.0			
Sodium	1000		200.0		
Strontium					10.0
Thallium		10.0			
Thorium				10.0	
Tin					10.0
Tungsten					
Uranium				10.0	
Vanadium		10.0			
Zinc		10.0			

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

TABLE 10 (continued)

ELEMENT CONCENTRATIONS IN STOCK STANDARDS

Element	CONCENTRATION IN SOLUTION, ug/L		
	6020ICS-0A[1] (Inorganic Ventures)	**Internal Standard Mix 1 (Spex)**	**ICP-MS-TS-2 (High Purity)**
Aluminum	1000		
Arsenic			
Cadmium			
Calcium	1000		
Chromium			
Cobalt			
Copper			
Iron	1000		
Magnesium	1000		
Manganese			
Molybdenum	20.0		
Nickel			
Potassium	1000		
Silver			
Sodium	1000		
Zinc			
Bismuth		1000	
Cerium			10000
Germanium		1000	
Indium		1000	
Lithium			10000
Lithium (^{6}Li)		1000	
Scandium		1000	
Terbium		1000	
Thallium			10000
Yttrium		1000	10000

1) Solution also contains 10000 mg/L Chloride, 2000 mg/L Carbon, and 1000 mg/L Phosphorus and Sulfur, and 20 mg/L Titanium.

TABLE 11

REQUIRED ANALYTICAL SEQUENCE

Sequence Number	Standard/Sample	Purpose
1	Method Tuning Solution	Verify mass calibration and resolution
2	S0 (Calibration Blank)	Initial calibration
3	S1 (Calibration Standard)	Initial calibration
7	ICV (Initial Calibration Verification)	Check calibration accuracy
8	ICB (Initial Calibration Blank)	Check calibration accuracy
9	PQL (Practical Quantitation Limit)	Check calibration accuracy at low concentration
10	ICS-A (Interference Check Solution A)	Verify accuracy of mass correction equations
11	ICS-AB (Interference Check Solution AB)	Verify accuracy of mass correction equations
12	CCV (Continuing Calibration Verification)	Check calibration stability
13	CCB (Continuing Calibration Blank)	Check calibration stability
14-23	Analyze up to 10 samples	
24	CCV (Continuing Calibration Verification)	Check calibration stability
25	CCB (Continuing Calibration Blank)	Check calibration stability
…	Continue analyzing sequences of up to 10 samples, followed by a CCV and a CCB	
…	After last analytical sample, analyze PQL , followed by a CCV and a CCB	

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

TABLE 12

INSTRUMENT OPERATING CONDITIONS

Data Acquisition Program	Acquisition Mode	Spectrum
	Points per Mass	3
	Number of Replicates	3
	Detector Mode	Auto for all elements
	Integration Time per Point (for listed masses and their correction masses)	0.10 sec for Li, B, ^{29}Si, Sc, V, Cr, Mn, Ni, Cu, Zn, Y, Mo, Ag, In, Sn, Sb, Ba, Tb, W, Tl, Pb, Bi, Th, U
		0.30 sec for Be, As, Cd, Ge
		0.010 sec for Na, Al, K, ^{28}Si
		0.030 for Ca, Fe, Sr
		1.00 sec for Se
		0.050 sec for Mg, Co
	Spray Chamber Temperature	2^{o} C
	Total Acquisition Time	105 sec for 3 replicates
Peristaltic Pump Program	Analysis Speed	0.15 rps
Before Acquisition	Uptake Speed	0.15 rps
	Uptake Time	5 sec
	Stabilization Time	15 sec
After Acquisition (Probe Rinse)	Rinse Speed	0.15 rps
	Rinse Time (sample)	5 sec
	Rinse Time (standard)	5 sec
After Acquisition (Rinse)	Rinse Vial	1
	Uptake Speed	0
	Uptake Time	0 sec
	Stabilization Time	0 sec
Calibration Curve fit	All quantitation masses	Y=ax+(blank)
	All internal standard masses	(Excluded)
	All interference correction masses	(Excluded)
Reporting Parameters	QC Reports	On-Printer
	All Other Reports	Off

TABLE 13

INSTRUMENT TUNE SPECIFICATIONS

Sensitivity	Li >5000 cts/0.1 sec/10 ppb
	Y >10,000 cts/0.1 sec/10 ppb
	Tl >5000 cts/0.1 sec/10 ppb
Precision	Li <8% RSD (0.1 sec integration time)
	Y <5% RSD (0.1 sec integration time)
	Tl <5% RSD (0.1 sec integration time)
Oxides	<1.0%
Doubly Charged (Ce^{++}/Ce^{+})	<2.0%
Background	Li <15 cps
	Y <15 cps
	Tl <15 cps
Mass Resolution	Width at 10% peak height: 0.7-0.8 amu
Mass Axis	Li ±0.1 amu of nominal mass
	Y ±0.1 amu of nominal mass
	Tl ±0.1 amu of nominal mass

TABLE 14

METHOD TUNE SPECIFICATIONS

Precision	≤5% RSD of 4 replicates
Mass Resolution	Width at 10% peak height: <0.9 amu
Mass Calibration	±0.1 amu of nominal mass

TABLE 15

REPORTED ISOTOPES AND INTERNAL STANDARDS

ELEMENT	MASS	INTERNAL STANDARD (mass)
Aluminum	27	Scandium (45)
Antimony	123	Terbium (159)
Arsenic	75	Yttrium (89)
Barium	135	Terbium (159)
Beryllium	9	Lithium (6)
Boron	11	Lithium (6)
Cadmium	114	Yttrium (89)
Calcium	44	Scandium (45)
Chromium	52	Yttrium (89)
Cobalt	59	Yttrium (89)
Copper	65	Yttrium (89)
Iron	57	Yttrium (89)
Lead	208	Bismuth (209)
Magnesium	25	Scandium (45)
Manganese	55	Yttrium (89)
Molybdenum	98	Yttrium (89)
Nickel	60	Yttrium (89)
Potassium	39	Scandium (45)
Selenium	82	Yttrium (89)
Silicon	29	Scandium (45)
Silver	107	Yttrium (89)
Sodium	23	Scandium (45)
Strontium	88	Yttrium (89)
Thallium	203	Bismuth (209)
Thorium	232	Bismuth (209)
Tin	118	Terbium (159)
Tungsten	182	Terbium (159)
Uranium	238	Bismuth (209)
Vanadium	51	Yttrium (89)
Zinc	66	Yttrium (89)

TITLE: **TRACE METALS ANALYSIS BY ICP-MS USING USEPA METHOD 6020**

ATTACHMENT 1

HARDNESS BY CALCULATION

As referenced in "Standard Methods for the Examination if Water and Wastewater," Methods 2340 A & B, Hardness Introduction and Hardness by Calculation, American Public Health Association, 18th Edition, Revised 1992, total hardness is the sum of the calcium and magnesium concentrations, both expressed as calcium carbonate, in milligrams per liter.

Once the calcium and magnesium concentrations have been determined by EPA methods 6010, 6020, 200.7 or 200.8, the total hardness of an aqueous sample may be calculated as follows:

$$\text{Total Hardness, mg equivalent } CaCO_3/L = 2.497\ (Ca, mg/L) + 4.118\ (Mg, mg/L)$$

The calcium hardness of an aqueous sample may also be calculated as follows:

$$\text{Calcium Hardness, mg equivalent } CaCO_3/L = 2.497\ (Ca, mg/L)$$

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

SOP Number: CA-709
Revision History
Cover Page
Page 1

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045.**

Prepared By: Wet Chemistry Date: 8/96

Approved By:

Group Supervisor: Keith Tanguay Date: 02/13/01

Operations Manager: John C. Benton Date: 2/13/01

QA Officer: Deborah J. Nadeau Date: 2/13/01

General Manager: Dennis P. Hurley Date: 2/12/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
03 9045C	Format changes, added pollution prevention, database and operation of Accumet pH meter and calibration.	DH	2/13/01	2/13/01
04 9045C	Addition to Scope and Application to include reference for 9040B use when aqueous phase is 720%	DH	8/27/02	8/27/02
05 9045C	added KIMS Minor changes throughout added wording to sect. 6 New fig. 1 and 2	LAD	120104	120104
06 9045C	Added SW-846 reference. Minor formatting changes throughout.	LAD	03/07	03/07
07 9045D	Section 7.18 - Renamed "Equipment Maintenance" and revised for current practices. Add Wet Chem. Data Entry SOP reference. Updated references in Section 10. Updated log book example.	LAD	08/09	08/09

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
08 9045D	Added references to sections 7 and 10.	LAD	06/10	06/10
09 9045D	Sect. 7.- Updated calibration procedure. Changed buffer pH probe stored in. Updated archived of reports. Added and edited references. Updated Figures 1 & 2 added 3. Changed H.T. from ASAP to 28 days.	LAD	05/12	05/12
10 9045D	Sect. 6 - Updated holding time criteria. Sect. 7 - Updated calibration procedure to reflect current practice. Sect. 10 - Updated and added references. Updated fig. 1 → 3	LAD	07/14	07/14
11 9045D	Sect. 7. Added requirement to reprep the sample if no standing water is present.	LAD	08/16	08/16

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **CA-709-11**, titled **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**.

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KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **CA-709-11**, titled **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**.

Recipient: _____ Date: _____

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedures and techniques followed by Katahdin Analytical Services personnel to determine the pH of soils and waste samples in accordance with EPA method 9045 (current promulgated revision). Method 9045 is an electrometric procedure for measuring pH in soils and waste samples. Wastes may be solids, sludges, or non-aqueous liquids. If water is present, it must constitute less than 20% of the total volume of the sample. If the aqueous phase is greater than 20%, pH determination should be performed in accordance with EPA method 9040 (current promulgated revision). Refer to the current revision of Katahdin SOP CA-708, pH Concentration Measurements in Aqueous Samples.

The procedures in this SOP are applicable to all non-CLP pH measurements performed for all soil matrices analyzed in the laboratory.

1.1 Definitions

pH - A measure of the acidity or alkalinity of a solution, defined as -log $[H^+]$.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of pH in solids by EPA Method 9045. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in the determination of pH concentration measurements in solid matrices to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for pH data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to indicate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method

has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention and Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Analytical Environmental Health and Safety Manual and SOP SD-903, “Sample Disposal,” current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP.

2.0 SUMMARY OF METHOD

A representative aliquot of sample, measured in grams, is mixed with an equivalent volume of laboratory reagent grade water, measured in mL. The solution is allowed to settle, and the pH of the standing water (decanted) is determined electrometrically.

3.0 INTERFERENCES

3.1 Samples with very low or very high pH may give incorrect readings on the meter. For samples with a true pH of >10, the measured pH may be incorrectly low. This error can be minimized by using a low-sodium-error electrode. Strong acid solutions, with a true pH of <1, may give incorrectly high pH measurements.

3.2 Temperature fluctuations will cause measurement errors.

3.3 Errors will occur when the electrodes become coated with an oily material. See section 7.18 for special cleaning instructions.

4.0 APPARATUS AND MATERIALS

4.1 pH meter, Accumet Model 20 or equivalent with Automatic Temperature Compensation (ATC)

4.2 Glass beakers, 25 mL and 400 mL

4.3 25 mL dose cups

4.4 Teflon coated stir-bars

4.5 Stir-bar retriever

4.6 Magnetic stirplate

4.7 Shaker, 12 place

4.8 Analytical balance, capable of weighing to 0.1 g

5.0 REAGENTS AND STANDARDS

5.1 Buffer solutions (pH 4.0, 6.0, 7.0, 8.0, 10.0, 12.0)

5.2 Laboratory reagent grade water (Lab Water)

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Samples are collected in soil jars and stored at 4°C until analysis. Samples are collected in plastic or glass jars and stored at 4°C until analysis.

pH samples require immediate analysis upon receipt by the laboratory.

SW846 Chapter 3 states the holding time for pH is “immediate”.

Katahdin project managers will remind clients that in order to meet the regulatory requirements for holding times, a field pH is required. If requested to perform a laboratory pH, the analysis must be performed as soon as possible and the data must be notated as being performed out of hold time.

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

7.0 PROCEDURES

SAMPLE PREPARATION

7.1 Please refer to Katahdin Analytical Services SOP CA-108, "Basic Laboratory Technique", current revision, for more information on subsampling. Mix samples thoroughly. Discard any foreign objects such as sticks, leaves and rocks. Decant any standing liquid. Using the balance, weigh out 20.0 g of sample into a 400 mL glass beaker. Record weight in pH logbook (Figure 1).

7.2 Add 20 mL of laboratory reagent grade water to the sample. Cover the top of the beaker with parafilm.

7.3 Place the sample on the shaker and allow it to shake, at medium speed, for five minutes. (CLP methods require the sample to shake for one hour.)

7.4 After five minutes (or one hour), remove the sample from the shaker and allow it to settle for one hour.

7.5 After one hour, decant the standing liquid into a 25 mL beaker. If no standing liquid is present, reprep the sample using 20g of sample and 40 mL of laboratory reagent grade water, cover with parafilm, and repeat steps 7.3 and 7.4.

7.6 Record total volume of laboratory reagent grade water added to sample in pH logbook. If volume of laboratory reagent grade water (in mL) added to sample exceeds the initial gram weight of the sample, flag sample data in pH logbook and record the reason for addition of excess laboratory reagent grade water (eg. minimum volume of water required in order to cover pH probe).

NORMAL RANGE CALIBRATION (pH range 3.5 – 10.5)

7.7 Meter should be calibrated daily. As described in the following steps, conduct a three-point calibration with pH buffers 4, 7 and 10. Perform a calibration check using pH 7 buffer. The source/lot number of each solution at the time of analysis must be recorded in the logbook (Figure 1).

7.8 Rinse pH electrode and temperature probe with laboratory reagent grade water. Gently blot dry with kimwipe.

7.9 Place pH 4 buffer on stir plate. Turn stir plate on so that the stir bar spins without creating a vortex, place pH electrode and temperature probe into buffer. Push **Standardize** key. Then push *2,* to clear previous calibration. Push **Standardize** key, then push 1, to update. Enter value of pH buffer, once stabilized record the value in the pH calibration logbook (Figure 3).

7.10 Remove pH 4 buffer. Rinse pH electrode and temperature probe. Blot dry.

7.11 Repeat step 7.1.3 with the pH 7 buffer. Record the value in the pH calibration logbook (figure 3). Remove pH 7 buffer. Rinse and dry pH electrode and temperature probe.

7.12 Repeat step 7.1.3 with the pH 10 buffer. Record the value in the pH calibration logbook (figure 3). Remove pH 10 buffer. Rinse and dry pH electrode and temperature probe.

NOTE: If any buffer readings are not within 0.05 pH units of expected values prior to calibration, the electrode may need cleaning. Note any maintenance performed and rerun the calibration.

LOW RANGE CALIBRATION

7.13 For samples with a pH less than 3.5, the meter must also be calibrated with pH buffer 2.

7.14 Rinse pH electrode and temperature probe with laboratory reagent grade water. Gently blot dry with kimwipe.

7.15 Place pH 2 buffer on stir plate. Turn stir plate on so that the stir bar spins without creating a vortex, place pH electrode and temperature probe into buffer. Push **Standardize** key. Push **Standardize** key, then push 1, to update. Enter value of pH buffer, once stabilized record the value in the pH calibration logbook (Figure 3).

7.16 The source/lot number and temperature of each solution at the time of analysis must be recorded in the logbook (Figure 1).

HIGH RANGE CALIBRATION

7.17 For samples with a pH greater than 10.5, the instrument must also be calibrated using a ph buffer 12.

7.18 Rinse pH electrode and temperature probe with laboratory reagent grade water. Gently blot dry with kimwipe.

7.19 Place pH 12 buffer on stir plate. Turn stir plate on so that the stir bar spins without creating a vortex, place pH electrode and temperature probe into buffer. Push **Standardize** key. Push **Standardize** key, then push 1, to update. Enter value of pH buffer, once stabilized record the value in the pH calibration logbook (Figure 3).

7.20 The source/lot number and temperature of each solution at the time of analysis must be recorded in the logbook (Figure 1).

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

CALIBRATION CHECK / LABORATORY CONTROL SPIKE (LCS)

7.21 Place pH 7 buffer on stir plate. Turn stir plate on so that the stir bar spins without creating a vortex, place pH electrode and temperature probe into buffer., but DO NOT press any keys as this reading is a calibration check. Record the reading in pH logbook as the LCS. Results must be within 0.05 pH units of the true value for analysis to proceed.

ANALYSIS OF SAMPLES

7.22 Sample analysis may proceed once the meter has been calibrated for the day with three buffers that bracket the expected pH of the sample.

7.23 Run the pH 7 buffer as the LCS for the analytical batch (Section 7.21). An LCS is required at the beginning of every batch of twenty or fewer samples.

7.24 Record date, time and initials for this analytical session.

7.25 The decanted samples should be equilibrated to room temperature prior to analysis (i.e., at the same temperature as the calibration buffers, □2 □C). A more accurate pH reading will be achieved when the buffers and the samples are at the same temperature. However, the Accumet□ pH meter is equipped with automatic temperature compensation (ATC) for when samples and buffers are not at the same temperature. Refer to the Accumet□ Model 20 pH/Conductivity Meter operating Instructions, #300143.3 (Revision C) for information on the ATC probe.

7.26 Pour about 25 ml of the supernatant into a clean dose cup. Place a tiny stir bar in cup. Place on stir plate, turn on stir plate and immerse probes.

7.27 When meter locks, record value displayed.

7.28 Rinse pH electrode and temperature probe. Blot dry

7.29 Place probe in pH 7 buffer solution to store until next analysis.

EQUIPMENT MAINTENANCE

7.30 If an electrode becomes coated with an oily material that will not rinse free, the electrode can either (refer to instrument manual):

- be cleaned with an ultrasonic bath, or

- be washed with detergent, rinsed several times with laboratory reagent grade water, placed in 1:10 HCl so that the lower third of the electrode is submerged, and then thoroughly rinsed with laboratory reagent grade water.

An electrode that will not calibrate properly must be replaced.

REPORTING OF RESULTS

7.31 All pH measurements less than 10.0 are to be reported using two significant figures.

Examples: 2.46 = 2.5
6.32 = 6.3
9.94 = 9.9

7.32 All pH measurements which are at or greater than or round up to 10.0 are to be reported to three significant figures.

Examples: 9.95 = 10.0
12.25 = 12.3
13.76 = 13.8
11.95 = 12.0

7.33 When a sample duplicate is analyzed, both the original result and duplicate result are recorded in the pH logbook; however, the original sample result is to be reported to the client.

7.34 After completion of each test, the logbook must be signed and dated by the person performing the test. All unused lines are to be “z-ed” out and initialed and dated.

7.35 The sample data results, with any appropriate notations, are entered into KIMS by the analyst. Refer to the current revision of SOP CA-762 for instructions on data entry. A batch sheet is generated (Figure 2). Raw data and batch sheets are reviewed for completeness and accuracy by the Inorganic Department Manager or other qualified designee.

7.36 All batch sheets, raw data, and supporting documents are scanned after final review and the resulting image files are saved on a Katahdin server for use in data package assembly. Image files of raw data are periodically archived by the laboratory’s MIS department.

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Refer to Table 1 for a summary of QC requirements, acceptance criteria, and corrective actions. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgements. These decisions are based on holding time considerations, remaining sample volume and client and project specific Data Quality Objectives. The Department Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

8.1 One sample duplicate is to be analyzed per batch or every 10 sample analyses.

8.1.1 Acceptance criteria for duplicates is a difference of less than or equal to 20% relative percent difference between sample and duplicate results.

8.1.2. If criterion is not met, check calibration and reanalyze sample in duplicate.

8.2 One Laboratory Control Sample (LCS) is to be analyzed per batch or every 20 samples.

9.0 METHOD PERFORMANCE

Refer to method 9045.

10.0 APPLICABLE DOCUMENTS/REFERENCES

"Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods", SW-846, third Edition, Final Updates I, II, IIA, IIB, III, IIIA, IIIB, and IV, February 2007, Method 9045D.

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP CA-762, Wet Chemistry Data Entry and Review Using Katahdin Information Management System (KIMS), current revision.

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 4.2, 10/25/2010.

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.0, March, 2013

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

LIST OF TABLES AND FIGURES

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

TABLE 1

QC REQUIREMENTS

Analytical Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW9045	PH (soil)	3-5 point calibration with pH buffers with a midrange cal. check	Once per day, prior to use	± 0.05 pH units for each buffer	If calibration is not achieved, check meter, buffer solutions, and probe; replace if necessary; repeat calibration
		LCS	One per batch of twenty or fewer samples	90-110% recovery	Correct problem, recalibrate
		Sample duplicate	One sample duplicate per every ten field samples	RPD ≤20%	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD is still unacceptable, report original result with notation or narration.

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

TABLE 2

SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-709-11	METHOD SW846 9045, current revision
Apparatus/Materials		
Reagents		
Sample preservation/ handling		
Procedures	1) Shake, at medium speed, for one hour. 2) Add more liquid after shaking and settling if there is no standing liquid left. 3) All buffers and samples are analyzed at room temperature. pH meter is equipped with automatic temperature compensation.	1) Continuously stir the suspension for five minutes. 2) No guidance for samples with no standing liquid left. 3) Report both pH and temperature at the time of analysis.
QC – Spikes		
QC – LCS		
QC - Accuracy/Precision		

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

FIGURE 1

EXAMPLE OF pH LOGBOOK PAGE

KATAHDIN ANALYTICAL SERVICES, INC.

CORROSIVITY pH / pH Soil

Accumet 20 pH Meter - SN - C0024321 pH Probe SN - 2089100P

SW 846 9045D

CALIBRATION STDS:	CALIBRATED TO:	LOT NO:	NOTES:
pH 2.00	2.00	SWL 3617	WG147312
pH 4.00	4.00	3578	R284017
pH 7.00	7.00	3577	
pH 10.00	10.02	3579	
pH 12.00	11.98	3618	

LAB SAMPLE ID	ANALYSIS TIME	SAMPLE VOL (mL)	SAMPLE WEIGHT(g)	SAMPLE TEMP. (°C)	pH	REPORTED pH
LCS	15:11	—	—	22.3°C	7.00	7.0
SH5400-1	15:14	100	21.01	22.0°C	7.45	7.5
-1 Dup	15:18	"	21.91	21.9°C	7.67	7.8
SH5481-1	15:20	50	21.66	22.0°C	9.64	9.6
SH5494-1	15:22	X 100	20.65	22.0°C	12.77	>12
SH5497-1	15:23	"	19.16	22.0°C	6.71	6.7
SH5585-1	15:26	50	20.85	22.0°C	6.73	6.7
-2	15:27	"	20.56	22.2°C	7.13	7.1
-3	15:31	"	20.37	22.0°C	7.24	7.2
-4	15:33	"	20.35	22.1°C	6.50	6.5
-5	15:35	"	19.97	22.2°C	6.69	6.7
CCV	15:37	—	—	22.5°C	7.02	7.0
SH5585-6	15:40	50	21.82	22.4°C	10.21	10.2
-6 Dup	15:46	"	20.98	22.6°C	9.71	9.7
-7	15:48	"	20.20	22.3°C	7.90	7.9
-8	15:51	"	20.05	22.3°C	7.44	7.4
-9	15:52	"	20.44	22.4°C	7.33	7.3
CCV	15:53	—	—	22.5°C	7.03	7.0
Blank	15:55	—	—	20.9°C	5.47	5.5
			ZS 7.29.14			

PREP ANALYST: ZS DATE/TIME: 7·28·14 16:00
ANALYST: ZS DATE: 7.29.14
CHECKED BY: DATE:

WL-015 - Revision 2 - 04/30/2012 QAWL693 0000099

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

FIGURE 2

EXAMPLE OF BATCH SHEET FOR pH

WET CHEMISTRY BATCH REPORT
Jul 15 2014, 01:23 pm
Batch: WG146539

Parameter: pH(Soil)
Prep Date: 15-JUL-14

Date Analyzed: 15-JUL-14
Prep Method: SW846 9045C

Analyst Initials: ZS
Prep Chemist: ZS

Sample	Samp Type	Method	Initial Amt.	Final Amt.	Rpt. DF	Result	Rpt Result	TS(%)	PQL	MDL	Adj PQL	RPD	%Rec
SB4998-1	SAMP	SW846 9045D	10.63g	30mL	1	8.4	8.4 pH	92.	.1	0.10	0.10		
SB4998-2	SAMP	SW846 9045D	11.06g	30mL	1	7.58	7.6 pH	91.	.1	0.10	0.10		
SB5046-1	SAMP	SW846 9045D	10.51g	50mL	1	5.3	5.3 pH	33.	.1	0.10	0.10		
SB5074-3	SAMP	SW846 9045D	12.17g	30mL	1	9	9.0 pH	83.	.1	0.10	0.10		
SB5074-4	SAMP	SW846 9045D	11g	30mL	1	8.94	8.9 pH	81.	.1	0.10	0.10		
SB5150-1	SAMP	SW846 9045D	25.64g	150mL	1	7.03	7.0 pH	14.	.1	0.10	0.10		
WG146539-1	LCS	SW846 9045D	20g	20mL	1	7	7.0 pH	NA	.1	0.10	0.10		100
WG146539-2	DUP	SW846 9045D	10.99g	20mL	1	9.08	9.1 pH	NA	.1	0.10	0.10	2	
WG146539-3	MBLANK	SW846 9045D	20g	20mL	1	5.69	5.7 pH	NA	.1	0.10	0.10		

Comments:

SB5074-3 NYC-NYCDEP-SED-SPLIT-21: MS/DUP on metals and cyanide. DUP on Black Carbon, TS, pH. MS/MSD on Ammonia, TKN, N+N and Total P. Can be moved to another sample if needed.
SB5074-4 NYC-NYCDEP-SED-SPLIT-22: MS/MSD on DOBS and SVOC,MS/DUP on TOC. Can be moved to another sample if needed.
WG146539-1 SB5074-4
WG146539-2 SB5074-4
WG146539-3 SB5074-4

Entered by: ZS Date: 7.15.14 Accepted by: Date: 7/15/14

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

FIGURE 3

EXAMPLE OF PH CALIBRATION LOGBOOK

KATAHDIN ANALYTICAL SERVICES, INC.

pH METER CALIBRATION RECORD

FISHER ACCUMET 20 - SERIAL NUMBER C0024321

DATE	INITIALS	pH TRUE VALUES AND ACCEPTABILITY														
		2.00	± 0.05 (3)	Lot #	4.00	± 0.05 (3)	Lot #	7.00	± 0.05 (3)	Lot #	10.00	± 0.05 (3)	Lot #	12.00	± 0.05 (3)	Lot #
6-16-14	BN	2.00	✓	SWL 3617	3.96	✓	SWL 3578	7.00	✓	SWL 3577	10.00	✓	SWL 3579	11.95	✓	SWL 3618
6-17-14	BN	1.98	✓	"	3.96	✓	"	7.01	✓	"	9.99	✓	"	11.95	✓	"
6-18-14	ZS	2.00	✓	"	4.00	✓	"	7.00	✓	"	10.00	✓	"	12.00	✓	"
6/19/14	UNP				3.99	✓	"	6.98	✓	"	9.99	✓	"	12.00	✓	"
6/20/14	UNP				4.00	✓	"	6.98	✓	"	9.98	✓	"	12.03	✓	"
6/23/14	UNP	1.99	✓	"	3.98	✓	"	6.99	✓	"	9.99	✓	"	12.01	✓	"
06-24-14	[illegible]	2.00	✓	SWL 3617	4.00	✓	"	7.03	✓	"	10.03	✓	"	11.97	✓	"
6-25-14	DW			↓	4.00	✓	"	7.00	✓	"	10.00	✓	"			
06/26/14	[illegible]	2.01	✓	"	4.00	✓	"	7.00	✓	"	9.99	✓	"			
6-27-14	ZS	2.00	✓	"	3.96	✓	"	6.99	✓	"	9.99	✓	"	12.00	✓	SWL 3618
6/30/14	UNP	2.00	✓	"	3.97	✓	"	6.99	✓	"	9.99	✓	"	12.01	✓	"

MAINTENANCE – Include date, initials and task

QA-070 – Revision 1 – 09/30/2010

QAQC615

0000039

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

SOP Number: CA-733
Revision History
Cover Page
Page 1

TITLE: **REACTIVE CYANIDE: SW-846, 7.3.3.2**

Prepared By: Wet Chemistry Date: 8/96

Approved By:

Group Supervisor: Keith Tarquay Date: 02/30/1

Operations Manager: Jol C. Buston Date: 2/13/01

QA Officer: Deborah J. Nadeau Date: 2.13.01

General Manager: Duncan F. Hagan Date: 2/13/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Format changes, added pollution prevention, database and new CN SOP reference. Other minor changes throughout.	DN	2.13.01	2.13.01
02	major changes to apparatus and procedure to reflect current practice. Added reference for SOP CA-107 to sect. 1.4. Added program specific info to Sect. 8. Supervisor ⇒ dept. manager, ASTM II water ⇒ lab. reagent grade H_2O. updated figures	LAD	04/06	04/06
03	Section 7.1.3 and 7.1.4 changed spike amount from 0.1 mL to 0.05 mL. Added definitions to section 1.	LAD	02/08	02/08
04	Sec. 1.4 - Changed "G" Stream to "N-High" Stream. Sect. 2.0 - Changed SOP reference. Removed Secs 4.7 and 4.10. Sect. 4.13 - changed to Eppendorf. Sect. 5.3 - Added purchased with certified reference value option. Added DOC and MDL criteria to Table 1. Added 2 method deviations to Table 2.	LAD	05/09	05/09
05	Added definitions to section 1.1. Revised Table 1. Added EHSM, Subsampling, QA-96, DoD, NELAC and CA-101 references.	DN	08/09	08/09

TITLE: **REACTIVE CYANIDE: SW-846, 7.3.3.2**

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
06	Minor changes to Sections 5, 7 and 8 to reflect current Standard volumes, concentrations and prep. Added CCB and CCV to Table 1. Added References	LAD	07/11	07/11

TITLE: REACTIVE CYANIDE: SW-846, 7.3.3.2

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document SOP CA-733-06, titled REACTIVE CYANIDE: SW-846, 7.3.3.2.

Recipient: _____ Date: _____

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document SOP CA-733-06, titled REACTIVE CYANIDE: SW-846, 7.3.3.2.

Recipient: _____ Date: _____

TITLE: REACTIVE CYANIDE: SW-846, 7.3.3.2

1.0 SCOPE AND APPLICATION

The intended application of this method is to determine the hydrogen cyanide released from wastes. This method is applicable to all waste except those that will form explosive mixtures when combined with acids. This test measures only the hydrocyanic acid evolved at the test conditions. It is not intended to measure forms of cyanide other than those that are evolved under the test conditions. The regulatory limit for *Total Releasable Cyanide* is 250 mg/Kg waste.

1.1 Definitions

Reactive Cyanide - Cyanide released under the test conditions defined under SW846 Chapter 7, 7.3.3.2 where the sample is exposed to mildly acidic conditions.

Duplicate - A second aliquot of a sample that is prepared and analyzed in the same way as the original sample in order to determine the precision of the method.

LCS - Laboratory Control Sample - A standard or solid reference material of known value that has been brought through the sample preparation an analysis process. The LCS is used to assess the accuracy of the method.

LOD – Limit of Detection. The smallest amount or concentration of an analyte that must be present in a sample to be detected at a 99% confidence level. At the LOD, the false negative rate is 1%.

MB – Method Blank - Reagent water that has been brought through the sample preparation and analysis process. The MB is used to assess contamination.

PQL - Practical Quantitation Limit - The lowest concentration of an analyte that is routinely reported by the laboratory; nominally three to five times the MDL.

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

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of reactive cyanide according to SW-846, 7.3.3.2. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, “Personnel Training & Documentation of Capability”, current revision.

It is the responsibility of all Katahdin technical personnel involved in analysis of reactive cyanide according to SW-846, 7.3.3.2, to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples

should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.
It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure. These materials include the following: Sodium Hydroxide, Potassium Cyanide, Sulfuric Acid, Hydrochloric Acid, Barbituric Acid, Silver Nitrate and Pyridine.

Each qualified analyst or technician must be familiar with the Katahdin Analytical Environmental Health & Safety Manual including the Katahdin Hazardous Waste Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their supervisor, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Plan for further details on pollution prevention techniques.

All remaining basic waste from the distillation, receiver contents, is treated as though cyanide is present and disposed of in the pyridine (“N-High” stream) waste satellite located in the Wet Chemistry laboratory. When this container is full, it is then taken to the hazardous waste disposal area and the contents are transferred to the pyridine waste drum.

The acidic portion of the distillation, still contents, is placed in acid waste (“A” stream) via the satellite accumulation in the Wet Chemistry laboratory. Other wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Hazardous Waste Management Plan and Safety Manual and SOP SD-903, “Sample Disposal” and CA-107, “The Management of

TITLE: REACTIVE CYANIDE: SW-846, 7.3.3.2

Hazardous Waste as it Relates to the Disposal of Laboratory Process Waste, Reagents, Solvents and Standards," current revisions. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with these SOPs.

2.0 SUMMARY OF METHOD

An aliquot of acid is added to a fixed weight of waste in a closed system. The gas that is generated is swept into a scrubber. The cyanide in the gas is absorbed in a NaOH scrubbing solution that is analyzed for cyanide by Katahdin SOP CA-773, "Colorimetric Analysis of Total and Amenable Cyanide Using the Automated Konelab Multiwavelength Photometric Analyzer".

3.0 INTERFERENCES

Interferences are undetermined.

4.0 APPARATUS AND MATERIALS

4.1 Flexible tubing for connection from the nitrogen supply to the apparatus and from the flask to the absorber impinger unit (scrubber).

4.2 Nitrogen gas tank with regulator.

4.3 Gas valve capable of metering N_2 flow to 20 psi

4.4 Flowmeter capable of measuring flow at 60 mL/min at the distillation station.

4.5 Analytical balance weighing to 0.001g.

4.6 10-mL buret

4.7 12 gas washing bottles with 250ml graduated cylinders

4.8 Buret stand and holder

4.9 0.1mL Eppendorf pipet and tips

5.0 REAGENTS

5.1 Sulfuric Acid (0.1 N), H_2SO_4: Add 5.6 ml of concentrated H_2SO_4 to laboratory reagent grade water and dilute to 2 liters.

TITLE: REACTIVE CYANIDE: SW-846, 7.3.3.2

5.2 Sulfuric Acid (0.01 N), H_2SO_4: Volumetrically transfer 200 ml of 0.1 N H_2SO_4 and dilute to 2 liters with laboratory reagent grade water to make the 0.01 N H_2SO_4.

5.3 Stock Cyanide Solution (1000 mg/L): purchase as certified solution

5.4 Sodium Hydroxide Solution (0.25 N) ,NaOH: Dilute 25.0 ml of 10 N NaOH to 1 liter of Laboratory reagent grade water. This solution could also be made by dissolving 10 g of NaOH in Laboratory reagent grade water and diluting to 1 liter.

5.5 Laboratory reagent grade water: Equivalent in protocol as reagent or DI water

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

6.1 Samples should be collected with a minimum of aeration. The filled sample bottle should contain no headspace and should be kept cool and in the dark until analysis. Samples can be held 14 days with no preservative. Perform analysis in a ventilated hood.

6.2 Samples can be preserved by adjusting the sample pH to 12 with strong base; however, this will cause dilution of the sample, increase the ionic strength, and possibly change other physical or chemical characteristics of the waste which may affect the rate of release of the hydrocyanic acid.

7.0 PROCEDURES

7.1 PREPARATION OF SAMPLE

7.1.1 Weigh approximately 10 g of sample in a 250 mL addition graduated cylinder. Record weight in the preparation logbook (Figure 1).

Note: Please refer to Katahdin Analytical Services SOP CA-108, “Basic Laboratory Technique”, current revision, for more information on subsampling.

7.1.2 To prepare Method Blank transfer 10 g of laboratory reagent grade water to a 250 mL addition graduated cylinder

7.1.3 To prepare LCS transfer 0.05 mL (50 μg CN) of the Stock Cyanide Solution (1000 mg/L, See Reagents 5.3) to a 250 mL addition graduated cylinder.
Note: Standard should be added last. Be sure to seal the gas washing bottle quickly after addition.

TITLE: REACTIVE CYANIDE: SW-846, 7.3.3.2

7.1.4 To prepare a Matrix Spike (MS), weigh approximately 10 g of sample in a 250 mL addition graduated cylinder. Spike the sample with 0.05 mL (50 μg CN) of the stock cyanide solution (1000 mg/L, see reagent 5.3). (See LCS note)

7.1.5 To prepare sample Duplicate weigh out approximately 10 g of the sample selected/designated as the sample duplicate in a 250 addition graduated cylinder

7.1.6 Add 190 ml of 0.25 N NaOH to each of the absorber graduated cylinders. Place all scrubbers in graduated cylinders. Connect nitrogen hoses to scrubbers.

7.1.7 Add 180 mL of 0.01 N H_2SO_4 to each addition graduated cylinder. Immediately seal all graduated cylinders.

7.1.8 Turn on the main valve on the Nitrogen tank. Make sure it is reading 300 psi or greater.

7.1.9 Adjust the local N_2 pressure valve in the hood ting knob and set the pressure to 20 psi on the low pressure gauge.

7.1.10 Turn the Outlet Valve on from the flowmeter on until the flow registers 60 mL/min.

7.1.11 Use timer set for 30 minutes. After 30 minutes, close off the main valve on the nitrogen tank followed by the pressure adjusting knob and then the outlet valve. Disconnect all of the scrubbers on the apparatus.

7.1.12 A portion of the scrubber is transferred to 40-mL VOA vial for CN analysis. The remainder (150 mL) is covered and titrated ASAP for reactive sulfide where requested.

7.2 ANALYSIS OF CN

7.2.1 Cyanide concentration in the scrubber is determined by automated colorimetry (e.g., Konelab) in accordance with the protocols delineated in the most current revision of Katahdin SOP CA-773, Total Cyanide, for the analysis procedure.

7.2.2 A portion of the scrubber solution may also be used for Reactive Sulfide analysis. See SOP CA-734, Reactive Sulfide: SW-846, 7.3.4.2.

7.2.3 The rate of release of HCN (mg/Kg/sec) is calculated as follows:

$$R = \text{Specific Rate or Release, mg/Kg/Sec} = \frac{A \times V}{W \times S}$$

where: A = concentration of HCN in the scrubber as mg/L
= 1.04 x CN mg/L (1.04=MW HCN/MW CN= 27.03/26.0179)
V = volume in scrubber, Liters, i.e. 0.19
W= weight of waste, Kg
S = Time of measurement, Time N_2 stopped - Time N_2 started, sec

7.2.4 The releasable HCN as mg/Kg is calculated as follows:

$$\text{Total Releasable HCN, mg/Kg} = \frac{A \times V}{W}$$

where: A = concentration of HCN in the scrubber as mg/L
= 1.04 x CN mg/L (1.04=MW HCN/MW CN= 27.03/26.0179)
V = volume in scrubber, Liters, i.e. 0.19
W= weight of waste, Kg

7.3 REPORTING

7.3.1 Enter results, including sample preparation information, measured sample concentrations, and quality control data, into the Katahdin Information Management System for calculation and reporting. Refer to the current revision of SOP CA-762 ("Wet Chemistry Data Entry and Review Using Katahdin Information Management System") for further information. A batch sheet is generated (Figure 2). Raw data and batch sheets are reviewed for completeness and accuracy by the Inorganic Department Manager or other qualified designee.

7.3.2 All batch sheets and copies of the raw logbook data are filed with the Inorganic Department Manager for approximately 3 months, for reference by analysts. Prior data are archived.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Refer to Table 1 for a summary of QC requirements, acceptance criteria, and corrective actions. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments.

These decisions are based on holding time considerations, remaining sample volume and client and project specific Data Quality Objectives. The supervisor, Operations Manager, General Manager and/or Quality Assurance Officer may be consulted to evaluate data. Some

samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

Every instance of noncompliant method quality control requires the generation of a Corrective Action Report describing the problem, suspected cause and final resolution. Corrective action reports must be signed by the initiator, Department Manager, QA officer, and lab management.

8.1 One laboratory control sample (LCS) is distilled with every batch of 20 samples. The LCS spike solution (1000 mg/L cyanide standard) is an independently prepared standard from which 0.05 ml is distilled. Evaluate the % recovery based on historical laboratory data. The range of recovery for the LCS is 0 – 100 %.

8.2 A duplicate is run every ten samples. Sample duplicates are expected to agree within 20% relative difference. If duplicate samples are out of control, re-distill another replicate.

8.3 A method blank is analyzed with every batch or analytical session. The concentration of the blank must be less than the detection limit (1 mg/kg).

8.4 Non-conformance report: Every instance of noncompliant method quality control requires the generation of a non-conformance report describing the problem, suspected cause and final resolution. Non-conformance reports must be signed by the initiator, Inorganic Department Manager, QA officer, and lab management.

9.0 METHOD PERFORMANCE

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 value is above zero. The MDLs are determined initially prior to sample analysis and filed with the Inorganic Department Manager and with the QAO. Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revisions of SW-846, 7.3.3.2 for other method performance parameters and requirements.

TITLE: REACTIVE CYANIDE: SW-846, 7.3.3.2

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Waste Physical/Chemical Methods, US EPA SW 846, 3rd edition, Volume 1C, Chapter Seven, Section 7.3.3.2, Rev. 2, September 1994.

Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, US EPA SW-846, 3rd Edition, Method 9012, Rev. 0, September 1986.

Department of Defense Quality Systems Manual for Environmental Laboratories (DoD QSM), Version 4.1, 04/22/09

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 4.2, 10/25/2010.

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Katahdin SOP CA-773, “Colorimetric Analysis of Total and Amenable Cyanide Using the Automated Konelab Multiwavelength Photometric Analyzer".

Katahdin SOP CA-101, “Equipment Maintenance and Troubleshooting”, current revision.

Katahdin SOP CA-762, “Wet Chemistry Data Entry and Review Using Katahdin Information Management System (KIMS)”

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision.

List of Figures and Tables

TITLE: REACTIVE CYANIDE: SW-846, 7.3.3.2

TABLE 1

QC REQUIREMENTS

Parameter/ Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Reactive Cyanide SW-846 7.3.3.2	Method blank	One per prep batch of 20 or fewer samples	HCN not detected >PQL (For DoD QSM, no analyte detected > ½ PQL and > 1/10 the amount measured in any sample)	(1) Investigate source of contamination (2) Report all sample results <PQL. (3) Report sample results >10X the blank result and flag results with a "B". (4) Reanalyze all other samples associated with the failing blank.
	CCV	At beginning of run, after every ten samples, and at end of run	85-115% recovery	(1) If the CCV fails high, report samples that are <PQL (2) Recalibrate and/or reanalyze other samples
	CCB	Immediately following each CCV	No analyte detected >PQL	(1) Investigate source of contamination (2) Report all sample results >10x the CCB (3) Report all sample results <PQL (4) Reanalyze all other samples associated with failing CCB
	LCS	One per prep batch of 20 or fewer samples	0 – 100% nominal; statistically derived after sufficient historical	(1) If the LCS fails high, report samples that are <PQL. (2)Reanalyze /or recalibrate and reanalyze (3) Redistill, recalibrate and/or reanalyze other samples.
	Matrix Spike	One per prep batch of 20 or fewer samples	0-100 %R	(1) Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. (2) If both the LCS and MS are unacceptable reprep and reanalyze the samples and QC. (3) Analyze unspiked sample scrubber solution with post-scrub spike to confirm matrix interference present in the scrubber (4) It should be anticipated that 0% to very low recoveries may be evidenced in high metals content samples. (5) Notate sample result in raw data if matrix interference confirmed
	Sample Duplicate	One every ten samples	RPD $\leq$ 20%	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >20, report original result with notation or narration.
	Demonstration of analyst proficiency	One time per analyst initially and annually thereafter	P&A meet method criteria	Repeat P&A study
	MDL study	Refer to KAS SOP QA-806, "Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications", current revision.		

TITLE: REACTIVE CYANIDE: SW-846, 7.3.3.2

TABLE 2

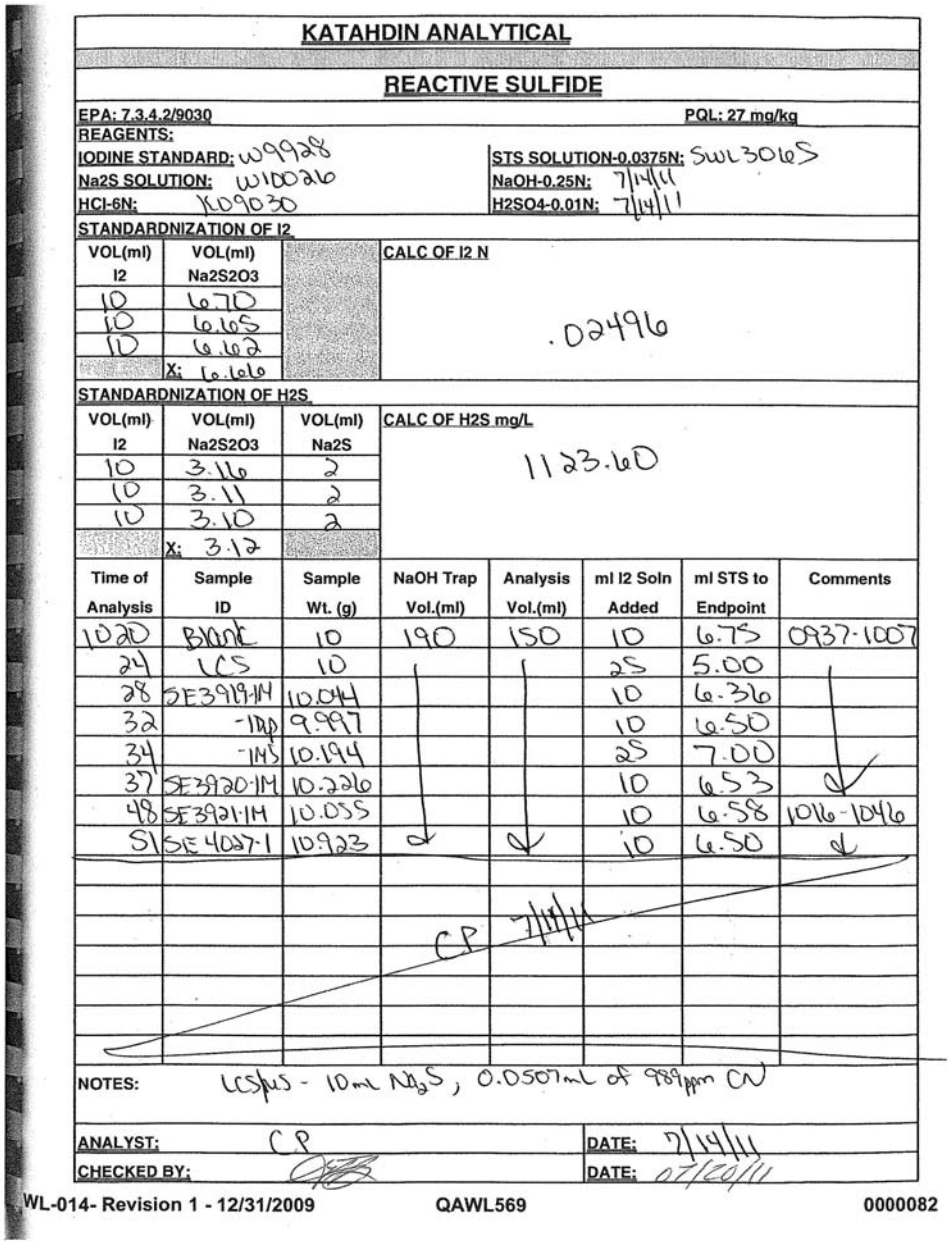
SUMMARY OF METHOD MODIFICATIONS

Topic	Katahdin SOP CA-733-06	Method 7.3.3.2, current revision
Apparatus/Materials	(1) 250 mL scrubber (2) Gas washing bottles	(1) 50 mL scrubber (2) Ground glass glassware
Reagents	(1) Cyanide reference solution, 1000 mg/L prepared in 250 mL with 0.5 g KOH	(1) Cyanide reference solution, 1000 mg/L prepared in 250 mL with 0.625 g KOH
Sample preservation/ handling		
Procedures	(1) 190 mL of 0.25 N NaOH are added to each scrubber (absorber bottle) prior to distillation. (2) 180 mL of 0.01 H2SO4 added to reflux bottle.	(1) 50 mL of 0.25 N NaOH is added to each scrubber, then diluted with water to obtain an adequate depth of liquid in the scrubber. (2) Add enough sulfuric acid to fill flask half full.
QC - Spikes		
QC - LCS		
QC - Accuracy/Precision		
QC - MDL		

TITLE: REACTIVE CYANIDE: SW-846, 7.3.3.2

FIGURE 1

EXAMPLE OF LOGBOOK PAGE



KATAHDIN ANALYTICAL

REACTIVE SULFIDE

EPA: 7.3.4.2/9030 PQL: 27 mg/kg

REAGENTS:

IODINE STANDARD: W9928
Na2S SOLUTION: W10026
HCl-6N: K09030
STS SOLUTION-0.0375N: SWL3016S
NaOH-0.25N: 7/14/11
H2SO4-0.01N: 7/14/11

STANDARDNIZATION OF I2.

VOL(ml) I2	VOL(ml) Na2S2O3
10	6.70
10	6.165
10	6.162
X:	6.609

CALC OF I2 N: .02496

STANDARDNIZATION OF H2S.

VOL(ml) I2	VOL(ml) Na2S2O3	VOL(ml) Na2S
10	3.116	2
10	3.11	2
10	3.10	2
X:	3.12	

CALC OF H2S mg/L: 1123.60

Time of Analysis	Sample ID	Sample Wt. (g)	NaOH Trap Vol.(ml)	Analysis Vol.(ml)	ml I2 Soln Added	ml STS to Endpoint	Comments
1020	BLANK	10	190	150	10	6.75	0937-1007
24	LCS	10			25	5.00	
28	SE3919-1M	10.044			10	6.36	
32	-1MD	9.997			10	6.50	
34	-1MS	10.194			25	7.00	
37	SE3920-1M	10.226			10	6.53	
48	SE3921-1M	10.055			10	6.58	1016-1046
51	SE4027-1	10.923			10	6.50	

CP 7/14/11

NOTES: LCS/MS - 10mL Na_2S, 0.050mL of 989ppm CN

ANALYST: CP DATE: 7/14/11
CHECKED BY: DATE: 07/20/11

WL-014- Revision 1 - 12/31/2009 QAWL569 0000082

TITLE: REACTIVE CYANIDE: SW-846, 7.3.3.2

FIGURE 2

EXAMPLE OF BATCH SHEET

WET CHEMISTRY BATCH REPORT
Jul 20 2011, 09:27 am
Batch: WG94252

Parameter: Cyanide, Reactive
Prep Date: 14-JUL-11

Date Analyzed: 18-JUL-11
Prep Method: SW846 7.3.4

Analyst Initials: AMB
Prep Chemist: CP

Sample	Samp Type	Method	Initial Amt.	Final Amt.	Rpt. DF	Result	Rpt Result	TS(%)	PQL	MDL	Adj PQL	RPD	%Rec
SE3919-1	SAMP	SW846 7.3.3	10.044g	190.00mL	.996	-.2001	U1.0 mg/Kg	NA	1	0.16	1.0		
SE3920-1	SAMP	SW846 7.3.3	10.226g	190.00mL	.978	.20921	U1.0 mg/Kg	NA	1	0.16	1.0		
SE3921-1	SAMP	SW846 7.3.3	10.055g	190.00mL	.994	.09258	U1.0 mg/Kg	NA	1	0.16	1.0		
SE4027-1	SAMP	SW846 7.3.3	10.923g	190.00mL	.915	-.2397	U1.0 mg/Kg	NA	1	0.16	1.0		
WG94252-1	MBLANK	SW846 7.3.3	10.000g	190.00mL	1	.49397	U0.80 mg/Kg	NA	1	0.16	1.0		
WG94252-2	LCS	SW846 7.3.3	10.000g	190.00mL	1	224.611	4.3 mg/Kg	NA	1	0.16	1.0		85
WG94252-3	DUP	SW846 7.3.3	9.9970g	190.00mL	1	.35493	U0.80 mg/Kg	NA	1	0.16	1.0	NC	
WG94252-4	MS	SW846 7.3.3	10.194g	190.00mL	.981	73.515	1.4 mg/Kg	NA	1	0.16	1.0		27

Comments:

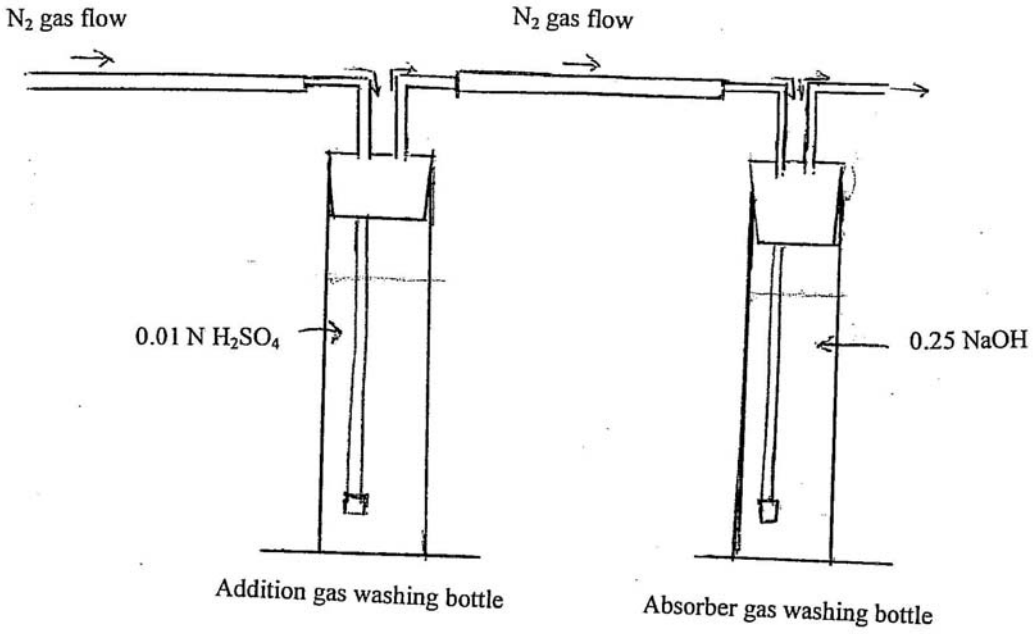
WG94252-1	SE3919-1
WG94252-2	SE3919-1
WG94252-3	SE3919-1
WG94252-4	SE3919-1

Entered by: BmB Date: 7/26/11 Accepted by: [signature] Date: 07/26/11

TITLE: REACTIVE CYANIDE: SW-846, 7.3.3.2

FIGURE 3

REACTIVE CYANIDE APPARATUS



ADDENDUM

SOP NO CHANGE FORM

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Derek Wright

Review Date: 1/28/13

SOP Number: CA-7336

SOP Title: Reactive Cyanide: SW-846, 7.3.3.2

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: _____ **Date:** 02/26/13

QAO Signature: Jessie Dimond **Date:** 030413

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Derek Wright

Review Date: 3/3/14

SOP Number: CA-753-06

SOP Title: Reactive Cyanide: SW846, 7.3.3.2

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: _____ **Date:** 03/21/14

QAO Signature: Teresa Dimond **Date:** 04/15/14

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

SOP Number: CA-734
Revision History
Cover Page
Page 1

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

Prepared By: Wet Chemistry Date: 8/96

Approved By:

Group Supervisor: J Bunton for K. Tanguay Date: 2/01

Operations Manager: J C Bunton Date: 2/01

QA Officer: Deborah J. Nadeau Date: 2.15.01

General Manager: Duncan T. Heffron Date: 2/15/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
02	Format changes, added pollution prevention and database. Deleted titration and added reference to analytical titrimetric SOP.	DH	2.15.01	2.15.01
03	Major changes to apparatus & procedure to reflect current practice. Added reference for CA-107 - sect. 1.4. Added program specific info to sect.'s Supervisor ⇒ manager. Changes throughout to reflect current practice. Updated figures.	LAD	04/06	04/06
04	Sect. 1.1 - Added definitions. Minor changes throughout to reflect current practices. Updated method and SOP references. Updated Table 2 (method modifications)	LAD	05/09	05/09
05	Added definitions to section 1.1. Updated Table 1 for DOD QSM version 4.1 compliance. Added references to section 10.	DH	08/09	08/09
06	Sect. 14 - Changed "G" to "Non-Hazardous" waste. Updated and/or added references to Sect. 10.	LAD	06/10	06/10

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
07	Sect. 7 – Added raw data archival information. Sect. 9 Added MDL, LOD & LOQ information. Sect. 10 – Added and edited references. Updated Figures 1 – 3.	LAD	05|12	05|12

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-734-07**, titled **REACTIVE SULFIDE: SW-846 7.3.4.2**

.

Recipient: _____ Date: _____

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-734-07**, titled **REACTIVE SULFIDE: SW-846 7.3.4.2**

Recipient: _____ Date: _____

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

1.0 SCOPE AND APPLICATION

The intended application of this method is to determine the hydrogen sulfide released from wastes. This method is applicable to all waste except those that will form explosive mixtures when combined with acids. This test measures only the hydrogen sulfide evolved at the test conditions. It is not intended to measure forms of sulfide other than those that are evolved under the test conditions. This method provides a means to determine the specific rate of release of hydrogen sulfide upon contact with an aqueous acid. The regulatory limit for *Total Releasable Sulfide* is 500 H_2S mg/Kg waste.

1.1 Definitions

Duplicate - A second aliquot of a sample that is prepared and analyzed in the same way as the original sample in order to determine the precision of the method.

Laboratory Control Sample (LCS): A standard material of known concentration that has been brought through the sample preparation and analysis process. The LCS is used to assess the accuracy of the method. One LCS is required per batch.

LOD – Limit of Detection. The smallest amount or concentration of an analyte that must be present in a sample to be detected at a 99% confidence level. At the LOD, the false negative rate is 1%.

MB – Method Blank - Reagent water that has been brought through the sample preparation and analysis process. The MB is used to assess contamination.

PQL - Practical Quantitation Limit - The lowest concentration of an analyte that is routinely reported by the laboratory; nominally three to five times the MDL.

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

Reactive Sulfide: Hydrogen Sulfide released under the test conditions defined under SW846 Chapter 7, 7.3.4.2 where the sample is exposed to mildly acidic conditions

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of reactive sulfide according to SW-846, 7.3.4.2. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, “Personnel Training & Documentation of Capability,” current revision.

It is the responsibility of all Katahdin technical personnel involved in the analysis of reactive sulfide according to SW-846, 7.3.4.2 and sulfide according to SW-846, 9034 to

read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure. These materials include the following: Sodium Hydroxide, Sulfuric Acid, Hydrochloric Acid, Sodium Thiosulfate, Potassium Bi-iodate, Iodine and Sulfide.

Each qualified analyst or technician must be familiar with Katahdin Analytical Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and follow appropriate procedures such as: wearing safety glasses and gloves when working with chemicals or near an instrument; not taking food or drink into the laboratory; each analyst should know the location of all safety equipment and be trained on how to use it.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Plan for further details on pollution prevention techniques.

The basic waste generated from this analysis is placed in satellite “NHi” or pyridine waste. The acidic waste is put in satellite “A” or acid waste.

Other wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Analytical Health and Safety Manual and SOP SD-903, “Sample Disposal” and CA-107, “The Management of Hazardous Waste as it Relates to the Disposal of Laboratory Process Waste, Reagents, Solvents and Standards,” current revisions. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with these SOPs.

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

2.0 SUMMARY OF METHOD

An aliquot of acid is added to a fixed weight of waste in a closed system. The gas that is generated is swept into an alkaline scrubber. The specific rate of release of hydrogen sulfide is determined. The sulfide is quantified using method 9034, Katahdin SOP CA-722, "Titrimetric Determination of Sulfide using EPA Method 376.1, SM4500S2 F, SW846 9034 and SW 7.3.4".

3.0 INTERFERENCES

Interferences are undetermined.

4.0 APPARATUS AND MATERIALS

4.1 Magnetic stirrer; to achieve approximately 30 rpm.

4.2 Magnetic stirring bars and retriever.

4.3 Flexible tubing for connection from the nitrogen supply to the apparatus and from the flask to the absorber impinger unit.

4.4 Nitrogen gas tank with regulator.

4.5 Gas valve capable of metering N_2 flow to 20 psi

4.6 Flowmeter capable of measuring flow at 60 mL/min at the distillation station.

4.7 12 gas scrubbers, with 250mL graduated cylinders

4.8 Analytical balance weighing to 0.001g.

4.9 10-mL buret

4.10 Stir plate for titration

4.11 Buret stand and holder

4.12 Disposable pasteur pipets

4.13 1 mL and 5 mL calibrated Eppendorf pipets and tips

4.14 250 mL graduated cylinder (Class A)

4.15 400 mL beakers

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

5.0 REAGENTS

5.1 Laboratory reagent grade water: Equivalent in protocol as reagent or DI water

5.2 Sulfuric acid (0.1 N), H_2SO_4: Add 5.6 ml of concentrated H_2SO_4 to laboratory reagent grade water and dilute to 2 liters.

5.3 Sulfuric acid (0.01 N), H_2SO_4: Volumetrically transfer 200 ml of 0.1 N H_2SO_4 and dilute to 2 liters with laboratory reagent grade water to make the 0.01 N H_2SO_4.

5.4 Sodium hydroxide solution (0.25 N) ,NaOH: Dilute 25.0 ml of 10 N NaOH to 1 liter of Laboratory reagent grade water. This solution may also be prepared by dissolving 10 g of NaOH in laboratory reagent grade water and diluting to 1 liter.

5.5 6N hydrochloric acid - CAUTION: In a fume hood add 500 mls of concentrated HCl to 500 ml laboratory reagent grade water, slowly mix and allow to cool.

5.6 Standard iodine solution 0.0250N: Dissolve 20 - 25 g KI in 1 L of laboratory reagent grade water and add 3.2 g iodine. After iodine has dissolved, standardize against 0.0375N sodium thiosulfate using the starch solution as an indicator. (See Katahdin SOP CA-722, Titrimetric Determination of Sulfide, for the standardization procedure).

5.7 0.0375N sodium thiosulfate titrant, ($Na_2S_2O_3$): purchased

5.8 Potassium iodide, KI, granular certifed ACS grade

5.9 Starch, 0.5%, preserved with chloroform: purchased

5.10 Sodium sulfide (Na_2S) standard: Dissolve 3.75 g reagent grade sodium sulfide nonahydrate ($Na_2S \cdot 9H_2O$; FW240.18) into 500 mL laboratory reagent grade water. This is equivalent to an estimated value of 1001 mg/L S or 1064 mg/L H_2S. This must be standardized in accordance with the procedure described in Section 7 below. The sodium sulfide standard is stable for 6 months from the date of preparation. Store in an amber glass container in the refrigerator.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

6.1 Samples should be collected with a minimum of aeration. The filled sample bottle should contain no headspace and should be kept cool and in the dark until analysis. Begin analysis as soon as possible. Perform analysis in a ventilated hood.

6.2 Samples can be preserved by adjusting the pH to 12 with NaOH and adding zinc acetate. This may cause dilution of the sample, increase the ionic strength, and possibly change other physical or chemical properties of the waste that may affect the release of hydrogen sulfide. Samples are stored at 4°C in the dark.

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

7.0 PROCEDURES

7.1 STANDARDIZATION OF IODINE

7.1.1 Repeat the titration in triplicate. Base normality on the mean of the titrations unless an outlier is established by statistical rationale.

7.1.2 Using a class A volumetric pipet 10.0 mL of the Standard Iodine Solution (5.6) into a 400 mL beaker. Add 2 mL 6 N HCl and add 200 mL Laboratory reagent grade water.

7.1.3 Place beaker on a stir plate; stir gently so as not to excessively aerate the sample. Titrate with 0.0375N sodium thiosulfate from a 10- mL buret with the tip submerged. Titrate until a straw color (pale yellow) develops.

7.1.4 Add approximately ~1 mL of starch indicator with a disposable pasteur pipet. The color will turn blue. Titrate with sodium thiosulfate until blue color disappears and the solution is clear and colorless.

7.1.5 Record to two decimal places the total volume of sodium thiosulfate used for each of the three replicates. Using the average of the of the mLs of sodium thiosulfate used in the triplicate determinations calculate the normality of the I_2

$$Normality\ I_2 = \frac{mLs\ Na_2SO_3 \times Normality\ Na_2SO_3}{mLs\ I_2\ Titrated}$$

solution as follows:

7.2 STANDARDIZATION OF SODIUM SULFIDE

7.2.1 To standardize the Sodium Sulfide Standard (5.10) repeat the titration in triplicate. Base normality on the mean of the titrations unless an outlier is established by statistical rationale. The analysis is accomplished by placing an excess of iodine based upon the sulfide concentration in the flask and back titrating the excess iodine with sodium thiosulfate.

7.2.2 Using an adjustable pipet, add 10.0 mL of the Standard Iodine Solution (5.6) into a 400 mL beaker. Add 2 mL 6 N HCl and add 200 mL Laboratory reagent grade water.

7.2.3 Quantitatively aliquot 2.0 mL of standard sulfide solution (5.10) dispensing below the surface of the liquid in the Erlenmeyer.

7.2.4 Place Erlenmeyer flask on a stir plate; stir gently so as not to excessively aerate the sample. Titrate with 0.0375N sodium thiosulfate from a 25- mL buret with the tip submerged. Titrate until a straw color (pale yellow) develops.

7.2.5 Add approximately ~1 mL of starch indicator with a disposable pasteur pipet. The color will turn blue. Titrate with sodium thiosulfate until blue color disappears and the solution is clear and colorless.

7.2.6 Record to two decimal places the total volume of sodium thiosulfate used for each of the three replicates. Using the average of the of the mLs of sodium thiosulfate used in the triplicate determinations calculate the concentration of sulfide as S^{2-} mg/L as follows:

$$mg\ S^{2-} / L = \frac{(A \times B) - (C \times D) \times 16{,}000}{mLs\ Na_2S}$$

where: A = mLs iodine solution
B = normality of iodine solution
C = mls $Na_2S_2O_3$ solution
D = normality of $Na_2S_2O_3$ solution, and
16,000 = mg equivalence S^{2-}, 32,066 mg / 2 equivalence

7.2.7 To convert the S^{2-} mg/L to H_2S multiply determined concentration of the sulfide solution times 1.06 where 1.06 = 34.08 g (MW H_2S)/32.07 g (MW S).

7.2.8 The concentration as H_2S is entered into the spreadsheet for further calculations.

7.3 SAMPLE PREPARATION FOR GENERATION OF RELEASABLE SULFIDE

7.3.1 Weigh approximately 10 g of sample in a 250 mL addition graduated cylinder. Record weight in the preparation logbook. Refer to Katahdin SOP CA-108, Basic Laboratory Technique, current revision, for information on subsampling.

7.3.2 To prepare Method Blank transfer 10 g of Laboratory reagent grade water to a 250mL addition graduated cylinder.

7.3.3 To prepare LCS transfer 10.0 mL of Sodium Sulfide Standard (5.10) to a 250mL addition graduated cylinder.

7.3.4 To prepare a Matrix Spike (MS), weigh approximately 10 g of sample in a 250mL addition graduated cylinder. Spike the sample with 10.0 mL of Sodium Sulfide Standard Solution (5.11).

7.3.5 To prepare sample Duplicate weigh out approximately 10 g of the sample selected/designated as the sample duplicate in a 250mL addition graduated cylinder

7.3.6 Add 190 ml of 0.25 N NaOH to each of the absorber graduated cylinders

7.3.7 Turn on the main valve on the Nitrogen tank. Make sure it is reading 300 psi or greater.

7.3.8 Adjust the local N_2 pressure valve in the hood and set the pressure to 20 psi on the low pressure gauge.

7.3.9 Turn the Outlet Valve of the flowmeter until the flow registers 60 mL/min.

7.3.10 Add 180mL of 0.01N H2SO4 to the addition graduated cylinders and connect the apparatus as shown in fig. 3.

7.3.11 Use a timer set for 30 minutes. After 30 minutes, disconnect all of the scrubbers on the apparatus.

7.3.12 Close off the main valve on the nitrogen tank followed by the pressure adjusting knob and then the outlet valve.

7.3.13 When requested a portion of the scrubber is transferred to 40-mL VOA vial for reactive CN analysis. The remainder is covered and titrated ASAP for reactive sulfide.

7.4 ANALYSIS OF SULFIDE

7.4.1 Releasable sulfide concentration is determined titrimetrically by analyzing a portion of the scrubber solution in accordance with the protocols delineated in the most current revision of Katahdin SOP CA-722, Titrimetric Determination of Sulfide Using EPA Method 376.1; SW846 9034. The scrubber aliquot is acidified to a pH of 2 using 15.0 mL 6N HCl prior to the start of the iodometric titration. In the case where only reactive sulfide is performed take the entire 190 mL scrubber solution for titration else take 150 mL.

7.4.2 A 40 mL portion of the scrubber solution may also be used for Reactive Cyanide analysis. See SOP CA-733, Reactive Cyanide: SW-846, 7.3.4.2.

7.4.3 The rate of release of H_2S (mg/Kg/sec) is calculated as follows:

$$R = specific\ rate\ of\ \ release\ , mg / Kg / Sec = \frac{A \times V}{W \times S}$$

Where: *A* = concentration of H_2S in the scrubber as mg/L = 1.06 x S^{2-} mg/L
(1.06=MW H_2S/MW S=34.08 g /32.07 g)
V = volume in scrubber, Liters, i.e. 0.25
W= weight of waste, Kg
S = Time of measurement, Time N_2 stopped - Time N_2 started, sec

7.4.4 The releasable H_2S as mg/Kg is calculated as follows:

$$Total\ \mathrm{Re}leasable\ H_2S, mg / Kg = \frac{A \times V}{W}$$

where: *A* = concentration of H_2S in the scrubber as mg/L = 1.06 x S^{2-} mg/L
(1.06=MW H_2S/MW S=34.08 g /32.07 g)
V = volume in scrubber, Liters, i.e. 0.25
W= weight of waste, Kg

7.4.5 The above calculations are typically done using a spreadsheet template on which the analyst enters the sample number, date prepared, date analyzed, initial sample weight, trap volume, volume of sample distillate, volume of standard iodine solution used, volume of sodium thiosulfate used, and the normality of both the iodine and sodium thiosulfate solutions. Results are reported to 2 significant figures with the method reported as SW 846, 7.3.4.2.

7.4.6 Enter spreadsheet results, including sample preparation information, measured sample concentrations, and quality control data, into the Katahdin Information Management System for calculation and reporting. Refer to the current revision of SOP CA-762 ("Wet Chemistry Data Entry and Review Using Katahdin Information Management System") for further information. A batch sheet is generated (Figure 3). Raw data and batch sheets are reviewed for completeness and accuracy by the Inorganic Department Manager or other qualified designee.

7.4.7 All batch sheets, raw data, and supporting documents are scanned after final review and the resulting image files are saved on a Katahdin server for use in data package assembly. Image files of raw data are periodically archived by the laboratory's MIS department.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Refer to Table 1 for a summary of QC requirements, acceptance criteria, and corrective actions. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in

Table 1 may rely on analyst experience to make sound scientific judgements. These decisions are based on holding time considerations, remaining sample volume and client and project specific Data Quality Objectives. The supervisor, Operations Manager, General Manager and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

Every instance of noncompliant method quality control requires the generation of a Corrective Action Report describing the problem, suspected cause and final resolution. Corrective action reports must be signed by the initiator, Department Manager, QA officer, and lab management.

8.1 A method blank consisting of laboratory reagent grade water is analyzed with every batch or analytical session. The concentration of the blank must be less than the Practical Quantitation Limit (27 mg/kg)

8.2 A duplicate sample is also analyzed with every batch and duplicate samples are expected to agree within 20% relative difference.

8.3 A matrix spike sample is also analyzed with every batch of twenty samples. Acceptance criteria for spikes are 50 - 150% recovery.

8.4 The efficiency of this method is measured by first standardizing the Sodium Sulfide Standard (5.10) using three 2.0 mL aliquots diluted to 200 mL as described in steps 7.2.3-7.2.7. After standardization, a 10.0 mL aliquot of the Sodium Sulfide Standard (5.10) is distilled and then analyzed as the LCS. A recovery of 50 - 150% is adequate to demonstrate proper system operation.

8.5 If any of the QC requirements are outside the recovery ranges listed above in Section 8.0, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Refer to table 1 for corrective actions. The Department Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Due to the short hold time associated with this method, samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

9.0 METHOD PERFORMANCE

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 value is above zero. The MDLs shall be determined and verified one time per type of instrument unless otherwise required by the method.

A Limit of Detection (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent. LODs must be determined for all parameters for which the laboratory is accredited under the DoD Environmental Laboratory Accreditation Program. LOD's must be verified for every preparation and analytical method combination and on every applicable instrument on a quarterly basis.

The Limit of Detection (LOQ) is the minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ shall be set at the lowest point in the calibration curve for all analyses utilizing an initial calibration. LOQ's must be verified quarterly for every preparation and analytical method combination and on every applicable instrument on a quarterly basis for all parameters included in the DoD Scope of Accreditation. The LOQ must be verified at least once annually if the analysis is not included in the DoD Scope of Accreditation.

MDLs are filed with the Inorganic Department Manager and then with the QAO. LOD and LOQ verifications are filed with the QAO

Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revisions of SW-846, 7.3.4.2 for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, US EPA SW-846, 3rd Edition, Volume 1C, Chapter Seven, Section 7.3.4.2, "Test Method to Determine Hydrogen Sulfide Released from Wastes", Rev. 3, December, 1996.

Test Methods for Evaluating Solid Waste Physical/Chemical Methods, US EPA SW 846, 3rd edition, Volume 1C, Chapter Seven, Section 7.3.4.2, Rev. 2, September 1994.

Department of Defense Quality Systems Manual for Environmental Laboratories (DoD QSM), Current Version.

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The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Katahdin SOP CA-722, Titrimetric Determination of Sulfide Using EPA Method 376.1, SM4500-S^{2-} F, SW846 9034 and SW846 7.3.4, current revision.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP CA-762, Wet Chemistry Data Entry and Review Using Katahdin Information Management System (KIMS), current revision.

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications

List of Figures and Tables

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

TABLE 1

QC REQUIREMENTS

Parameter/ Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Reactive Sulfide SW-846 7.3.4.2	Method blank	One per prep batch of 20 or fewer samples	No analyte detected >PQL (For DoD QSM, no analyte detected > ½ PQL and > 1/10 the amount measured in any sample)	(1) Investigate source of contamination (2) Report all sample results <PQL. (3) Report sample results >10X the blank result and flag results with a "B". (4) If possible, reanalyze all other samples associated with the failing blank.
	LCS	One per prep batch of 20 or fewer samples	50%-150% rcvy, statistically derived from lab data	(1) If the LCS fails high, report samples that are <PQL. (2) Reanalyze /or recalibrate and reanalyze (3) Redistill, recalibrate and/or reanalyze other samples.
	Matrix Spike	One for every set of 10 samples	50%-150% rcvy.	(1) Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. (2) If both the LCS and MS are unacceptable reprep and reanalyze the samples and QC. (3) Analyze unspiked sample scrubber solution with post-scrubber spike to confirm matrix interference (4) Notate sample result in raw data if matrix interference confirmed
	Sample Duplicate	One sample duplicate per ten samples	RPD $\leq$ 20%	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >20, report original result with notation or narration.
	Demonstration of analyst proficiency – 4 replicates.	Once per analyst.	P&A meet method criteria	Repeat analysis until able to perform passing QC; document successful performance in personal training file
	MDL study and/or LOD/LOQ Verifications	Refer to KAS SOP QA-806, "Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications", current revision.		

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

TABLE 2

SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-734-07	METHOD 7.3.4.2, current revision
Apparatus/Materials	Gas washing bottles are used	Glassware with ground glass connections is used
Reagents	1) 0.0375 N sodium thiosulfate purchased commercially. 2) Sodium Sulfide standard is prepared by dissolving 3.75g of Sodium Sulfide into 500 mL reagent water	1) 0.025 N sodium thiosulfate prepared in lab. 2) Sodium Sulfide standard is prepared by dissolving 4.02g of Sodium Sulfide into 1000 mL reagent water
Sample preservation/ handling		
Procedures	1) 190 mL of 0.25 N NaOH are added to each scrubber (absorber bottle) prior to distillation. 2) 15.0 mL of 6N HCl are added to the scrubber solution (sample distillate) to bring pH to <2; actual pH of scrubber solution is not verified. 3) 180 mL of 0.01N H_2SO_4 is added to each of the addition graduated cylinders	1) 50 mL of 0.25 N NaOH are added to each scrubber, then diluted with water to obtain an adequate depth of liquid in the scrubber. 2) A small amount of scrubber solution (sample distillate) is titrated with 6N HCl to determine volume of HCl needed to acidify entire scrubber solution to pH <2; the small acidified aliquot is then combined with the remainder of the acidified scrubber solution. 3) Add enough sulfuric acid to fill the flask half full
QC - Spikes		
QC - LCS		
QC - Accuracy/Precision		

FIGURE 1

EXAMPLE OF LOGBOOK PAGE

KATAHDIN ANALYTICAL

REACTIVE SULFIDE

EPA: 7.3.4.2/9030 PQL: 27 mg/kg

REAGENTS:

IODINE STANDARD: W10433 — STS SOLUTION-0.0375N: SU13218
Na2S SOLUTION: W10396 — NaOH-0.25N: 3/27/12
HCl-6N: K33032 — H2SO4-0.01N: 3/27/12

STANDARDNIZATION OF I2

VOL(ml) I2	VOL(ml) Na2S2O3		CALC OF I2 N
10.000	6.85		
	6.75		
↓	6.70		
	X: 6.77		

STANDARDNIZATION OF H2S

VOL(ml) I2	VOL(ml) Na2S2O3	VOL(ml) Na2S	CALC OF H2S mg/L 805.60
10.000	4.20	2.000	
	4.20		
↓	4.30	↓	
	X: 4.23		

Time of Analysis	Sample ID	Sample Wt. (g)	NaOH Trap Vol.(ml)	Analysis Vol.(ml)	ml I2 Soln Added	ml STS to Endpoint	Comments
1451	Blank	10.000	190	150	10.000	6.70	1338-1408
1452	LCS	10.000			25.000	~~8.00~~ 6.30	
1453	SF15651	10.105			10.000	6.80	
1454	-1MS	10.104			10.000	6.70	
1455	-1MSD	10.061			25.000	8.40	
1456	SF1566-1	10.113			10.000	6.45	↓
1521	SF16246	9.526			10.000	6.75	1450-1520
1522	SF1635-2	9.547			10.000	6.70	
1523	SF1635-4	10.316			10.000	6.40	
1524	SF1657-1	10.752	↓	↓	10.000	6.60	↓

NOTES:

ANALYST: DMB DATE: 3/27/12
CHECKED BY: DN DATE: 3-28-12

WL-014- Revision 1 - 12/31/2009 QAWC630 0000031

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

FIGURE 2

EXAMPLE OF REACTIVE SULFIDE SPREADSHEET OF RESULTS

REACTIVE SULFIDES
TITRIMETRIC

EPA: 7.3.4.2/9030
PQL = 27 mg/kg

DATE:	4/16/2012
ANALYST:	AMB

STANDARDIZATION OF IODINE SOLUTION

VOL (mL) I_2	VOL (mL) $Na_2S_2O_3$
10.00	6.50
10.00	6.50
10.00	6.45
Mean $Na_2S_2O_3$=	6.48
CALC I_2 N =	0.02431

STANDARDIZATION OF SODIUM SULFIDE STANDARD

VOL (mL) I_2	VOL (mL) NA_2S	VOL (mL) $Na_2S_2O_3$
10.00	2.00	3.90
10.00	2.00	4.05
10.00	2.00	4.10
Mean Vol $Na_2S_2O_3$=		4.02
CALC NA_2S (mg H_2S/L):		784.40

$Na_2S_2O_3$ Normality:	0.0375

Sample ID	Sample Wt. (g)	Trap Vol. (mL)	Analysis Vol. (mL)	Volume I_2 Added (mL)	Volume $Na_2S_2O_3$ Added (mL)	Extraction Time (sec)	Calc. Sulfide (as H_2S) in Analysis Aliquot (mg)	Releasable H_2S in Smpl. (mg/kg)	Recovery (%)	Duplicate RPD (%)
BLK	10.000	190.00	150.00	10.00	6.55	1800.00	-0.04	-5.40		
LCS S2	10.000	190.00	150.00	25.00	9.15	1800.00	4.24	571.30	72.8	
SF1987-1	10.054	190.00	150.00	10.00	6.65		-0.10	-13.42		
SF1987-1DUP	9.986	190.00	150.00	10.00	6.25		0.14	18.91		
SF1987-1MS	9.954	190.00	150.00	25.00	9.35		4.12	557.68		
SF1987-2	10.185	190.00	150.00	10.00	6.60		-0.07	-9.27		
SF2023-1	10.574	190.00	150.00	10.00	6.45		0.02	2.55		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		
							0.00	#DIV/0!		

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

FIGURE 3

EXAMPLE OF BATCH SHEET

WET CHEMISTRY BATCH REPORT
Mar 28 2012, 08:10 am
Batch: WG106300

Parameter: Sulfide,Reactive
Prep Date: 27-MAR-12

Date Analyzed: 27-MAR-12
Prep Method: SW846 7.3.4

Analyst Initials: AMB
Prep Chemist: AMB

Sample	Samp Type	Method	Initial Amt.	Final Amt.	Rpt. DF	Result	Rpt Result	TS(%)	PQL	MDL	Adj PQL	RPD	%Rec
SF1565-1	SAMP	SW846 7.3.4	10.105g	190.00mL	.99	-.02	U27. mg/Kg	NA	27	16.39	27.		
SF1566-1	SAMP	SW846 7.3.4	10.113g	190.00mL	.99	-.11	U27. mg/Kg	NA	27	16.39	27.		
SF1621-6	SAMP	SW846 7.3.4	9.8260g	190.00mL	1	.01	U27. mg/Kg	NA	27	16.39	27.		
SF1635-2	SAMP	SW846 7.3.4	9.5470g	190.00mL	1	.04	U27. mg/Kg	NA	27	16.39	27.		
SF1635-4	SAMP	SW846 7.3.4	10.316g	190.00mL	.97	-.08	U27 mg/Kg	NA	27	16.39	27		
SF1657-1	SAMP	SW846 7.3.4	10.752g	190.00mL	.93	.1	U27 mg/Kg	NA	27	16.39	27		
WG106300-1	MBLANK	SW846 7.3.4	10.000g	190.00mL	1	.04	U20. mg/Kg	NA	27	16.39	27.		
WG106300-2	LCS	SW846 7.3.4	10.000g	190.00mL	1	4.58	610 mg/Kg	NA	27	16.39	27.		76
WG106300-3	DUP	SW846 7.3.4	10.104g	190.00mL	.99	.04	U20. mg/Kg	NA	27	16.39	27.	NC	
WG106300-4	MS	SW846 7.3.4	10.061g	190.00mL	.99	4.82	640 mg/Kg	NA	27	16.39	27.		80

Comments:

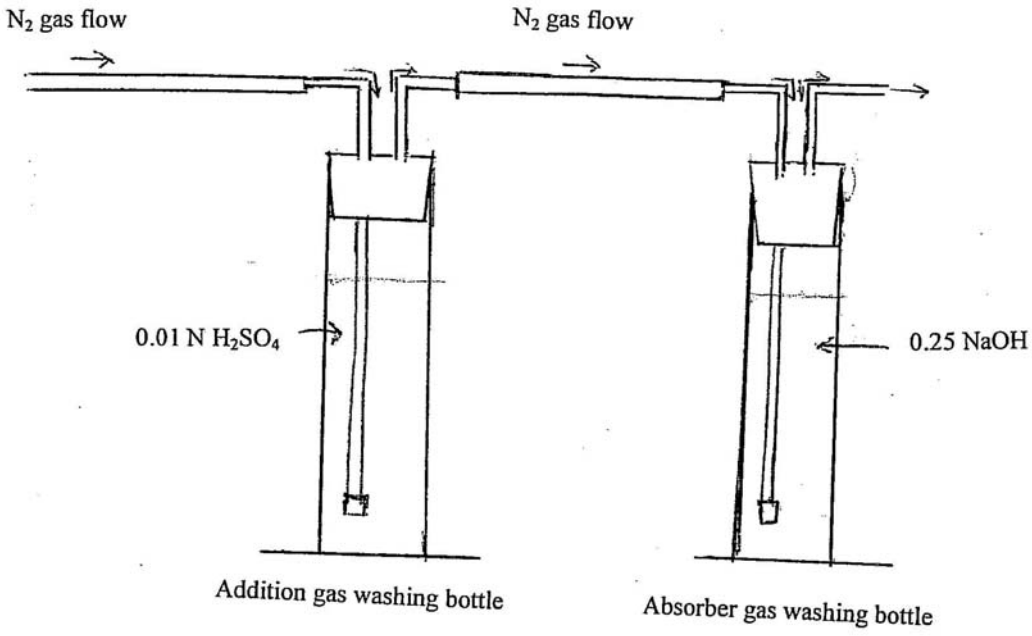
SF1566-1	VOA sample in Walkin with Soils
WG106300-1	SF1565-1
WG106300-2	SF1565-1
WG106300-3	SF1565-1
WG106300-4	SF1565-1

Entered by: AMB Date: 3/28/12 Accepted by: D. Madeau Date: 3/28/12

TITLE: REACTIVE SULFIDE: SW-846 7.3.4.2

FIGURE 4

REACTIVE SULFIDE APPARATUS



ADDENDUM

SOP NO CHANGE FORM

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Kerri Pawlina

Review Date: 8/29/13

SOP Number: CA 734

SOP Title: Reactive Sulfides

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: A. Brewer **Date:** 11/18/13

QAO Signature: Leslie Dimond **Date:** 11.18.13

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Derek Wright

Review Date: 3/3/14

SOP Number: CA-734-07

SOP Title: Reactive Sulfide: SW 846 7.3.4.2

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: _____ **Date:** 03/21/14

QAO Signature: Jessie Dimond **Date:** 041514

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Alex Pimentel

Review Date: 021617

SOP Number: CA-734-07

SOP Title: Reactive Sulfide. SW-846 7.3.4.2

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: _____ **Date:** 03/08/17

QAO Signature: _____ **Date:** 03.13.17

TITLE: TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER

Prepared By: Betsy Carbone Date: 8/96

Approved By:

Group Supervisor: Keith Longley Date: 012401

Operations Manager: J C Burton Date: 1/22/01

QA Officer: Deborah J. Nadeau Date: 1.22.01

General Manager: Donna L. Hufford Date: 1/22/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Format changes, added pollution prevention, p-xylene in duplicate, correction for barometric pressure	DH	1.22.01	1.22.01
02	Many changes throughout to reflect current practices. New fig. 2	LAD	031805	031805
03	Added method blank and LCS definitions	LAD	06/08	06/08
04	Added definitions.	LAD	09/10	09/10
05	Sect. 7 - Change increase temperature to 5±6°C/min to set instrument to correct matrix. Also, added raw data archival info. Sect. 10 - Added and edited references. Updated Figures 1 and 2.	LAD	05/12	05/12

TITLE: TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER

Revision History (cont.):

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
06	Sect. 2 and 7 – Added Method B for Suspensions of solids and highly viscous materials. Sect. 1 and 10 – Updated method references. Sect. 7 – Added using organic solvents may be used to clean cup. Changed KAS INC to KAS	LAO	08/15	08/15

TITLE: TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ____ of document **SOP CA-736-06**, titled **TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER**.

Recipient: _____ Date: _____

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ____ of document **SOP CA-736-06**, titled **TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER**.

Recipient: _____ Date: _____

TITLE: TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedure utilized by Katahdin Analytical Services laboratory personnel to measure the tendency of a sample to form a flammable mixture with air under controlled laboratory conditions. The objective of the ignitability characteristic is to identify wastes that either present fire hazards under routine storage, disposal, or transportation or are capable of severely exacerbating a fire once started. The SOP is applicable to SW-846 method 1010A and ASTM method D 93-79.

The test method covers the determination of the flash point by Pensky-Martens closed-cup tester for fuel oils, lube oils, suspensions of solids, liquids that tend to form a surface film under test conditions and other liquids.

1.1 Definitions

Flash Point - The lowest temperature of the sample, corrected to a barometric pressure of 760 mm of Hg, at which application of the test flame ignites the vapor above the sample.

Laboratory Control Sample (LCS): LCS is a known standard carried through the entire analytical procedure in the same manner as a sample. The LCS determines the validity of the batch.

Method Blank - A Laboratory Reagent Grade Water sample that is carried through the entire analytical procedure in the same manner as a sample.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in flashpoint analysis by Pensky-Martens Closed-Cup method. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in flashpoint analysis by Pensky-Martens Closed-Cup method to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Plan for further details on pollution prevention techniques.

p-Xylene must be stored separately and disposed of as a flammable liquid. All sample residues under this protocol are disposed of in satellite wastes for flammable liquids. Other wastes generated during the preparation of samples must be disposed of in adherence with the Katahdin Hazardous Waste Management Plan and Safety Manual and SOP SD-903, Sample Disposal, current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP SD-903.

2.0 SUMMARY OF METHOD

Samples are heated at a slow, constant rate with continual stirring. A small flame is directed into the cup at regular intervals with simultaneous interruption of stirring. The flash point is the lowest temperature at which application of the test flame ignites the vapor above the sample. For most samples, Method A is used to determine flash point, for suspensions of solids and highly viscous materials, Method B should be used.

TITLE: TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER

3.0 INTERFERENCES

None determined.

4.0 APPARATUS AND MATERIALS

4.1 Pensky-Martens Closed-Cup Flash Tester

4.2 Calibrated thermometer capable of reading up to 120°C

4.3 Barometer

5.0 REAGENTS

5.1 p-Xylene Reference Standard - Reagent grade, Flash point 27°C

5.2 Laboratory Reagent Grade Water

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Not applicable.

7.0 PROCEDURES

7.1 Record the ambient barometric pressure in inches of mercury. Multiply this number by 25.4 mm/in to obtain the barometric pressure in mm of mercury. Record this number in the appropriate place in the logbook (figure 1).

7.2 Preparation of Apparatus - Place the tester on the bench top located under a fume hood. Although the hood is turned off while performing the analysis, a draft is still present. The tester must be surrounded on three sides with a shield that is sufficient enough to prevent sputtering of the pilot flame.

7.3 Preparation of Sample - Samples of very viscous materials must be warmed until they are reasonably fluid before they are tested. However, no sample should be heated more than is absolutely necessary. Samples shall never be heated above a temperature of 17°C below the expected flash point.

7.4 Analytical Procedure – Method A, Basic Procedure

7.4.1 Thoroughly clean and dry all parts of the cup and its accessories before starting the test, being sure to remove any solvent which had been used to clean the apparatus. Organic solvents (methylene chloride, hexane) may be used in clean cup. Additional cleaning may be accomplished with the aid of sand or sandpaper.

7.4.2 Check to be sure that the orifice for the flame wick is not clogged. A piece of wire should fit into the opening.

7.4.3 For aqueous samples, fill the cup with the sample to be tested to the level indicated by the filling mark. For solid samples, fill the cup with the sample to be tested to the level indicated by the filling mark. Please refer to Katahdin Analytical Services SOP CA-108, "Basic Laboratory Technique", current revision, for information on subsampling.

7.4.4 Place the lid on the cup and set the cup in the apparatus stove. Be sure to have the locking or locating device properly engaged.

7.4.5 Insert the thermometer.

7.4.6 If the flashpoint is known to be high, bring the material to be tested and the tester to a temperature of 25 $\pm$ 5°C or 15 $\pm$ 5°C lower than the estimated flash point, whichever is lower. Otherwise, start the flame when the samples are still cold (below room temperature)

7.4.7 Light the test flame and adjust it to 5/32 inch (4mm) in diameter.

7.4.8 Turn the heating dial to the black mark which corresponds to the sample matrix being tested.

7.4.9 Turn the stirrer on (90-120 rpm), stirring in a downward direction.

7.4.10 Apply the test flame when the temperature is between 20 and 25°C.

7.4.11 Apply the test flame by operating the mechanism on the cover that controls the shutter and test flame burner so that the flame is lowered into the vapor space of the cup in 0.5 seconds, left in its lowered position for 1 second and quickly raised to its high position.

NOTE: Do not stir the sample while applying the test flame.

7.4.12 After 25°C, apply the test flame in increments of 2°C.

7.4.13 Continue applying the test flame at temperature increments of 2°C until the flash point of the sample or 71°C is reached, whichever comes first.

7.4.14 If the sample flashes between 25 and 71°C, obtain a fresh aliquot of the sample. Bring the sample material to a temperature 15 ± 5°C lower than the initially determined flash point. Apply the test flame and thereafter at temperature readings in increments of 2°C until the flash point of the sample is reached. Results obtained from Steps 7.4.13 and 7.4.14 should agree within ±2 °C.

7.4.15 Record the observed flash point as the temperature read on the thermometer at the time the test flame application causes a distinct flash in the interior of the cup. The lowest reading from the duplicate analyses (Steps 7.4.13 and 7.4.14) should be reported.

NOTE: Do not confuse the true flash with the bluish halo that sometimes surrounds the test flame at applications preceding the one that causes the actual flash.

7.4.16 If the sample flashes below 25°C, the reported value should be <25°C. If the sample did not flash, the reported value should be >71°C. If the sample was not heated to 71°C, record the highest temperature achieved.

7.4.17 The observed flash points must be corrected for the ambient barometric pressure. If the ambient barometric pressure at the time of analysis differs from 760 mm Hg (one atmosphere), the following formula must be used:

Corrected flash = (observed flash + 0.033 (760 mm Hg – ambient barometric
Point (° C) point in ° C) pressure in mm Hg)

Record all corrections in the logbook (Figure 1).

7.4.18 After completion of each test, the logbook must be signed and dated by the person performing the test.

7.4.19 The sample data results from the logbook, with any appropriate notations, are entered manually into the Katahdin Information Management System (KIMS) for calculation and reporting. Refer to the current revision of Katahdin Analytical Services SOP CA-762 (“Wet Chemistry Data Entry and Review Using Katahdin Information Management System”) for further information.

7.5 Analytical Procedure – Method B, Determination of Flash Point of Suspensions of Solids and Highly Viscous Materials.

7.5.1 Follow steps in section 7.4 **except -**

7.5.1.1 Bring the sample material to a temperature 15 ± 5°C or 11°C lower than the estimated flash point, whichever is lower.

7.5.1.2 Increase the stirrer speed to 250 +/- 10 rpm

7.6 Archival of Raw Data

All batch sheets, raw data, and supporting documents are scanned after final review and the resulting image files are saved on a Katahdin server for use in data package assembly. Image files of raw data are periodically archived by the laboratory's MIS department.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

A typical analytical run consists of a tester calibration using p-Xylene (analyzed in duplicate), a blank consisting of laboratory reagent grade water (immediately following the p-Xylene), the samples to be analyzed and a duplicate sample analysis. A duplicate sample analysis is performed every ten samples, every daily batch, or for any sample that flashes, whichever is more frequent. If a sample flashes, that sample is run in duplicate. Refer to Table 1 for acceptance criteria and corrective actions.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

9.0 METHOD PERFORMANCE

Refer to the current revision of Method 1010 for method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

ASTM, Test Methods for Flash Point by Pensky-Martens Closed Tester, D 93-79,1979.

"Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods", SW-846, third Edition, Final Update III, November 2004, Pensky-Martens Closed-Cup Method for Determining Ignitability, Method 1010A.

TITLE: TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 4.2, 10/25/2010.

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.0, March, 2013

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP QA-803, Laboratory QA: Self Inspection System, current revision.

LIST OF TABLES AND FIGURES

TITLE: TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER

TABLE 1

QC REQUIREMENTS

Parameter/ Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Flashpoint Pensky-Martens Closed-Cup, Method 1010A	Method blank	One per prep batch	No flash	(1) Investigate source of contamination (2) Reprep and analyze method blank and all samples processed with the contaminated blank
	Sample Duplicate	One sample duplicate per ten samples	Results of sample and sample duplicate agree within ±2 °C – Report the lowest value.	(1) If lab QC in criteria and duplicates do not agree within ±2 °C , report the lowest value and narrate the other values. (2) Else, reanalyze
	LCS / p-xylene	In duplicate per batch of twenty samples or less	Flash point 27°C ± 2°C	1)Repeat analysis of reference standard and associated samples

TITLE: TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER

TABLE 2

SUMMARY OF METHOD MODIFICATIONS

Topic	Katahdin SOP CA-736-06	METHOD 1010, current revision
Apparatus/Materials		
Reagents		
Sample preservation/ handling		
Procedures	Test flame is applied at 2 °C increments; if sample flashes during test, a second aliquot is tested for confirmation of flash point. The lowest value is reported unless the values do not agree within ± 2 °C. In these cases, the lowest value is reported and the others narrated.	Test flame is applied at 1 °C increments; single analysis is performed.
QC - Spikes		
QC - LCS		
QC - Accuracy/Precision		
QC - MDL		

TITLE: TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER

FIGURE 1

EXAMPLE OF FLASHPOINT LOGBOOK PAGE

KATAHDIN ANALYTICAL SERVICES, INC. - FLASHPOINT – CLOSED CUP LOGBOOK

WG107342 R153375

METHOD: SW 846 1010	p-XYLENE: 27 Degrees Celcius	Ambient Barometric Pressure (*) = 749.3 mm Hg (in. of Hg) X (25.4 mm/in) 29.50
PQL: 25 Degrees Celcius	p-XYLENE Lot Number: SWL3203	

Sample ID	Analysis Time	Start Temperature (°C)	End Temperature (°C)	Flash? (Check appropriate box & record temp.) YES	Temp.(°C)	NO	Reported Flashpoint Corrected For Ambient Barometric Pressure	Comments
p-Xylene (LCS)	13:05	25.0	25.0	✓	25.0		25.353	
p-Xylene (LCS)	13:10	25.0	27.0	✓	27.0		27.353	
Method Blank	13:27	25.0	71.0			✓		
SF2013-3	13:45	25.0	71.0			✓		
-3Dup	15:00	25.0	71.0			✓		
SF2151-4	15:19	25.0	71.0			✓		
SF2152-4	15:35	25.0	71.0			✓		
			DW	4/24/12				

QAWL633

* = Ambient Pressure of the laboratory at the time of the test. When the pressure differs from 760 mm Hg, correct the flashpoint as follows: Corrected Flashpoint = (Observed Flashpoint in °C) + 0.033 (760 - the ambient barometric pressure in mm Hg) .

0.353

Analyst DW Date 4/24/12
Reviewed By [signature] Date 04/24/12

WL-029 – REVISION 1 – 10/06/2010

0000022

TITLE: TEST METHOD FOR FLASH POINT BY PENSKY-MARTENS CLOSED-CUP TESTER

FIGURE 2

BATCH SHEET FOR FLASHPOINT

WET CHEMISTRY BATCH REPORT
Apr 24 2012, 03:49 pm
Batch: WG107342

Parameter: Ignitability
Prep Date: N/A

Date Analyzed: 24-APR-12
Prep Method: N/A

Analyst Initials: DW
Prep Chemist: N/A

Sample	Samp Type	Method	Initial Amt.	Final Amt.	Rpt. DF	Result	Rpt Result	TS(%)	PQL	MDL	Adj PQL	RPD	%Rec
SF2013-3	SAMP	SW846 1010	1.0000mL	1.0000mL	1	71	>71. Deg. C	NA	71	71.	71.		
SF2151-4	SAMP	SW846 1010	1.0000mL	1.0000mL	1	71	>71. Deg. C	NA	71	71.	71.		
SF2152-4	SAMP	SW846 1010	1.0000mL	1.0000mL	1	71	>71. Deg. C	NA	71	71.	71.		
WG107342-1	LCS	SW846 1010	1.0000mL	1.0000mL	1	25.353	25. Deg. C	NA	71	71.	71.		94
WG107342-2	LCSD	SW846 1010	1.0000mL	1.0000mL	1	27.353	27. Deg. C	NA	71	71.	71.	8	101
WG107342-3	MBLANK	SW846 1010	1.0000mL	1.0000mL	1	71	>71. Deg. C	NA	71	71.	71.		
WG107342-4	DUP	SW846 1010	1.0000mL	1.0000mL	1	71	>71. Deg. C	NA	71	71.	71.	NC	

Comments:

WG107342-1	SF2013-3
WG107342-2	SF2013-3
WG107342-3	SF2013-3
WG107342-4	SF2013-3

Entered by: DW Date: 4/24/12 Accepted by: [signature] Date: 04/24/12

ADDENDUM

SOP NO CHANGE FORM

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Ryan Oliver

Review Date: 3/8/16

SOP Number: CA-736-06

SOP Title: Flash point by Pensky-Martens

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: K. Brewer **Date:** 03/23/16

QAO Signature: Leslie Dimond **Date:** 03.25.16

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Zach Fuller

Review Date: 1-24-17

SOP Number: CA-736-06

SOP Title: Ignitability

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: [signature]

Date: 03/03/17

QAO Signature: [signature]

Date: 03.13.17

KATAHDIN ANALYTICAL

SERVICES, LLC

QUALITY ASSURANCE MANUAL

600 TECHNOLOGY WAY

SCARBOROUGH, MAINE 04074

207-874-2400

Katahdin Analytical Services, LLC

600 Technology Way
P.O. Box 540
Scarborough, ME 04074
(207) 874-2400

Analytical Laboratory Quality Assurance Manual

TITLE: Katahdin Analytical Services, LLC. Quality Assurance Manual

Prepared By/Date: Deborah Nadeau/Leslie Dimond February 2016

Approved By Management/Date:

Leslie Dimond — 02.29.16
Leslie Dimond, QA Officer — Date

3/1/16
Travis Cote, IT/Production Manager — Date

Deborah J. Nadeau — 3.1.16
Deborah Nadeau, Laboratory Operations Manager — Date

Michael V. Flanders — 2/29/2016
Michael Flanders, President — Date

Section	Revision No.	Date
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5	11	02/16
6	11	02/16
7	12	02/16
8	12	02/16
9	10	02/16
10	12	02/16
11	11	02/16
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13	12	02/16
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15	12	02/16
16	11	02/16
17	9	02/16

Date of Issue: February 2016

Supersedes No.: ALL

Copy #:

Katahdin Analytical Services, LLC

600 Technology Way
P.O. Box 540
Scarborough, ME 04074
(207) 874-2400

TITLE: Katahdin Analytical Services, LLC. Quality Assurance Manual

Prepared By/Date: Deborah Nadeau/Leslie Dimond February 2016

Approved By NELAC Technical Directors/Date:

Peter Lemay — Date: 2-29-16

George Brewer — Date: 02/29/16

Charles Gomez — Date: 2-29-16

Jim Sampson — Date: 2-29-16

Jennifer Prescott — Date: 2/29/16

Kristen Schultz — Date: 2/29/16

Ed Morgan — Date: 02-29-16

Katahdin Analytical Services, LLC
QUALITY ASSURANCE MANUAL

Document Number QAM-001, Revision 11

February 2016

Document Control Number

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1.0 INTRODUCTION

1.1 Purpose and Scope

This manual details the quality assurance program in effect at Katahdin Analytical Services, LLC. It is meant to be a teaching tool and source of information for laboratory personnel and clients. The manual describes the quality assurance policies and their implementation as they relate to the type, range and volume of environmental work performed at Katahdin. The Manual is divided into sections, each dealing with a different phase of laboratory operation, yet all sections overlap and function together to form a complete quality assurance program. The Manual is based on Good Laboratory Practices, technical knowledge, industry-accepted standard analytical practices and common sense. This manual meets the requirements of the current versions of the National Environmental Laboratory Accreditation Program (NELAP), the Department of Defense Quality Systems Manual (DoD QSM), including the requirements of ISO 17025:2005, the State of Maine certification program and other Federal and state specific requirements.

The Manual must be read and understood by all laboratory personnel as part of their training program. The Manual should also be referred to regularly as a source of information. A system of continuous updating is built into the Manual to allow it to change as laboratory conditions change or as new regulations are promulgated. This manual is a controlled document, which means that its identity, development, distribution, and status must be known and traceable at all times. All Katahdin permanent laboratory personnel are assigned a controlled temporary copy. Upon completion of reading, the employee must return the controlled copy to the Quality Assurance Officer and sign an attestation stating they have read and understood the QA manual. Temporary personnel are expected to read and understand the QA Manual.

Whenever a technician or analyst is in doubt as to proper procedures in a specific circumstance, the Manual should be consulted. Omissions or errors should be immediately reported to the Quality Assurance Officer for corrective action. **IT IS THE RESPONSIBILITY OF EACH LABORATORY WORKER TO ENSURE THAT THE PROVISIONS OF THIS MANUAL ARE FOLLOWED**. Disagreement with specific requirements or knowledge of changes causing deviation from the procedures should be discussed with the immediate supervisor before further work is completed. Laboratory personnel are encouraged to comment on the Manual and make recommendations for more efficient procedures.

The latest revision of each section of the Manual is the applicable rule. Therefore, revisions will be announced to all laboratory personnel. An uncontrolled copy of the Manual is offered to clients and regulatory agencies as the definitive quality assurance program used at Katahdin.

1.2 Quality Assurance Policy and Commitment

Katahdin is committed to quality as priority number one. Katahdin's quality assurance policy is based on the definition of quality as conformance to requirements governed by company policies, government regulations and standard operating procedures. This commitment recognizes the need for data to be representative of the environmental

conditions under investigation supported by measurements generated within a system that is designed to address applicable regulatory compliance criteria. Katahdin's Quality Assurance (QA) Manual and QA Program have been developed to fulfill this commitment. Our Quality Assurance Program contains provisions for establishing, maintaining and executing protocols to produce data of known quality and defensibility through the proper documentation of all measurement activities. No other concerns will be permitted to interfere with the execution of the elements of this QA Program and the quality of the data generated and delivered.

This manual describes the set of policies and principles, which guide day-to-day operations. Specific protocols are included by reference and are contained in a series of volumes cited in Section 8.0 of this document.

1.3 Management Commitment to Quality Assurance

Katahdin Management is committed to providing the highest quality analytical services and customer satisfaction available in the industry. To ensure this, Katahdin management is committed to:

- maintaining a quality system that supports the generation of data that are scientifically sound, legally defensible, meet client objectives, and are appropriate for their intended use,
- maintaining compliance with all applicable statutes, regulatory agencies and/or programs as described in the purpose and scope above,
- providing all employees with guidelines and an understanding of the ethical and quality standards required to work in the environmental testing industry,
- providing all employees with an understanding of the importance of meeting client requirements and providing superior service,
- improving the quality system through continuous feedback from staff and clients,
- maintaining a professional working environment that fosters open communication with both clients and staff,
- continued investment in new technologies, automation and quality improvements.

1.4 Quality Assurance Objectives

Katahdin Analytical Services, LLC is committed to the philosophy that quality operations result from quality planning, design, and work performance by skilled operational personnel. Katahdin's policy is to perform its varied types of technical work in accordance with standard quality assurance practices such as those put forth in the Good Laboratory Practices (GLP), the EPA Contract Laboratory Program (CLP), the National Environmental Laboratory Accreditation Council (NELAC) standards, the Department of Defense Quality Systems Manual (DoD QSM), the International

Organization for Standardization (ISO 17025:2005) manual, other various EPA guidance documents, and Standard Methods. The Quality Assurance Officer is responsible for maintenance of standard operating procedures, laboratory audits, performance evaluations, federal and state certifications and quality assurance training documentation.

Each laboratory worker is responsible for reviewing and understanding standard operating procedures; adhering to these procedures during routine analyses; recording quality control information required by those procedures in the proper location, and taking appropriate corrective action including suspending analyses when quality control criteria are not met.

Objectives of the quality program are:

- to provide representative data of documented quality to clients and regulators
- to provide a quality organization independent of the pressures of project performance with the responsibility and authority for auditing and recommending corrective action;
- to provide a quality organization with clear paths of communication with management;
- to perform regularly scheduled audits and thereby document an objective evaluation of quality-related practices;
- to promptly identify variances and implement corrective actions and root-cause analysis;
- to maintain readily identifiable and retrievable records that provide documentary evidence of the quality of activities performed;
- to provide procedures for implementing project-specific quality plans;
- to define responsibility and authority for developing and implementing quality plans; and
- to provide quality reference documentation for each project.

Quality Assurance objectives for measurement data can be expressed in terms of completeness, representativeness, accuracy, precision**,** comparability and traceability.

1.4.1 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. The QA objective for completeness is to maximize the number of valid results. This can be attained by:

- selecting the appropriate methodology
- minimizing sample loss and breakage
- performing sufficient QC samples to document control
- documenting all aspects of the analytical system
- effectively understanding and communicating Data Quality Objectives (DQOs)
- adherence to designated holding times

The goal for completeness is dependent on project-specific DQOs and relies on planning and communication between the client and the lab. Realistic completeness goals are 80-95%.

The equation for completeness is:

$$\frac{\text{\# of data points obtained}}{\text{\# of data points expected}} \times 100 = \text{\% completeness}$$

1.4.2 Representativeness

Representativeness is the extent to which reported analytical results truly depict the chemistry of the sampled environment. Representativeness is a qualitative objective that is optimized through selection of appropriate sampling protocols, proper sample handling procedures, appropriate selection of holding times and analytical procedures, proper sample preservation, and prompt extraction and analysis.

Clients, Katahdin Sales and Marketing, Katahdin Project Managers and Katahdin Managers are responsible for selection of the appropriate sampling and analytical procedures.

Sample preservation follows USEPA guidance (40 CFR 136, Table II and SW-846) and Standard Methods unless dictated by other programs. Field preservation is checked upon sample receipt in the laboratory with the exception of volatiles that are checked immediately prior to analysis. Refer to the current revision of Katahdin Analytical Services SOP SD-902, Sample Receipt and Internal Control.

The Laboratory follows EPA guidance for sample holding times as stipulated in 40CFR 136, Table II and SW-846, Standard Methods or individual references. Refer to Table 6.1 for Katahdin Analytical Services sample container, preservation, and holding time requirements.

1.4.3 Accuracy and Precision

Accuracy and precision data are optimized through the use of analytical procedures that minimize biases through the use of standard procedures, traceable standards and QA lots, calibration of analytical equipment within

established acceptance limits and by implementing corrective action when measured accuracy and precision exceed pre-established limits.

Accuracy and precision are assessed through the analysis of several types of quality control (QC) samples. Laboratory generated QC samples, such as method blanks, laboratory control samples (LCSs), and sample duplicates, are used to assess the accuracy and precision of measurements due to laboratory activities. Surrogate spikes, matrix spike/matrix spike duplicates (MS/MSDs), and sample duplicates are used to monitor the effects of the sample matrix on precision and accuracy. Field blanks, field duplicates and trip blanks are used to assess the accuracy and precision of both sampling and laboratory activities. Accuracy and precision goals for the laboratory are based on laboratory historical data, specific method requirements and the requirements of each specific project. A more detailed discussion of these goals is provided in Section 11.0.

1.4.4 Comparability

Comparability is the extent to which comparisons among different measurements of the same quantity or quality will yield valid conclusions. Comparability is a qualitative objective that is attained by utilizing standard techniques for sample analysis and by reporting analytical data in appropriate units. Comparability between Katahdin's analytical results and those obtained by other environmental analytical laboratories will be ensured through the use of EPA, ASTM, and other recognized methods.

1.4.5 Traceability

Traceability is the extent to which results can be substantiated by hard copy and/or electronic documentation. Traceability documentation exists in two forms: that which links final numerical results to authoritative measurement standards, and that which explicitly describes the history of each sample from collection to analysis. Refer to Sections 6.0 and 10.0 for more specifics on Katahdin Analytical Services procedures.

1.5 Terms and Definitions

Acceptance: Criteria	Specific limits placed on characteristics of an item, process, or service defined in requirement documents.
Accreditation:	The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.
Accuracy:	The closeness of agreement between an observed value and an accepted reference value. When applied to a set of observed values, accuracy will be a combination of a random component and of a common systematic error (or bias) component.
Aliquot:	A measured portion of a sample taken for analysis.
Analyte:	The specific component or constituent that the analytical measurement seeks to determine.
Audit:	A systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity.
Batch:	A group of samples that are treated similarly with respect to the sampling or the testing procedures being employed and which are processed as a unit. For QC purposes, if the number of samples in a group [first] is greater than 20, then each group [successive] of 20 samples or less will all be handled as a separate batch.
Blank:	See Equipment Rinsate, Method Blank, Trip Blank, Field Blank, Calibration Blank.
Blind Sample:	A sample submitted for analysis whose composition is known to the submitter but unknown to the analyst.
Calibration:	The process of establishing the relationship between instrumental response and known traceable quantities of analytes of interest.
Calibration Blank:	A quality control sample prepared in the same manner as calibration standards with the exception of the addition of the analytes of interest. A calibration blank is used to establish solvent/reagent and system contributions to the analytical result.
Calibration Verification:	The process of analyzing a mid-level calibration standard to verify the validity of the calibration curve.
Chain of Custody:	An unbroken trail of accountability that verifies the physical security of samples, data and records.

Comparability:	Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Comparable data are produced through the use of standardized procedures and techniques.
Completeness	Measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions
Continuing Calibration:	The process of analyzing standards periodically to verify the maintenance of calibration of the analytical system.
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 statistical control. A process is considered in control if data falls within the prescribed limits. A process is considered "out-of-control" if data falls outside the established control limits. These data are considered suspect and require corrective action including, but not limited to, qualification of the data.
Data Quality Objectives:	Qualitative and quantitative statements derived from the DQO Planning Process clarifying the purpose of the study, defining the most appropriate type of information to collect, determining the most appropriate conditions from which to collect that information, and specifying tolerable levels of potential decision errors.
Data Validation:	The internal process of review by which data are shown to be valid as evidenced by the soundness of the analytical system and successful meeting of the Data Quality Objectives (DQOs).
Dry Weight:	The weight of a sample based on percent solids. The weight after drying in an oven. Refer to Katahdin Analytical Services SOP, CA-717, Total Solids (% Moisture).
Duplicate Analysis:	A second measurement made on the same sample, sample extract or sample digestate to assist in the evaluation of precision of analysis.
Duplicate Sample:	See Field Duplicate, Matrix Duplicate, and Matrix Spike Duplicate.
Equipment Blank:	A field blank used to verify the effectiveness of equipment decontamination procedures. Laboratory deionized water is passed over sampling equipment after decontamination, collected, and analyzed by the lab.

Field Blank:	Samples of analyte-free media (generally water) taken from the laboratory to the field as: 1) distinct aliquots in the same containers used to collect samples with the appropriate preservative reagents added, or; 2) a single reserve to be aliquoted in the field into the appropriate containers with the appropriate preservatives for the parameters of interest. The intent of the field blank is to ascertain and document any contamination attributable to shipping, field handling procedures and potentially to ambient conditions.
Field Duplicate:	Independent samples that are collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers and analyzed independently. These duplicates are useful in documenting the precision of the sampling process.
Field Sample:	A portion of material received by the laboratory to be analyzed, that is contained in single or multiple containers and identified by a unique field ID number.
Holding Time:	The elapsed time expressed in days (except for parameters requiring analysis in < 48 hours, which are expressed in hours) from the date of sample collection by the field personnel until the date of its processing/analysis. Holding time requirements are dictated by the EPA Federal Register 40CFR Part 136, Table II, or other appropriate method references, QAPPs, State regulation, or specific agency programs (i.e. AFCEE, NFESC, etc.).
Homogeneity:	The degree to which a property or substance is evenly distributed throughout a material.
Instrument Detection Limit:	The smallest signal above background noise that an instrument can detect at a 99% confidence level. The IDL does not consider any effects that the sample matrix, handling or preparation may have.
Initial Calibration:	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.
Internal Standards:	Analytes, selected as non-targets or in a deuterated state, which are added to all standards and samples at the time of instrumental analysis. Internal standard quantitation takes into account the variability of the instrumental components at the discrete time of standard or sample analysis. The quantitation of the internal standard provides the evaluation of the influence upon the analysis and provides for the application to final sample data.

KIMS:	Katahdin Information Management System
Lab Control Sample:	A control sample whose matrix is of known composition or analyte-free matrix spiked with a known concentration of analytes of interest. Laboratory control samples are handled using the same preparation, reagents, and analytical methods employed for field samples. Laboratory Control Samples are utilized as indicators of the accuracy of the analysis.
Limit of Detection (LOD):	An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific. An LOD is the smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). The false negative rate at the LOD is 1%.
Limit of Quantitation (LOQ):	The minimum levels, concentrations, or quantities of a target analyte that can be reported with a specified degree of confidence. The LOQ is the lowest concentration that produces a quantitative result within specified limits of precision and accuracy. The LOQ is set at or above the concentration of the lowest initial calibration standard.
Lot	A quantity of bulk material of similar composition processed or manufactured at the same time.
Matrix:	The component or substrate (e.g. surface water, drinking water) which contains the analyte of interest.
Matrix Duplicate:	An intralaboratory split sample which is used to document the precision of a method in a given sample matrix.
Matrix Spike:	Aliquot of sample fortified (spiked) with known quantities of specified analytes and processed through the entire procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.
Matrix Spike Duplicate:	Intralaboratory split samples spiked with identical concentrations of target analyte (s). The spiking occurs prior to sample preparation and analysis. They are used to document the precision and bias of a method in a given sample matrix.
Method Blank:	An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank should be carried through the complete sample preparation and analytical procedure. The method blank is used to document analyte contribution resulting from the analytical process. Acceptable levels of contamination are defined in individual SOPs and/or by project specific data quality objectives.

Method Detection Limit:	The statistically derived minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The false positive rate at the MDL/DL is 1%. Method detection limits are determined using replicate spike samples prepared by the lab and taken through all preparation and analysis steps of the method. The method detection limit is calculated using the appropriate Student's t parameter times the standard deviation of a series of spiked samples.
Performance Audit:	A process to evaluate the compliance of actual laboratory practices with relevant project requirements, regulations, contract specifications or internally stated standard operating procedures and practices.
Performance Evaluation:	A process to evaluate the proficiency of an analyst or laboratory by evaluation of the results obtained on known test materials.
Precision:	The agreement among a set of replicate measurements without assumption of knowledge of the true value. Precision is estimated by means of duplicate/replicate analyses. These samples should contain concentrations of analyte above the MDL, and may involve the use of matrix spikes. The most commonly used estimates of precision are the relative standard deviation (RSD), when two or more samples are available and the relative percent difference (RPD), when only two samples are available.
Preservation:	Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.
Protocol:	A stated plan that clearly defines the objectives, methods and procedures for accomplishing a task.
Practical Quantitation Limit:	Practical Quantitation Level is the laboratory's standard reporting limit for routine analytical work. The PQL is generally three to five times greater than the corresponding MDL or IDL and represents a level that the laboratory can routinely and reliably detect and quantitate in a variety of sample matrices. For many methods the PQL corresponds to the lowest level initial calibration standard.
Proficiency Test Sample:	A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria.
QAPP:	A Quality Assurance Project Plan or QAPP is a project specific document that describes the policies, organization, objectives, functional activities, and specific QA and QC activities designed to achieve the data quality goals of a specific project.

Quality Assurance Program:	A system of policies and procedures whose purpose is to ensure, confirm and document that the product or service rendered fulfills the requirements of Katahdin and its client. Quality Assurance includes quality planning, quality control, quality assessment (auditing), quality reporting and corrective action.
Quality Control:	A system of checks and corrective measures, integrated with the activities that directly generates the product or service that serves to monitor and adjust the process to maintain conformance to predetermined requirements.
Quantitation Range:	The range of values in a calibration curve between the reporting limit (PQL/LOQ) and the highest successfully analyzed initial calibration standard.
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 instrument printouts, including dictated observations, and recorded data from automated instruments.
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 amounts, the dry weight of solids, and instrument dilution factors, unless otherwise specified.
Retention Time:	The time between sample injection and the appearance of a solute peak at the detector.
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. 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. If the figure following those to be retained is 5, 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. 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.

Original #	Rounded To
11.443	11.44
11.446	11.45
11.435	11.44
11.425	11.42

Sensitivity:	Capability of methodology or instrumentation to discriminate between samples having different concentrations or containing differing amounts of an analyte.
Significant Figures:	The number of digits in a value that are justified by the accuracy and precision of the method being used. A value is made up of significant figures when it contains all digits known to be true and one last digit in doubt.
Spike:	A known mass of target analyte added to a blank sample or sub-sample that is used to determine recovery efficiency.
Split Sample:	Aliquots of sample taken from the same container and analyzed independently. In cases where aliquots of samples are impossible to obtain, field duplicate samples should be taken for the matrix duplicate analysis. These are usually taken after mixing or compositing and are used to document intra- or interlaboratory precision.
Standard:	A substance or material the properties of which are known with sufficient accuracy to permit its use to evaluate the same property in a sample.
Standard Operating Procedure:	A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps that outline expected limits of achievement and will produce consistent performance with repetitive use. This document must be officially approved as the method for performing certain routine or repetitive tasks.
Surrogates:	A compound which is similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which is not normally found in environmental samples. When employed, these compounds are added to every field and quality control sample prior to processing or preparation. Surrogate compounds are used to evaluate analytical efficiency by measuring recovery. Surrogates are generally utilized for organic analyses.
Systems Audit:	An on-site inspection or assessment of a laboratory's quality system or one of its components.
Traceability:	The ability to trace the source and accuracy of a material (i.e., standard) to a recognized primary reference source such as the National Institute of Standards and Technology (NIST) or USEPA. Also, the ability to independently reconstruct and review all aspects of the measurement system through available documentation.

Trip Blank:	A sample of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organics samples.
Validation:	The internal process of review by which data are shown to be valid as evidenced by the soundness of the analytical system and successful meeting of the DQOs (not to be confused with data validation by an outside independent source).
Verified Time of Sample Receipt:	VTSR is the time that the laboratory accepts samples into its custody as documented by Sample Management signature and record of time of receipt on the chain-of-custody accompanying the samples. VTSR includes the inspection and resolution of any inconsistencies or issues regarding sample status, condition, or analytical request. VTSR begins at the time of final resolution
Warning Limits:	The limits (typically 2 standard deviations either side of the mean) within which most analytical results are expected to lie with a 95% probability while the system remains in a state of statistical control.
Work Cell:	A well-defined group of analysts with specifically defined tasks that together perform the test method. The members of the work group and their specific functions must be fully documented.

TABLE 1-1: ACRONYMS

ACOE	Army Corps of Engineers
AFCEE	Air Force Center for Environmental Excellence
AOAC	Association of Analytical Communities
APHA	American Public Health Association
ASTM	American Society for Testing & Materials
BAM	Bacteriological Analytical Manual
CCB	Continuing Calibration Blank
CCC	Calibration Check Compounds
CCV	Continuing Calibration Verification
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act
CLP	Contract Laboratory Program
COC	Chain of Custody
CRDL	Contract Required Detection Limit
DoD	Department of Defense
DQO	Data Quality Objectives
EHSO	Environmental Health & Safety Officer
EPA	Environmental Protection Agency
GC	Gas Chromatograph
GCMS	Gas Chromatograph Mass Spectrometer
GFAA	Graphite Furnace Atomic Absorption
GLP	Good Laboratory Practices
IC	Ion Chromatography
ICB	Initial Calibration Blank
ICP	Inductively Coupled Plasma (Spectrophotometer)
ICV	Initial Calibration Verification
IDL	Instrument Detection Limit
KMS	Katahdin Information Management System
LCS(D)	Laboratory Control Sample (Duplicate)
LOD	Limit of Detection
LOQ	Limit of Quantitation
LRS	Linear Range Standard
MCP	Massachusetts Contingency Plan
MDL	Method Detection Limit
MIS	Management Information System
MS(D)	Matrix Spike (Duplicate)
MSDS	Material Safety Data Sheet
NBS	National Bureau of Standards
NELAP	National Environmental Laboratory Accreditation Program
NFESC	Naval Facilities Engineering Service Center
NJDEP	New Jersey Department of Environmental Protection
NPDES	National Pollutant Discharge Elimination System
PE	Performance Evaluation
PM	Project Manager
PQL	Practical Quantitation Limit
PT	Proficiency Test
QA	Quality Assurance
QAM	Quality Assurance Manual

TABLE 1-1: ACRONYMS cont'd

QAPP	Quality Assurance Project Plan
QC	Quality Control
QSM	Quality Systems Manual
RCRA	Resource Conservation & Recovery Act
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
S&HW	Solid & Hazardous Waste
SD	Sample Duplicate
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SPCC	System Performance Check Compound
SRCR	Sample Receipt Condition Report
USGS	United States Geological Survey
VTSR	Verified Time of Sample Receipt
WP	Water Pollution
WS	Water Supply

2.0 QA ORGANIZATION, PERSONNEL, & TRAINING

Katahdin Analytical Services, LLC (tax ID # and Articles of Corporation) is a privately held, full service environmental testing firm. The company consists of one permanent laboratory facility located at 600 Technology Way in Scarborough, Maine. The company is comprised of analytical services, field sampling and measurement services, accounting, business development, financial management, human resources development, information systems, marketing and quality activities. A copy of all job classifications, including responsibilities and minimum requirements, is kept on file with the Human Resources Department and with the Operations Manager. The organizational structure of the company is provided in Figure 2-1.

It is important for efficient laboratory operation that all laboratory employees understand the operational structure, specific areas of responsibility and lines of authority within the organization. It is equally important for laboratory personnel to understand that the structures of the Quality Organization may be separate from other laboratory operations but that the quality function is totally integrated into every aspect of laboratory operation. All laboratory personnel are responsible for knowing and following proper methods and standard operating procedures; recording quality control information required by those procedures in the proper location; and suspending analyses when quality control criteria are not met.

2.1 Laboratory Organization

The laboratory is managed by the President. The Quality Assurance Officer reports directly to the President.

The President is directly responsible for the following functional groups:

- Project Management
- Sales & Marketing Department
- Sample Management Department
- Waste Management Department
- Laboratory Operations
- Field Services/Courier Services
- Management Information Systems/Production

Under the direction of the Laboratory Operations Manager working in conjunction with the Production Manager, the technical staff is further organized into the following departments:

- Organic Department
- Inorganic Department
- Food/Microbiology Department
- Reporting/Data Management Department

The inorganic department, headed by the Inorganic Department Manager consists of the Wet Chemistry and Metals Preparation and Analysis groups. The Wet Chemistry group is further managed by the Wet Chemistry Supervisor. The organic department, headed by the Organic Department Manager, consists of the Organic Extractions (sample preparation), Extractables Analysis, and Volatiles Analysis groups. The Organic Extractions (sample preparation) and part of Extractables Analysis is further managed by the Extractions Supervisor. The Sample Management Department, headed by the

Sample Management Supervisor, consists of Sample Receipt, Bottle Preparation and Waste Disposal. Food/Microbiology is headed by the Food/Microbiology Supervisor. Field Operations is headed by the Field Operations Supervisor.

Each department manager or supervisor is responsible for operations in their department on a daily basis. Environmental chemists, analysts, laboratory technicians and laboratory assistants report to the department managers and supervisors. Resumes of all key personnel employed at Katahdin Analytical Services, LLC are retained by the QA Department.

2.2 Responsibilities

It is the individual responsibility of all employees to perform their assigned tasks according to this QA Manual, applicable SOPs, QA Project Plans, Study Protocols, Scopes of Work, Work Plans, and to specifically assigned job classifications. This includes responsibility for performing quality control analyses as specified in the method SOP and for entering the QC data in the appropriate logbook, electronic database, or method control file system. Failure to comply with the policies and/or requirements contained in this QA Manual or other Katahdin SOPs will result in mandatory further training and/or disciplinary action, up to, and including termination.

It is the responsibility of the Management Hiring Team, including the President, Operations Manager, IT/Production Manager, Department Managers, Quality Assurance Officer or other Supervisors/Technical Directors, to formulate the goals appropriate for each job task/title with respect to educational, technical, productivity and training requirements.

Educational, technical, and/or productivity requirements for each individual job title are filed with the Operations Manager and with the Human Resources Department.

Additionally, it is the responsibility of the Management Hiring Team to ensure that only personnel with the appropriate educational and/or technical background are hired to perform testing and/or supportive functions at Katahdin. This responsibility includes ensuring that any specific regulatory (i.e. NELAC, DoD, etc.) educational or technical background requirements for certain positions are met.

All laboratory managerial and technical personnel will be given the authority and resources needed to carry out their duties. All laboratory managerial and technical personnel are responsible for identifying any occurrences of departures from the quality system or from procedures for performing environmental tests and for initiating actions to prevent or minimize such departures.

Department Managers and group Supervisors shall assure that analysts and technicians are instructed in and are compliant with the requirements of the Laboratory QA Manual, QA Project Plans, SOPs, Protocols, and other regulatory criteria such as the NELAC standards and the DoD QSM. Department Managers and group Supervisors shall review sample QC data to assure that QC analyses are being performed at the required frequency, that data are documented in the appropriate logbook, electronic database, or method control file system, and that established corrective action procedures for out-of-control situations are followed and the results documented. It is the responsibility of the Department Manager or group Supervisor to assure that data have been validated and

reported to the Reporting/Data Management Group, IT/Production Manager or Operations Manager as appropriate. Department Managers shall report to the Laboratory Operations Manager.

In the absence of the Department Manager or group supervisor, it shall be the responsibility of a designated senior analyst, other department manager, other qualified individual, the IT/Production Manager or the Operations Manager to carry on his/her duties.

The IT/Production Manager shall work seamlessly with the Operations Manager to promote and improve employee productivity, to address laboratory constraints, to improve turn-around time and to provide continuous improvement and automation in the lab. Additionally, the IT/Production Manager is responsible for the management and quality control of all computing systems (hardware, software, documentation and procedures), generating, updating, and controlling quality of automated deliverables. The IT/Production Manager is also responsible for maintaining archives of electronic data including software. The IT/Production Manager is responsible for the operations and maintenance of all PC based computer systems and for integration with the LIMS and other data software. The IT/Production Manager is responsible for managing databases, developing macros and required programs as well as providing electronic data in various formats such as Access, ASCII, dBase, Excel, Monitor and GISKey. The IT/Production Manager shall report to the President.

In the absence of the IT/Production Manager, it shall be the responsibility of his/her designee, who may be a senior technical person, department manager, or other manager to carry on his/her duties.

The Operations Manager shall take overall responsibility for technical conduct, evaluation and reporting of all tasks associated with analytical work performed by the laboratory. The Operations Manager shall monitor standards of performance in quality control and quality assurance and monitor the validity of the analyses performed and data generated in the laboratory to assure reliable data. The Operations Manager assures that approved procedures are documented and followed, that all data are recorded and verified and that all deviations from approved procedures are documented. The Operations Manager shall assure that Department Managers and group Supervisors are instructed in and are compliant with the requirements of the Laboratory QA Manual, QA Project Plans, SOPs, Protocols, and other regulatory criteria such as the NELAC standards and the DoD QSM. The Operations Manager provides guidance and assistance in the development of laboratory quality control procedures, approves quality control limits for methods, works with Department Managers and group Supervisors to bring out-of-control methods back to within established acceptance limits, and assists Department Managers/Group Supervisors in correcting analytical problems revealed by QA audits. The Operations Manager shall report to the President.

In the absence of the Operations Manager, it shall be the responsibility of his/her designee, who may be a senior technical person or department managers, to carry on his/her duties.

Technical Directors shall be named on the title page of this QA Manual. Technical Managers shall include the Operations Manager, the Department Managers/Group

Supervisors and senior analysts who may take on some or all of the responsibilities listed above for the Operations Manager and Department Managers/Group Supervisors. These responsibilities could be assumed in the absence of the Operations Manager and/or a Department Manager/Group Supervisor. All technical directors shall meet the educational and experience requirements dictated by NELAC and the DoD QSM for the laboratory areas that could fall under their responsibility for any amount of time.

The Quality Assurance Officer (QAO) shall have experience in QA/QC procedures and be knowledgeable in the quality systems defined under NELAC and under the DoD QSM. The QAO shall have a general knowledge of the tests performed by the laboratory. The QAO shall be responsible for conducting systems audits and inspections for compliance with this manual, SOPs and QA Project Plans or other project-specific protocols. The QAO shall be responsible for maintaining historical files of all QA documents, reviewing QC charts, documenting findings and corrective actions, reviewing training records, managing PTs, maintaining conformance with certification requirements and reporting findings related to all of the above to management. The QAO shall ensure that communication takes place at all levels within the laboratory regarding the implementation and effectiveness of the QA Program. The QAO shall utilize available tools such as audits, PT results, corrective and preventive actions, customer feedback and management reviews to monitor and continuously improve the quality system. The QA Officer shall function independently from laboratory operations and be able to evaluate data objectively and perform assessments without outside influence. The QA Officer has the authority to independently halt production operations (including data reporting) if warranted by quality problems. The Quality Assurance Officer shall report directly to the President.

In the absence of the Quality Assurance Officer, it shall be the responsibility of his/her designee, who shall not be involved in the direct production of the work in the area of concern, to carry out his/her duties.

Project Managers (PMs) are responsible for managing sample projects within the laboratory. PMs are responsible for communicating on a daily basis with all external clients as well as with internal Department Managers and analysts. PMs are responsible for providing bids to clients, for reviewing bids compared to the lab's capabilities, for providing clients with bottles and necessities on a timely basis, for communicating with clients on a timely basis prior to work being received and throughout the project as needed. PMs must communicate any analytical issues to the client with professionalism and sufficient knowledge to resolve any issues with the client. PMs will act as the main contact for the assigned clients. Additional tasks may include sample log-in, bottle order preparation, working on QAPP tables and/or client visits.

In the absence of a Project Manager, it shall be the responsibility of his/her designee, who may be the Sales and Marketing Representative, a senior manager or qualified analyst , to carry on his/her duties.

The President is responsible for managing all activities related to laboratory services, including the Quality Assurance Program. The President shall assure that there is a Quality Assurance Department, that personnel and other resources are adequate, that personnel have been informed of their responsibilities, that deficiencies are reported to the Operations Manager, that corrective actions are taken and documented and that the quality assurance program is effective in accomplishing the underlying goals.

Additionally, as the owner of Katahdin Analytical Services, the President shall ensure that all management and personnel are free from any undue internal and external commercial, financial and other pressures and influences that may adversely affect the quality of their work. These policies are outlined in the company ethics agreement and training (refer to section 2.3 of this manual and SOP QA-811) and in the company Conflict of Interest Policy (refer to Figure 2-2).

2.3 Training and Orientation

The training program at Katahdin can be divided into four parts, Orientation Training, Technical Training, Quality Assurance Training, and Environmental Health & Safety Training. The Orientation Training is further divided into five parts, Human Resources Training, Basic Safety Training & Tour, An Introduction to Katahdin, Basic QA Training (an overview of the QA Program) and Ethics Training. The Ethics Training provides employees with information relating to their legal and ethical responsibilities. The Technical Training consists of the initial training for a method or process and the Initial Demonstration of Proficiency and any continuing or retraining that is deemed necessary by the individual Department Managers/Group Supervisors, IT/Production Manager, Operations Manager or Quality Assurance Officer. The Quality Assurance Training provides more details on quality related to data review and reduction. Environmental Health & Safety Training provides an overview of the entire safety, chemical hygiene and hazardous waste programs at Katahdin.

On the first day of beginning employment, each new employee will receive a new employee orientation consisting of a Human Resources orientation, Ethics training, An Introduction to Katahdin, Basic QA training and a basic safety training & tour. Within the next few days of employment, each employee will begin their departmental technical training. Within one to two months (per the applicable regulations or as deemed appropriate by management) each employee will have more advanced quality assurance training and environmental health & safety training. We have found that waiting one to two months allows employees time to begin their technical training and to become familiar with standard terminology and practices.

2.3.1 Human Resources Orientation

The Human Resources Director will conduct the human resources part of the orientation first. At this time the New Employee Human Resources Check List (Figure 2-3) will be used to document orientation and receipt of all human resources material. Each new employee will receive an Employee Handbook, which they will be asked to read over the next few weeks.

2.3.2 Ethics Training

Each employee will be asked to sign a Katahdin Code of Ethics, which will be maintained by the Human Resources Manager. Each new employee will be trained at the beginning of employment, and annually thereafter, on their ethical and legal responsibilities at Katahdin. This training is supported by Katahdin Analytical Services Code of Ethics (Figure 2-6). The training is conducted by the Katahdin Operations Manager and will cover, but is not limited to, the following:

(Refer to the current revision of Katahdin SOP, QA-811, Ethics and Data Integrity in the Laboratory, for further information.

- responsibilities of data handling
- responsibilities of documentation
- confidentiality
- responsibilities for reading, understanding, and adhering to all Katahdin documents
- compliance and regulatory framework
- valid data (true and representative of the measurement)
- data defensibility
- manual integration policy
- deviations from QA/QC criteria
- repercussions of unethical behavior

It is every employee's responsibility to read, understand and adhere to the Katahdin Code of Ethics. It is also a Katahdin policy to participate in an ethics training session. Attendance is mandatory and will be documented. Failure to comply with these policies and/or requirements associated with ethics training will result in mandatory further retraining and/or disciplinary action, up to, and including termination.

Training materials will be filed with the Operations Manager and/or QA Officer.

This training will be documented as a sign-off provided during the training. This sign-off will be filed with the Operations Manager.

2.3.3 Safety Tour

Safety training is an essential part of the orientation of each new employee. The training provides an overview of the safety considerations specific to the employee's lab area. On the first day of employment, each employee will be given a basic safety orientation/tour including information on the location and use of Personal Protective Equipment (PPE), emergency response equipment, MSDS's, the locations of general chemical hazards in the pertinent laboratory(ies), and information regarding the names of emergency and management personnel. Additionally, each employee will be given an Environmental Health & Safety Manual and be required to read sections B,C and D. Refer to Figure 2-4 for the Safety Tour Training Form. Safety Tours will be conducted by the Environmental Health & Safety Officer or by a member of the Safety Committee.

2.3.4 An Introduction to Katahdin

This training will provide each new employee with information on Katahdin's background, philosophy, and scope of work. It will incorporate keys to success, expectations of each employee and a brief summary of how training will be accomplished.

2.3.5 Basic Quality Assurance

When an employee begins employment, the QA Officer will assign each employee a controlled copy of the company QA Manual. As part of new employee orientation, the Operations Manager or the QAO will conduct the Quality Assurance orientation. QA Training will involve a summary of the QA Program contained within the QA Manual.

Each employee has the responsibility to read the Quality Assurance Manual and understand the systems and company policies it sets forth. An overview of the laboratory QA program will be discussed as well as an overview of the contents of the QA manual. Each analyst shall have a clear concept of the quality objectives of Katahdin, the laboratory organization and paths of communication, standard practices and an understanding of their individual responsibilities.

Training will include discussions of the following:

Organization, Responsibilities & Training
Materials & Apparatus
Sample Handling and Chain-of-Custody
Holding Times & Preservation
Measurement & Calibration Techniques
Methodology & Regulations
Standard Operating Procedures
Reporting Limits – PQLs & MDLs
Record Keeping
Accuracy & Precision Measurements
Auditing & Proficiency Testing
Preventive Maintenance
Corrective Action

The training will focus on Katahdin's policies, the execution of these policies and the reasons for the policies. Analysts will be given sufficient time to ask questions about any aspect of the QA Program. In addition, the QA Officer and/or Operations Manager will remind analysts of the importance of documenting the training that they are receiving and will provide additional forms if necessary. Training materials will be filed with the Operations Manager and/or QA Officer.

This training will be documented as a sign-off provided during the training. This sign-off will be filed with the QA Officer.

It is the responsibility of the Human Resources Department, the Operations Manager, and the Environmental Health & Safety Officer to schedule, conduct, and document their respective orientations with the new employee.

2.3.6 Technical Training

Technical competency and proficiency means that an analyst has achieved an acceptable level of skills and understanding, sufficient to generate data of documented and acceptable precision and accuracy as defined in the applicable method. Training shall be conducted in a two-fold manner. First, the trainer demonstrates the procedure to the employee. Second, the employee conducts the procedure while the trainer observes and discusses the procedure with the employee. A Certification Statement (Figure 2-5) must be completed for each procedure in which the analyst is being trained. It is the intent of this training program to train each analyst to the level of competence required for the completion of the analyst's assigned tasks.

Department managers and group supervisors shall be responsible for providing documentation of training and proficiency in accordance with Katahdin Analytical Services SOP QA-805, for each employee under their supervision. The training documentation file indicates what procedures (SOPs) an analyst or technician is capable of performing either independently or with supervision. As part of the certification statement, employees must complete an Initial Demonstration of Proficiency (IDP) that meets the requirements of the method. Please refer to Katahdin SOP QA-807, Method Performance / Precision & Accuracy Requirements, and individual methods for IDP requirements. This SOP gives specific details for this demonstration including all acceptable forms to meet this requirement. A summary of results and documentation of the applicable raw data files is maintained in the employee's training file. Each individual is responsible for maintaining an updated and current training documentation file.

SOP QA-805 further describes specific procedures for documenting training when an employee comes to Katahdin with prior training already or when an experienced employee "trains" themselves on a new procedure through method development. Additionally, employees must document training in new SOP revisions where changes are deemed significant by the QAO or Operations Manager. Training in new SOP revisions shall be documented as applicable on Katahdin Analytical Services Retraining Form. This form should also be used to document refresher training for employees who have not performed a method for greater than 18 months. In addition, if a department manager, manager, QAO or other auditor observes non-conformance, this form may used to document retraining of the personnel involved.

Continued Demonstration of Proficiency (CDP) must be documented annually within each employee's training files. This may be accomplished by comparing the results of four LCSs to laboratory or method limits. CDP is also accomplished through the continuous implementation of Katahdin's QA program. QA/QC elements such as LCSs, blanks, matrix spikes, MDLs, performance evaluations, sample duplicates and surrogates are all functions of the QA Program. Evaluation

of these elements on a daily or routine basis can reveal where additional training may need to occur.

It is Katahdin's policy that all preparation and analytical chemists complete their IDP and CDP independently of each other. Each individual must maintain their IDP and CDP in their training files. Even though a procedure may consist of same "work cell", or group of analysts working together to perform a method, each member of the "work cell", must document their own IDP and CDP.

2.3.7 Advanced Quality Assurance Training

Once an employee has begun to train on analytical methods and has encountered different aspects of testing including data reduction and evaluation, additional training may be performed as dictated by the management staff. This training would be tailored to the specific needs of the individuals.

2.3.8 Environmental Health & Safety Training

Environmental Health & Safety Training is performed in accordance with the current revision of Katahdin's Environmental Health & Safety Manual. The training will encompass the Laboratory Safety Plan, the Chemical Hygiene/Hazard Communication Plan, the Hazardous Matter Spill Prevention, Control, & Clean-Up (SPCC)/ Contingency & Emergency Response Plan, the Hazardous Waste Management Program, and HAZMAT Security Awareness Training.

Katahdin's training program is extensive and involves both initial and continuing training in many different areas of environmental health & safety. Katahdin is committed to meeting all Federal and State regulations regarding training. Refer to Figure 2-7 for a summary of the training and frequency of training.

The Katahdin Environmental Compliance Officer (ECO) or the Katahdin Environmental Health and Safety Officer (EHSO) will conduct the training associated with the Environmental health & Safety Manual. All employees who complete the training will have to sign an attendance sheet. A copy of the training materials and records of training will be kept by the ECO.

Figure 2-1
Katahdin Analytical Services, LLC
Organizational Chart

Katahdin Analytical Services, LLC.
Organizational Chart

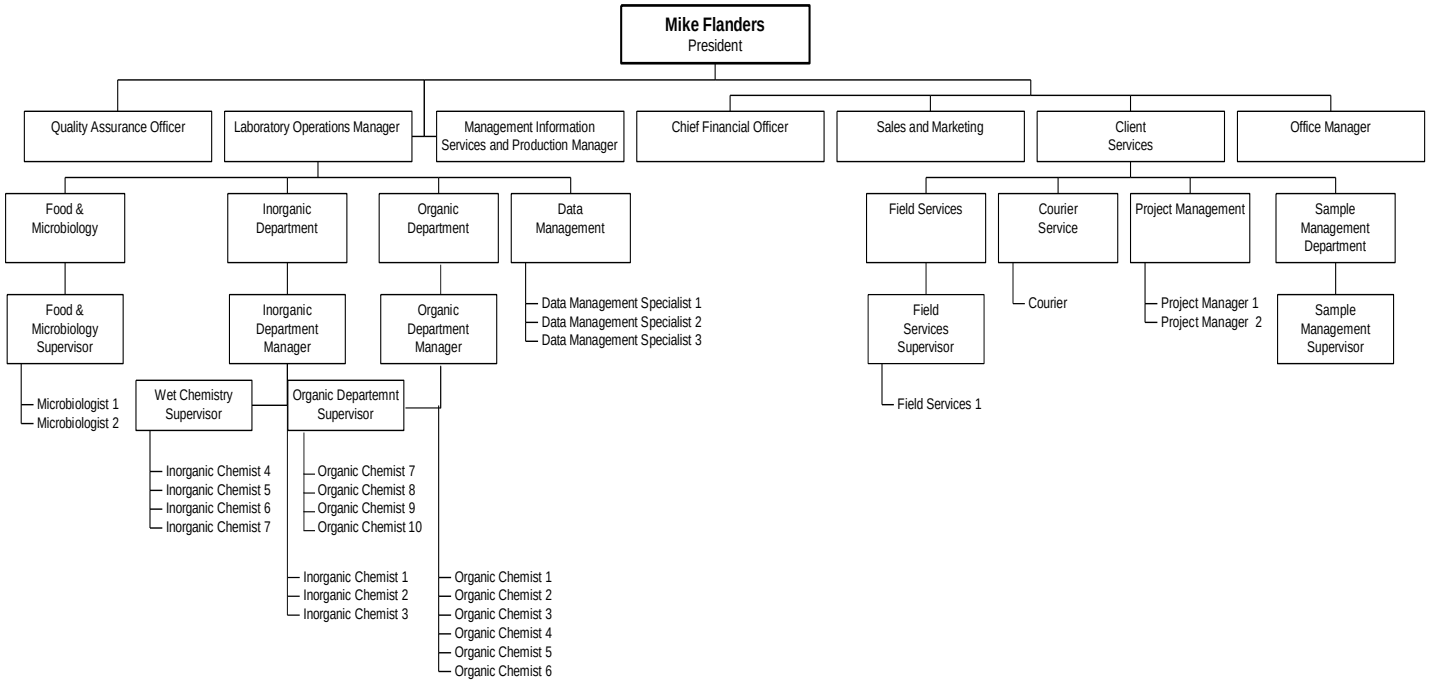

Figure 2-2

Katahdin Conflict of Interest Policy

CONFLICT OF INTEREST POLICY

Katahdin Analytical Services has several programs and policies in place in order to ensure that commercial or financial concerns of the laboratory operations do not affect or place undue pressures on employees that might adversely affect the quality of their work while employed by Katahdin. Specifically, the Quality Assurance Program is designed to establish, maintain and execute protocols to produce data of known quality and defensibility through the proper documentation of all measurement activities. The QA Manual states that, "No other concerns will be permitted to interfere with the execution of the elements of this QA Program and the quality of the data generated and delivered." Furthermore, the Katahdin Ethics Policy states that, "If a supervisor or a member of Katahdin management or any outside source requests an employee to engage in or perform an activity that they feel is compromising data validity or quality, the employee will not comply with the request and report this action immediately to a member of upper management." This last statement shall include any form of unethical behavior as defined in the current revision of Katahdin SOP, QA-811, Ethics in the Laboratory, or any other circumstance that may constitute a conflict of interest. A conflict of interest is a situation that arises when an individual, group of individuals, or organization is in, or could be in, circumstances that are or could be, questionable. Katahdin has the following policies concerning conflicts of interest.

No Katahdin employee shall accept gifts or gratuities valued at greater than $50 from customers or suppliers. All personnel are expected to act with integrity and good judgment and to recognize that the acceptance of personal gifts from those doing business or seeking to do business with Katahdin, even when lawful, may give rise to legitimate concerns about favoritism depending upon the circumstances.

All Katahdin employees shall disclose any personal, business, or financial relationship that he/she or any member of their household or immediate family has with a client or potential client of Katahdin Analytical Services for whom the lab is performing work which could be deemed as a conflict of interest.

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Figure 2-3

Katahdin New Employee Human Resources Checklist

NEW EMPLOYEE HUMAN RESOURCES CHECK LIST		
NAME:	EFFECTIVE DATE:	
ITEM	RECEIVED?	DATE COMPLETED
Status Change Form		
I-9		
Keycard Access Agreement		
Application		
Resume		
Health Insurance Forms – Medical & Dental		
Health Insurance Benefits Summary/Highlights		
Health Insurance Plan Book		
Create Employee File		
Enter information into Evolution		
Enter information into TimeTrak		
Create swipe card		
Set up PTO accrual		
W-4 Federal/State		
Direct Deposit		
Disability Forms		
New Hire Form		
Phone/Voice Mail Instructions		
Employee Handbook		
Employee Handbook Sign-off		
Drug-Free Workplace Sign-off		
Confidentiality Agreement Sign-off		
Ethics Agreement Sign-off		
Safety Glasses		

AD-006 – Revision 1 – 03/23/11

Figure 2-4

Safety Tour Training Form

Katahdin Analytical Services Safety Tour Training Form

Employee Name:	Date:
Employee's Work Area:	Administration or Laboratory
Safety Committee Member Performing Tour:	

Personal Protective Equipment (PPE)/Emergency Equipment & Information

Have safety glasses and a lab coat been issued?

Show location of the following and a description of how to use (if applicable). Circle each item shown and described:

Safety Shower	First Aid Kit	Fire Extinguisher	Spill Kit materials
Eyewash Station	Gloves	Goggles/Aprons	Main Shower/Spare Clothing
MSDS's (lab)	MSDS's (master)	Building exits (4)	Fire alarm pull boxes (4)
MSDS's (server_a/gendb/waste/KAS MSDS's)		Emergency Phone Numbers	

Other (specify):_____

Chemical Hazards

Show location of the following and a brief description of each (if applicable). Circle each item shown and described:

Acids Bases Solvents Flammables Poisons/Toxic Compressed Gases

Other(Specify):_____

Environmental Health & Safety Manual (EHSM) Reading

Show location of the following and a brief description of each (if applicable).

EHSM Bulletin Board – Appendix B-1 showing required/suggested PPE for each task and whether employee may work alone. Also note that it is important that employees let somebody know when they are leaving the building in case of emergency evacuations and so that another employee is not left alone unknowingly.

Each new employee is required to read sections B (Laboratory Safety Plan), C (Chemical Hygiene/Hazard Communication), and D (Hazardous Material Spill Prevention, Control & Clean-Up (SPCC)/Contingency & Emergency Response Plan of the EHSM.

Signature after reading:_____

Personnel Information

Katahdin Analytical Services Owners	Bill and Daphne Warren
Environmental Compliance Officer /Lab Operations Manager	Deb Nadeau
Environmental Health & Safety Officer	Galen Nickerson
Emergency Coordinators	George Brewer (1st), Peter Lemay (2nd), Deb Nadeau (3rd)
Department Managers	George Brewer (inorganic), Pete Lemay (organic)

Employee Signature:_____ Date:_____

Trainer Signature:_____ Date:_____

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Figure 2-5

Katahdin Training Certification Statement

Demonstration of Capability - Certification Statement

Date:	
Laboratory Name:	Katahdin Analytical Services, Inc. 600 Technology Way Scarborough, Maine 04074
Analyst(s):	
Matrix (circle):	Aqueous Soil Other:
Method # or SOP # :	

We, the undersigned, CERTIFY that:

1. The analyst(s) identified above, using the cited test method(s), which is in use at this facility for the analyses of samples under the National Environmental Laboratory Accreditation Program and other state and federal certifications, have met the Demonstration of Capability.
2. The test method(s) was performed by the analyst(s) identified on this certification.
3. A copy of the test method(s) and the laboratory-specific SOPs are available for all personnel on-site.
4. The demonstration of capability has been performed in accordance with the current revision of Katahdin SOP, QA-807, *Method Performance/Precision & Accuracy Requirements.* Acceptance criteria are referenced in this SOP.
5. The data associated with the demonstration of capability are true, accurate, complete, and self-explanatory(*).
6. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized assessors.
7. The analyst(s) identified above, have read, understood, and agreed to perform the applicable (approved method or SOP as specified by laboratory management) revision of the method and/or SOP.

Department Manager's or Trainer's Name	Signature	Date
Department Manager's or Trainer's Title		
Analyst's Name	Signature	Date
Quality Assurance Officer's Name	Signature	Date

* True: Consistent with supporting data
Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.
Complete: Includes the results of all supporting performance data.
Self-Explanatory: Data properly labeled and stored so that the results are clear and require no additional explanation.

QA-005 – Revision 1 – 09/23/09

Figure 2-6

Katahdin Code of Ethics

KATAHDIN ANALYTICAL SERVICES, INC.
CODE OF ETHICS

Our clients rely upon the integrity of our work. They may be homeowners who want to know whether their drinking water contains pollutants that may be harmful to their families. They may be government agencies or regulatory authorities that will rely upon our analytical test results as the basis for decisions that will affect public health and policy. In every case, it is vitally important that the information we provide to our clients be of a known and defensible quality.

As such, it is Katahdin's policy to incorporate the highest standard of data quality within all analytical programs. All Katahdin employees must remain committed to consistently demonstrating compliance with high quality. The integrity of our work depends upon the individual integrity of each employee. Accordingly, each employee is required to sign and adhere to the following policies.

I, _____(print name) understand that high standards of integrity are required of me with regard to the responsibilities that I have and to the data that I produce while employed at Katahdin. I agree that in the performance of my duties at Katahdin:

- I will adhere to all Standard Operating Procedures, including procedures described in the Katahdin Analytical Services' Quality Assurance Manual.
- I will not intentionally falsify data or results.
- I will not intentionally record or enter data or results that are not a true and accurate representation of the measured values or which are not validly quantitated.
- I will be accountable for my work.
- I will not intentionally misrepresent another individual's work.
- I will immediately inform my supervisor or a member of upper management if I am aware of misrepresentation of data.
- If a supervisor or a member of Katahdin management or any outside source requests me to engage in or perform an activity that I feel is compromising data validity or quality, I will not comply with the request and report this action immediately to a member of upper management.
- I agree to inform my supervisor or a member of management of any accidental reporting of non-authentic data by me or any other employee in a timely manner.

I have read and understand this Ethics Agreement. I understand that failure to comply with these policies and/or requirements associated with ethics training will result in mandatory retraining and/or disciplinary action, up to, and including termination.

Signature_____ Date_____

QA-079 – Revision 1 – 03/23/2011

Figure 2-7

Summary of Environmental Health & Safety Training

Katahdin Analytical Services, Inc. - Environmental Health & Safety Requirements Summary

Training Category	Applicable Regualtion(s)	EHSM Location	Initial Training	Continuing Training	Affected Employees
Laboratory Safety Plan and Chemical Hygiene/Hazard Communication	OSHA 1910.1450 – occupational Exposure to Hazardous Chemicals in Laboratories	Parts B and C	At initial assignment	To be determined by Katahdin	All employees
Video Display Training	Maine MRSA Title 26.	Part B	Within the first month of hire	Annually thereafter	Employees who spend at least 4 consecutive daily at a VDT.
Hazardous Waste Operations & Emergency Response Standard (HAZWOPER)	OSHA 1910.120 – Hazardous Waste Operations and Emergency Response	Part D	At initial assignment	Annually thereafter	All employees
RCRA Contingency Plan	EPA -Resource Conservation & Recovery Act – CFR 40 Parts 260-270 & MDEP Regulations	Parts D and E	Within six months of hire	Annually thereafter	All employees
Hazardous Waste Management	EPA -Resource Conservation & Recovery Act – CFR 40 Parts 260-270 & MDEP Regulations	Parts D and E	Within six months of hire	Annually thereafter	Those with hazardous waste duties as defined in job descriptions.
Bloodborne Pathogen Standard	OSHA 1910.1030 – Bloodborne Pathogens	Part C	At initial assignment	Annually thereafter	All employees
First Aid/CPR	OSHA 1910.151 – Medical Services & First Aid	Parts A, C & D	As assigned	When expired – First Aid = 3 yrs, CPR = 1 year	As chosen by company.
Security Awareness Training	DOT – 49 CFR 172 – Hazardous Materials	Part F	Within 90 days of hire	Every 3 years thereafter	All employees
Department of Transportation Hazmat	DOT – 49 CFR 171-178 – Hazardous Materials regulations	Part F	Within 90 days of hire	Every 3 years thereafter	Those dealing with receiving or shipping of Hazmat.

HZ-011 – Revision 1 – 03/23/2011

3.0 QA DOCUMENTS & DOCUMENT CONTROL

All documents issued to personnel in the laboratory as part of the quality system are reviewed and approved by members of management (Department Manager, Group Supervisors, IT/Production Manager, Operations Manager and Quality Assurance Officer) before distribution. The distribution is controlled so as to ensure that all personnel follow the current and relevant versions of these quality documents.

3.1 QA Manual

This document describes management policies related to operation of the analytical laboratories. It provides overall guidance regarding acceptable practices and discusses each element of the Quality Assurance Program. It functions as the Project QA Manual where no other Quality Assurance Project Plan, Statement of Work or other contractually mandated project plan has been specified. Adherence to the practices described in this manual is required of all employees. This manual must be reviewed and updated, if changes are required, at least annually. If there are no changes, a No-Change form shall be filled out and filed. This manual may be revised and/or superseded only with the written authority of the Katahdin President. The QA Department administers distribution of controlled copies of this manual.

In order that this document achieves the goals outlined in Section 1.0, it is necessary that each Katahdin laboratory employee be familiar with the current provisions of this document. It is also necessary that this document represent agreement among Katahdin management and operational personnel as to the quality level desired and the means to that end.

Prior to its publication as a controlled document, this manual must be approved by the Katahdin Quality Assurance Officer(s), Laboratory Operations Manager, the IT/Production Manager, the Katahdin President and all Katahdin NELAC Technical Directors. To obtain such approval, the document proceeds through an iterative process of review and revision, involving the affected managers and their designated representatives. The signature page at the beginning of the manual represents acceptance.

Each time a revision is made to this manual, it must also be approved. The Quality Assurance Officer(s) must approve each revision. If the revision constitutes a complete rewrite of the document, then review and approval by the Quality Assurance Officer(s), Laboratory Operation Manager, and the President becomes necessary. The Quality Assurance Officer(s) will decide the appropriate approval process in each case.

The QA Manual is assigned the QA number of QAM-001 followed by a numerical revision number. Additionally, each section of the QA Manual is assigned a revision number. In this manner, the QA Manual may be updated in whole, or receive updates to only certain sections.

3.2 Standard Operating Procedures Manuals

All procedures related to sample collection, storage, preparation, analysis, disposal, data validation, data reporting and employee training and safety shall be contained in written Standard Operating Procedures (SOPs) Manuals. Each SOP shall contain the elements

outlined in the current revision of SOP QA-800, Preparation of SOPs. All sections shall be structured in a step-wise manner using numbered sections. All record-keeping requirements shall be described at each step in the SOP. Examples of forms used shall be included as tables or figures and referenced within the text. Preparation of SOPs shall be the responsibility of each department under the guidance of and review by the appropriate department manager. SOPs shall be assigned a number from the inventory list for SOPs maintained by the Quality Assurance Department. This number shall become part of the document control number when the SOP is accepted for implementation by Katahdin management. SOPs shall be reviewed and approved by the appropriate department manager, the Operations Manager, and the QA Officer(s), and submitted by the QA Department to the Operations Manager for approval prior to implementation. Refer to the current revision of Katahdin SOP, QA-800, Preparation of SOPs, and to section 12.0 of this manual for further information.

3.3 Project QA Plans and/or Quality System Manuals

Project QA Plans shall be implemented as required. These shall include such documents as Quality Assurance Project Plans (QAPPs). Additionally, the use of a specified Quality Systems Manual (QSM) may be required for some projects. For those projects that require specific QA/QC criteria the client provides a QAPP or specifies a QSM that has been approved by a regulatory agency (i.e. EPA or DoD). In either case, Katahdin works closely with the client and/or regulatory agencies to define the specific scope and Data Quality Objectives (DQOs) of each project. Only in this manner can the laboratory determine the specific criteria to follow to meet the needs of the client. Often, Katahdin works in conjunction with the client to write the analytical section of a QAPP. In this instance the QAPP is reviewed and approved by the Katahdin Quality Assurance Officer, the Katahdin Operations Manager, the Katahdin IT/Production Manager, the Katahdin department managers and/or Field Services Manager as appropriate. All project QAPPs received by the laboratory are submitted to the QA Department. Each QAPP is scanned and may be stored on the server as a pdf file for use by the analytical departments. Refer to the current revision of Katahdin SOP, QA-810, Project Management: Review and Communication of Client Bids, Contracts and Project Specific Information & Service to the Client.

3.4 Laboratory Logbooks

In order to ensure traceability and retrievability of records, all laboratory run logs, raw data logs, prep logs, standards prep logs, maintenance logs and any calibration logs are document controlled. A QA assigned number is stamped on every page at the center top or center bottom. The QA number will resemble one of the following:

QAQCxxx for general QA logbooks
QAMSxxx for GC/MS logbooks
QAAAxxx for metals logbooks
QAWLxxx for wet chemistry logbooks
QAGCxxx for GC logbooks
QAEXxxx for extractions logbooks
QADMxxx for data management logbooks
QAFMxxx for food/microbiology logbooks

The assigned number is included at the bottom of each page of the logbook.

The Data Management Department will keep a record (tracking spreadsheet) consisting of the logbook number, the lab area (e.g., GC/MS, Wet Chemistry, etc.), the logbook title, the date initiated, and the name of the individual who initiated the logbook.

Once the logbook is full and a new one is initiated, the appropriate department will maintain the logbook for several months to facilitate tracking of historical data. After this time, all completed and/or closed out logbooks will be relinquished to the QA department.

3.5 Control of Other Printed Material

All laboratory designed forms, spreadsheets, and charts shall be controlled through an internal document control system to preclude the use of invalid and/or obsolete documents. The material covered in this system includes laboratory designed written material for QA, the analytical laboratory, support services and administration. All forms, charts, spreadsheets, etc. shall receive a control number with a revision number and date and an updated date, if applicable. The revision number shall apply to format changes in the structure of the form, chart, spreadsheet, etc. Forms will all begin with revision 1 effective with the start of this control system. The updated date shall apply to additional data being added to a form, chart, spreadsheet, etc., as with a dynamic form or inventory. The actual format does not change, only additional information is added.

The master electronic copies of these controlled documents shall reside on the company server. Only those individuals authorized to make format changes shall have access to the folders containing these documents. At this time, only the QAO, the Operations Manager, and the Department Managers have this authorization. Copies of current forms in pdf format are kept on a Katahdin server to be accessed by laboratory personnel and by project managers for client distribution.

Server_a\QAQC\QAQC\Current Forms

All outside written material applicable to the procedures and policies at Katahdin shall be controlled also. This material includes, but is not necessarily limited to, Project QAPPs, the DoD QSM, instrument manuals, etc. For material that is provided already in manual form, an internal control number and effective date will be assigned to the cover and maintained by the responsible supervisor in a central location. All material that is printed from the internet shall be given internal control numbers and effective dates and distributed accordingly.

All controlled documents in this system must be reviewed and approved by the QAO, the Operations Manager or a Department Manager. All controlled documents must be revised as necessary to comply with the applicable methods, regulations or policies. All invalid or obsolete documents must be removed from the controlled folder on the company server and moved to the obsolete folder.
A master list of all controlled material shall be maintained by the QAO, with authorized access to the Operations Manager, and the Department Managers. The list shall include a title for the controlled document, the control number, the revision number and date and

the updated date where applicable. The list shall also indicate where copies of the controlled document have been distributed. Controlled documents shall not be copied and distributed elsewhere unless approved by the QAO or the Operations Manager.

The document control procedures described in this section are not applicable to software. Control of software is described in the current revision of Katahdin SOP SD-906, Software Quality Assurance.

3.6 Document Control, Distribution and Revision

Maintaining laboratory SOPs, the QA Manual and all other pertinent printed material so that they accurately reflect current practices is an ongoing effort at Katahdin, particularly in light of rapidly changing industry needs, analytical processes, and operating systems. Logbooks and benchsheets are used by Katahdin personnel to record raw data and must be used and preserved so as to maintain the integrity of that data. To ensure that methods and procedures are followed in a consistent manner, that confidential information is not distributed and that all current copies of QA documents are from the latest applicable revision, Katahdin has developed a document control system. All SOPs, QA Manuals, logbooks and other printed materials distributed within Katahdin are maintained under this document control system.

The document control system provides:

- A unique identification for each controlled document
- A central location for all controlled documents
- A systematic means for distribution of controlled documents
- A tracking system for controlled documents
- A means for identifying revisions
- A mechanism for consistent review of documents
- A mechanism for archival of outdated documents

Every SOP and QA Manual in the laboratory must contain the colored Katahdin watermark identifier on each page. All controlled SOPs, QA Manuals and other printed laboratory material must clearly indicate the date that the document became effective. Photocopies of controlled SOPs and QA Manuals are not considered controlled documents. The use of photocopies of controlled documents is not allowed in the laboratory to prevent the use of outdated material. All controlled copies of the QA Manual and SOPs will be distributed by the QA department, and an inventory of all distributed controlled copies will be maintained in the QA files. The QA department will also maintain a current index, including revision number and date, of all SOPs approved for use in the lab. Please refer to the current revision of Katahdin SOP QA-804, Document Control Procedures for detailed descriptions of the document control process.

4.0 FACILITIES

4.1 General Information

Katahdin Analytical Services currently employs a staff of approximately 40 environmental professionals and occupies a new state of the art 14,500 square foot facility built in 2006, utilizing LEED-inspired (Leadership in Energy and Environmental Design) design and functionality. The facility utilizes a centralized office hub serving as the communications, data review, reporting, and operations point of origin. From this central hub, separate laboratories are arranged peripherally for Sample Receipt, Volatile Organics (GC and GC/MS), Extractable Organics (GC, GC/MS and HPLC), Wet Chemistry / Elemental Analysis, Elemental Preparation, Low-level Mercury Analysis, Microbiological Analyses / Food Testing, Air Analysis (GC/MS), and Grinding/Geotechnical Analysis. The floor plan offers hallways with access and entryways to all individual laboratory areas. Floor plans are provided in Figure 4-1.

The laboratory is designed to take into account environmental and accommodation conditions that could affect the results of a test. Each laboratory area is equipped with "reduced flow/velocity" hoods and separate HVAC systems. These hoods and all HVAC systems are integrated into a building direct computer control "DCC" system which allows for the building to be in monitored at any time. The system may be monitored off-site via "the web". Each laboratory functions on its own air system, efficiently managing the climate of the work environment and purifying the air to reduce and/or eliminate cross contamination between laboratories.

The Low-Level Mercury Analysis laboratory is designed as a clean room where special precautions have been taken to reduce dust and other contamination. The Microbiology/Food Testing laboratory has its own refrigerators to segregate food from environmental samples. Laboratory temperatures can be monitored and are recorded when required by the method. When such conditions are not met, or are out of criteria, the testing is redone with appropriate conditions, or the client is notified.

While the new facility is not a "LEEDS" certified building, many LEEDS specifications and materials are integral to the building. Lighting is provided by "high efficiency" florescent lights which are activated by motion sensors. To reduce air conditioning requirements, the roof is a "white" TPO (Thermoplastic Polyolefin) membrane. Some critical instrumentation such as GC/MS units and servers, including the data systems and Laboratory Information Management System (KIMS) are equipped with uninterruptable power supply systems (UPS) to minimize instrument downtime and damage during power surges or short duration power interruptions.

Additional features include walk-in refrigerators that can be locked when required and separate refrigerator storage for sample extracts, standards and volatile organics. An RO/DI water system is installed that delivers DI water to each individual laboratory room to increase efficiency and decrease the chance of cross-contaminated DI water. Added safety features include gas generators for some hydrogen, zero air and nitrogen, and a stainless steel pressure dispense system (SSPDS) that is plumbed to deliver methylene chloride to the extractables hoods.

4.2 Laboratory Safety

It is Katahdin Analytical Services' goal to maintain a safe and healthful work environment. Sample receiving areas and laboratories shall be equipped with suitable hoods, protective clothing and eye wear, gloves and/or other measures to prevent or minimize staff contact with hazardous substances. Safety equipment such as eyewash stations, drench showers, spill adsorbents and neutralizers, fire extinguishers, and first aid materials shall be available.

As a matter of policy, Katahdin Analytical Services shall not accept known initiator explosives, samples containing hydrofluoric acid, unusual biohazard materials or radioactive materials containing greater than background levels of radiation.

Environmental Health & Safety Training is performed in accordance with the current revision of Katahdin's Environmental Health & Safety Manual. The training will encompass the Laboratory Safety Plan, the Chemical Hygiene/Hazard Communication Plan, the Hazardous Matter Spill Prevention, Control, & Clean-Up (SPCC)/ Contingency & Emergency Response Plan, the Hazardous Waste Management Program, and HAZMAT Security Awareness Training. This document contains vital information related to training, safety equipment, personal considerations, chemicals, instrument / equipment operation, waste disposal, emergency situations and evacuation, glassware handling, housekeeping and first aid. Katahdin's training program is extensive and involves both initial and continuing training in many different areas of environmental health & safety. Katahdin is committed to meeting all Federal and State regulations regarding training. Refer to Figure 2-7 for a summary of the training and frequency of training.

The Katahdin Environmental Compliance Officer (ECO) will oversee the Environmental Health & Safety Program. The ECO shall designate a Katahdin Environmental Health and Safety Officer (EHSO) and a safety committee to help enforce and communicate the requirements of the Program. The committee shall consist of at least one staff member from each laboratory department. The Safety Committee shall meet on a quarterly basis to discuss any new safety or health related issues in the laboratory.

At the beginning of employment, each employee will be given a basic safety orientation/tour including information on the location and use of Personal Protective Equipment (PPE), emergency response equipment, MSDS's, the locations of general chemical hazards in the pertinent laboratory(ies), and information regarding the names of emergency and management personnel. Additionally, each employee will be given an Environmental Health & Safety Manual and be required to read sections B,C and D. Refer to Figure 2-4 for the Safety Tour Training Form. The safety orientation will be conducted by a member of the safety committee.

All employees will be trained on the EHS Manual and it's specific sections both initially and on as needed. The initial training should be conducted within 1-2 weeks of an employee's start date. The initial training will be extensive, but all employees will still be required to read and sign off on the manual. Refresher training will be conducted thereafter on an as needed basis. The ECO will conduct this extensive training.

Employees shall be responsible for their own safety. The Operations Manager and department managers may require that certain levels of protective equipment be worn, when in their judgment, it is appropriate. Failure of an employee to wear required protective equipment will result in immediate disciplinary action.

4.3 Security

Two tiers of security shall be maintained within the Katahdin Analytical Services laboratory for the purpose of controlling external influences on samples, analytical processes, and data. This helps assure the completeness, representativeness, accuracy, and precision of analytical results.

4.3.1 Facility Security

The first tier of security maintained shall be controlled access to the laboratory building. Exterior doors to the laboratory building shall remain either locked or continuously monitored by a Katahdin Analytical Services staff member. Any keycard issued to an employee shall be relinquished to laboratory management at the time that employee terminates employment at Katahdin Analytical Services. All visitors to the facilities must sign the Visitors' Logbook maintained by the receptionist. All visitors shall be accompanied by a staff member during the duration of their stay on the premises. The staff member shall escort the visitor back to the reception area at the end of their visit where they shall sign out in the Visitor's Logbook. Refer to the current revision of Katahdin Analytical Services SOP AD-004, Laboratory Facility Security and Confidentiality for more information. At the close of each day, all doors shall be checked and locked by the last staff member leaving the building.

4.3.2 Data Security

The second tier of security may involve specific secure areas for sample, data and client report storage which shall be lockable within the facilities and to which access may be limited to specific individuals or their designees. No samples are to be removed without filling out the associated chain-of-custody records. Security of client report archives shall be the responsibility of the Quality Assurance Officer or the Human Resources Manager.

Periodically, reports and raw data may be sent to secure, confidential off-site storage to be archived. This material is retained for a period of time dependent on the state, client or specific program regulations attached to it and may only be retrieved by designated personnel.

4.3.3 Electronic Security

As described in Section 2.0 of this manual and in the current revision of Katahdin SOP, QA-811, Ethics in the Laboratory, all employees are required to sign a Code of Ethics. This agreement requires the proper use and maintenance of computers and software at Katahdin. Katahdin utilizes dedicated computer work stations, which are used by only a group of cross-trained employees. This

prevents the accidental "changing" of data. As described above, Katahdin maintains a secure facility, requiring all visitors to be escorted and monitored. Additionally, Katahdin's policy is for a software user to log-in under their unique log-in so that all software audit trails are accurate. Using a software program for which another user is already logged on is not acceptable. Log-in passwords for the Laboratory Information System are changed on an annual basis as an added layer of security.

When test results are transmitted electronically, Katahdin will take steps to preserve confidentiality. Test results could be submitted via facsimile, website transmission, or via e-mail.

4.3.3.1 Facsimile Transmission

A statement is printed on the bottom of the fax cover page in the case of accidental incorrect transmission of results:

"The information contained in this facsimile transmission is privileged and confidential and intended for the use of the addressee named above. If the receiver of the following pages is not (one of) the above named recipient(s), you are hereby notified that any retention, dissemination, distribution, or copying of this facsimile is prohibited. If you received this facsimile in error, please notify us immediately by telephone. Thank you."

4.3.3.2 Website Transmission

Preliminary test results may be obtained on Katahdin's website using a Katahdin assigned unique client log-in and password. The site is secure, and clients may request several log-ins and/or passwords for different projects, etc.

4.3.3.3 E-mail Transmission

A statement, similar to the one below, is printed at the end of the e-mail message in the case of accidental incorrect transmission of results:

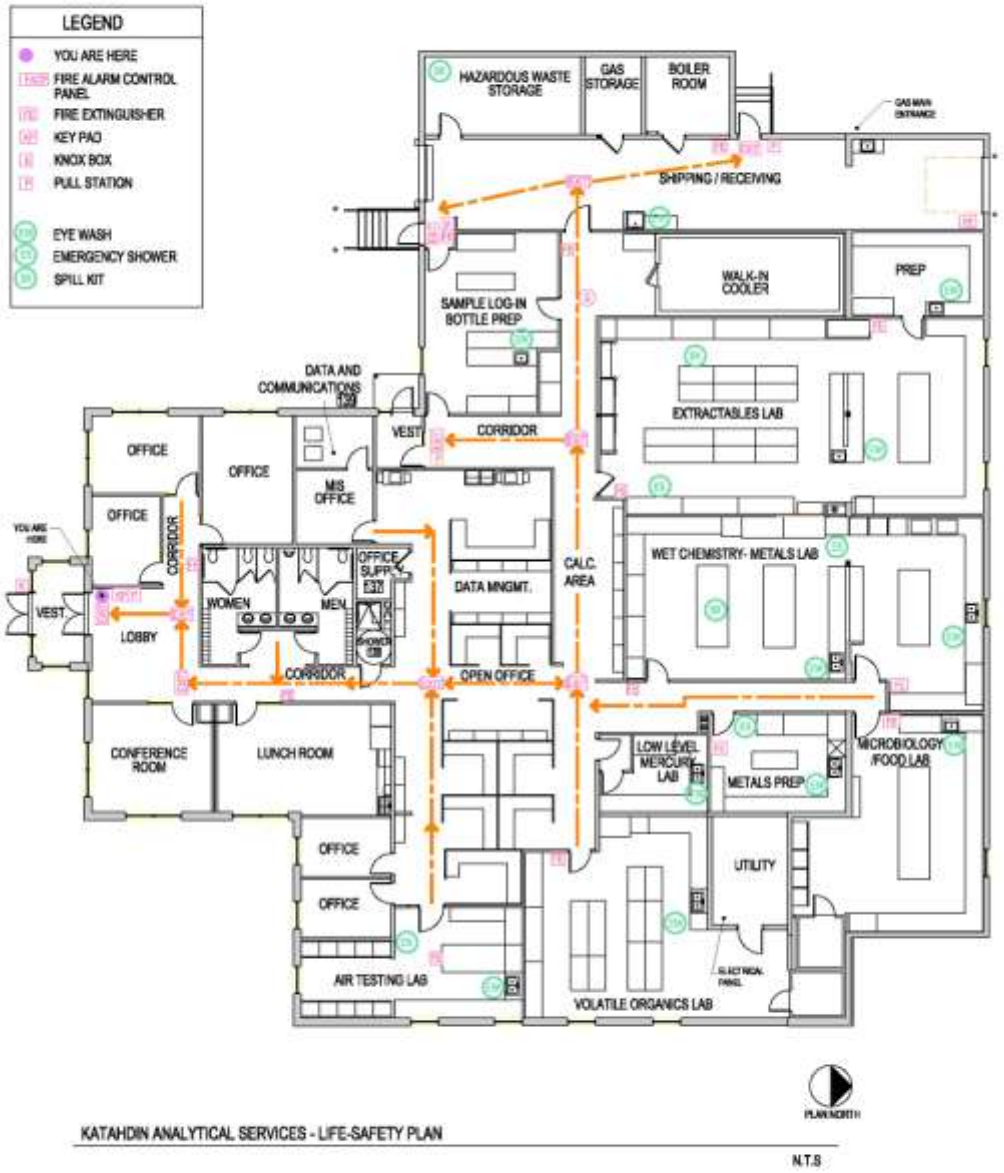
"Confidentiality Notice: This e-mail message, including any attachments, is for the sole use of the intended recipient(s) and may contain confidential and privileged information. If you are not the intended recipient please immediately contact the sender by reply e-mail and destroy/delete all copies of the original message. Any unauthorized review, use, copying, forwarding, disclosure, or distribution is prohibited."

4.4 Confidentiality

Standard business practices of confidentiality shall apply to all documents and information regarding client analyses. Specific protocols for handling confidential documents are described in the current revision of Katahdin Analytical Services SOP AD-004, Laboratory Facility Security and Confidentiality. Additional protocols for internal identification of samples and data by number only shall be implemented as required under contract-specific Quality Assurance Project Plans. No results from any testing are shared with anybody, except the client, without written consent from that client.

Figure 4-1

Katahdin Analytical Services, Incorporated
Facilities Floor Plan



5.0 MATERIALS AND EQUIPMENT

Evaluation and selection of suppliers and vendors is done primarily on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is accomplished through evaluation of supporting documentation provided by the vendor. This documentation may include certificates of analysis, recommendations and proof of historical compliance with similar programs for other clients.

To ensure that consumables and equipment conform to specified quality requirements, all purchases from specific vendors are approved by a member of the supervisory or management staff. Reagents, solvents, gases, glassware, sample containers, standards, media and general supplies are ordered as needed to maintain sufficient quantities. Each department submits their own purchase orders to a member of management for approval. As these are approved, they are ordered by the purchasing department.

The purchasing department maintains an inventory of current relationships with specific vendors and the details of those relationships (i.e. costs for shipping and handling, payment terms, etc.). Upon receipt of a purchase request from a “new” vendor, the Purchasing Department will set up any relationships with these new vendors and add them to the current record. All consumables are received by the receiving personnel and distributed to the appropriate department. Each department will track the receipt of the different consumables as described below and in the specific Katahdin SOPs that are referenced below. Any problems with ordering including the receipt of broken materials, the receipt of incorrect materials or any other ordering issues shall be brought to the attention of the Purchasing department immediately.

The laboratory shall ensure that purchased supplies, reagents and consumables are not used until they have been inspected or otherwise verified. Katahdin Analytical Services strives to purchase high quality reagents and supplies from reputable sources. Solvent lots are checked for purity prior to use in laboratory. Method blanks are used to assess any laboratory, background or reagent contamination.

5.1 Reagents, Solvents, Media and Gases

Chemical reagents, solvents, gases, and media used in the laboratory are supplied by reputable chemical suppliers. All chemical reagents used for analyses shall be sufficient to meet the quality control requirements of the method, i.e. no contamination and no interferences. Individual method references may indicate specific reagent requirements such as "Analytical Reagent Grade", “Ultra Pure” or “ACS (American Chemical Society) Grade”. When not specified by the method, “Analytical Reagent Grade” reagents shall be used.

Materials are dated upon receipt in the laboratories. Solvents are checked for purity before use (Section 5.2.2, Solvent Lot Checks). Filters are placed on gas lines supplying instruments as an extra precaution. Specific procedures are described in the current revision of Katahdin SOP CA-105, Reagent, Solvent and Media Receipt, Handling and Documentation.

All solvents, media and gases used shall be chosen to assure compliance with specific method and SOP requirements. Storage of solvents and chemical reagents shall comply with the current revision of Katahdin Analytical Service's Environmental Health and Safety Manual.

5.2 Laboratory Equipment

All support equipment shall be maintained in proper working order. All support equipment shall be operated only in accordance with the applicable SOPs, or in the absence of an SOP, in accordance with the manufacturer's specifications. Documentation of any repairs, service calls, and corrective actions shall be maintained in the appropriate logbook. All support equipment shall be calibrated or verified at least annually using NIST traceable references when available over the entire range of use. Individual SOPs and/or logbooks contain specific calibration criteria suitable for the use of the equipment. All equipment not meeting the specified criteria must be marked as not usable or removed from service until corrective action brings the equipment back into compliance. All records of calibration must be maintained. Refer to Table 5-1 for a summary of support equipment requirements. This table also contains some information described in section 7.0 of this manual.

Note: If more stringent support equipment criteria are included in a mandated test method or by regulation, those criteria must be used. If it is not apparent which standard is more stringent, the requirements of the regulation or mandated test method must be followed.

5.2.1 Refrigerator/Freezer Temperature Logs

Refrigerators and freezers are checked every weekday to ensure that they are operating properly and within established temperature ranges. All information is recorded in bound logbooks. Additionally, refrigerators used for sample and extract storage (thermal preservation) are checked on the weekends. These temperatures are recorded by wireless data loggers and transferred to a computer program held on the lab server. This data is monitored by Laboratory Operations Manager, the Quality Assurance Officer, the IT/Production Manager and the President.

Routine maintenance such as defrosting is performed as needed. Refer to the current revision of Katahdin Analytical Services SOP QA-803, Laboratory QA: Self-Inspection System. Responsibility for performing the checks is assigned within the laboratory section where the units are located. The QA Department is responsible for ascertaining that checks have been performed and that necessary corrective actions have been instituted when needed. The QA Department is responsible for archiving all historical temperature logsheets and/or logbooks.

5.2.2 Adjustable Pipettors

Adjustable pipettes are calibrated each day of use at the maximum volume and monthly at the minimum, mid and maxiumum volumes. All calibrations must be performed on a NIST calibrated balance. When adjustable pipettors are outside

of the tolerances expressed in the current revision of SOP CA-103, Calibration of Adjustable Pipettors, corrective actions are taken to bring the pipette into conformance or remove it from service.

Note: Microliter syringes used in the organics department shall come with certificates attesting to the established accuracy. Katahdin may request this certificate per lot of syringes.

5.2.3 Balances, Ovens, and Incubators

Refer to section 7.2 of this manual for calibration criteria.

5.2.4 Microbioloy Support Equipment

Specific checks are required for incubators, water baths, autoclaves, UV equipment and glassware used for microbiological testing. Refer to Figure 5-1 for a summary of these requirements.

5.3 Solvent Lot Checks

Some of the more commonly used solvents undergo a solvent lot check to identify any trace contamination. These solvents include methylene chloride, hexane and acetone. When a new lot is opened, the chromatogram for a concentrated volume of the new solvent lot is checked for any contamination. All information relevant to the check is recorded and maintained in a solvent check file. Responsibility for performing the checks and maintaining the records is assigned to the extractions personnel.

5.4 Glassware

All glassware used in the laboratory must be maintained in good condition, cleaned, properly stored, and separated according to its specific laboratory application. Cracked, excessively chipped or otherwise defective glassware is either discarded or repaired. Katahdin Analytical Services purchases all glassware from recognized commercial laboratory glassware suppliers such as Fisher Scientific and Baxter. All volumetric glassware utilized shall be sufficient to meet the quality control requirements of the method, i.e. to meet the precision and accuracy of the method. Class "A" certified glassware should be used whenever possible.

Refer to Table 5-1 for general guidance on volumetric and non-volumetric glassware. Also refer to the current revision of Katahdin SOP CA-108, Basic Laboratory Techniques, for further detail on lab glassware.

Each laboratory maintains its own set of glassware, completely independent from the other laboratories. Glassware is segregated for cleaning within each preparation laboratory to ensure that the glassware remains dedicated for use by specific laboratories.

5.5 Glassware Cleaning

Laboratory glassware is cleaned in accordance with its intended use at the end of the analytical process. Different cleaning procedures exist for different types of analyses and glassware. Refer to the current revision of Katahdin Analytical Services SOP CA-100, Lab Ware Cleaning.

5.6 Sample Containers

Please refer to Section 6.2.1 of this manual for Katahdin's standard practices concerning sample containers.

5.7 Instruments

Laboratory instrumentation used shall be as specified in the protocol for the analytical method. Table 5-2 lists the major analytical instrumentation currently in use in by Katahdin Analytical Services. All laboratory instrumentation shall be operated only in accordance with the applicable SOPs, or in the absence of an SOP, in accordance with the manufacturer's specifications. All laboratory instrumentation and associated hardware and software must be operated by trained employees only to safeguard instruments from accidental changes that would invalidate data.

Preventive maintenance is performed for each instrument by manufacturers, analysts and field service technicians on an ongoing basis and the activities documented in a bound instrument maintenance logbook or in the instrument runlogs as described in the current revision of Katahdin Analytical Services SOP CA-101, Equipment Maintenance, and section 14 of this manual.

Corrective maintenance shall be provided as required for all instruments and equipment and documented in appropriate logbooks. Factory replacement parts, trained service technicians and first quality materials shall be used whenever necessary. It is Katahdin Analytical Services' policy to conduct repairs at the lowest level of complexity necessary and to obtain parts directly from primary manufacturers where critical. The purpose of this policy is to maintain efficiency, economy and reliability of quality maintenance.

5.8 Stock Standards

Analytical standards are prepared from pure compounds or are purchased prepared from reputable vendors. These standards provide the stock used to prepare serial dilutions for calibration and spiking standards. Katahdin Analytical Services strives to purchase only the highest quality materials. To that end, reference standards must be traceable to national standards of measurement (e.g. NIST) whenever possible. Standards used for calibration must be traceable, when possible, to national standards of measurement, either directly through supplier documentation or by verification against a second source traceable reference standard. Supplier documentation is filed within each analytical section for ease in traceability. If assayed materials are unavailable, the material of highest purity available shall be obtained.

Each laboratory section is responsible for the preparation, storage and disposal of its standards. Pertinent standards preparation information is recorded into laboratory

specific standards logbooks in order to document traceability of prepared standards to their source material(s). Lot information is kept within each department. Manufacturers may keep purity records on file at their facilities. Refer to the current revision of Katahdin SOP CA-106, Standard Preparation, Documentation and Traceability.

5.9 Reagent Water

The performance of trace level analytical work requires that the water used for sample preparation, preparation of reagent solutions, and final rinsing of glassware be "theoretically pure," i.e. free from interferences, electrolytes, and other contaminants. In all cases, unless specified by the analytical SOP, reagent grade water is used. The electrical resisitivity of all water used for analytical work is monitored daily to meet the requirement of 16.7 Megohm-cm (maximum conductivity of approximately 0.06 umho/cm). Refer to the current revision of Katahdin SOP CA-104, Use of Laboratory Water Systems, for further details.

5.10 Holding Blanks

Holding blanks are prepared bimonthly by filling a 40 mL VOA vial with prepurged laboratory reagent grade water. These are then acidified to a pH less than 2 with HCL. The holding blanks are logged in and given a work order number. The holding time is 14 days. Two vials are placed in each of the refrigerators used to store Volatile samples. Two vials are also placed in the freezer used to store DI preserved Volatile samples. The holding Blanks are then analyzed and evaluated to track any consistent contamination above the laboratory PQL. Contamination is deemed consistent if detected in holding blanks analyzed over a 4-week interval.

TABLE 5-1
SUPPORT EQUIPMENT REQUIREMENTS

Table 5-1 - Support Equipment Requirements			
Check	Frequency	Acceptance Criteria	Documentation
NIST Traceable Weights	Every 5 years, if deemed necessary by the QAO.	Certificate of Calibration from outside accredited service.	Records of calibration maintained by Quality Assurance Officer.
Working class weights	Annually using NIST traceable weights	Refer to the current revision of Katahdin SOP CA-102.	Records of calibration maintained by Quality Assurance Officer.
Balances	Daily or before use with working class weights	Refer to the current revision of Katahdin SOP CA-102 and balance calibration logbooks.	Calibration records documented in individual balance logbooks maintained at each balance location.
Refrigerators/ Freezers	Daily (7 days) for sample and extract storage. Daily (working) for others.	Refrigerators: 0 °C to 6 °C Freezers: ≤ -10 °C	Calibration records documented in individual temperature logbooks maintained at each location.
Ovens	Before and after on days of use.	Specific criteria set by methods (i.e. TSS method)	Recorded in individual analytical logbooks for methods requiring oven use.
Incubators	Daily (7 days) for environmental samples. Daily (working) for food samples.	Specific criteria set by methods (i.e BOD method)	Calibration records documented in individual temperature logbooks maintained at each location.
Water Baths	Before and after use.	Specific criteria set by methods (i.e fecal coliform method)	Calibration records documented in individual temperature logbooks maintained at each location.
NIST traceable Thermometers	Replace or recertify by expiration date on Traceable Certificate of Calibration (Digital). Every five years, if deemed necessary by the QAO (Mercury).	Certificate of Calibration from outside accredited service.	Records of calibration maintained by Quality Assurance Officer.
Working Thermometers	Annually for spirit thermometers and quarterly for digital thermometers using NIST traceable thermometer.	Refer to the current revision of Katahdin SOP QA-809.	Records of calibration maintained by Quality Assurance Officer.
Autoclave	Annually for temperature and pressure. Cycle time, temperature and pressure with each use.	Specific criteria set by methods (i.e standard methods)	Records documented in autoclave logbook.
Adjustable Pipettors	Daily at maximum volume (Inorganics). Weekly at maximum volume (Microbiology). Monthly at minimum, mid and maximum.	Refer to the current revision of Katahdin SOP CA-103.	Calibration records documented in individual pipette logbooks maintained at each location.
Volumetric Glassware	Class A or B – Upon evidence of deterioration Class B – By lot before first use Also refer to Figure 5-1 for microbiology requirements.	Accuracy – Mean within ±2% of nominal value Precision – RSD ≤1% of nominal value (based on 10 replicate measurements)	Records of calibration maintained by Quality Assurance Officer.
Non-volumetric glassware (when used for measuring initial or final volumes)	By lot before use.	Accuracy – Mean within ±3% of nominal value Precision – RSD ≤3% of nominal value (based on 10 replicate measurements)	Records of calibration maintained by Quality Assurance Officer.

FIGURE 5-1

MICROBIOLOGY SUPPORT EQUIPMENT REQUIREMENTS

COLIFORM QC & MAINTENANCE LOGBOOK INSTRUCTIONS

Temperature Distribution – This check must be performed for each incubator and for the autoclave one time and annually thereafter to the incubators or autoclave. Using the thermometer located in the apparatus, check and record the temperature in different locations. This should be done on at least every shelf of the incubators in several locations on each shelf, depending on the size. The autoclave should be checked in several locations also. The acceptance ranges for the temperatures must meet the acceptance ranges for the use of each piece of equipment. The incubator temperature range must be 35 °C ± 0.5°C. The autoclave temperature range must be 121 °C ± 1°C. If a certain shelf or area does not fall within the range, corrective action may be taken. Corrective action may include maintenance or temperature adjustment. Be sure to record any changes in the logbook. If corrective action fails to improve the temperature, please note in the log that any area out of range should not be used for the test.

Autoclave Sterility Check – This check must be performed on a monthly basis to ensure autoclave sterility standards. Autoclave a Raven Labs Pro Spore (Biological Indicator) ampule for 15 minutes at 121 °C @ 15 psi. Upon completion of the autoclave cycle, completely submerge the ampule in the water bath @ 60 ±2 degrees C for 48 hours. If the ampule turns a turbid orange-yellow color, then the criteria for the autoclave sterility performance have not been met. Repeat the test to rule out analyst contamination error. Corrective action/autoclave maintenance must be performed if a positive is verified during the second analysis. If the ampule remains its purple color, this indicates an adequate sterilization cycle. Record all information in the autoclave maintenance logbook section.

Timing Device Check – This check must be performed quarterly or after any major maintenance to the autoclave. Using a stopwatch, check the timer on the autoclave. The autoclave timer should agree within 10% of the stopwatch.

Analyst Counting Check – Each analyst who may be counting colonies, must verify their counting accuracy monthly. Compare the counts of the primary and secondary analysts. They need to be within 10% of each other.

Sample Container Sterility Check – This check must be performed on every new lot # of IDEXX and Greenwood Products (or equivalent) 100 mL plastic containers. Aseptically pour approximately 20 mL of sterilized TSB into 3 containers of each new lot #. Close the lid and swirl the container so that all inner wall surfaces contact the TSB. Incubate the containers at 35 °C for 2 days. Any bacterial turbidity seen in the TSB could be indicative of analyst contamination, so the test should be repeated. If the vessels contain turbidity on the second analysis, then the vessels fail to meet the sterility criteria and should not be used. New lots should be ordered.

Membrane Filter Sterility Check - This check must be performed on every new lot # of membrane filters. Aseptically fill four IDEXX 100 mL vessels with 80 to 100 mL of sterilized TSB. Using forceps and flame technique, add one filter membrane to each vessel, ensuring that it is completely submerged (reserve one vessel for blank control). Incubate the containers at 35 °C for 2 days. Any bacterial turbidity seen in the TSB could be indicative of analyst contamination, so the test should be repeated. If the vessels contain turbidity on the second analysis, then the membrane filters fail to meet the sterility criteria and should not be used. New lots should be ordered.

Precalibrated Sample Container Accuracy Verification – This check must be performed with each new lot of precalibrated sample containers. Fill the sample container to the precalibrated 100 mL mark with DI water. Transfer the water to a graduated cylinder and record the volume of water. Repeat this step nine more times and record the volumes. Determine the average volume. Determine the % deviation (% D) using the formula provided.

Autofluorescence Check of Sample Containers - This check must be performed with each new lot of sample containers. Place the container within 5 inches under a 6 watt (365 nm) UV light source in a darkened room. Shine the UV light away from eyes and wear protective UV eyewear and gloves. The container should not fluoresce.

Bromothymol Blue Test- Check batches of clean glassware monthly for pH reaction (from cleaning solutions). Add a few drops of 0.04% bromothymol blue (BTB) and observe the color reaction. BTB should be blue-green in the neutral range.

UV Light Box Efficiency – Prepare a dilution (~1:100,000) of E coli (assayed at > 40,000 CFU's/mL). Plate this dilution on 6 m-Fc pour plates, place 3 plates of the dilution into the UV light box and expose for 20 minutes. Incubate all six plates for 24 hours at 44.5 ± 0.2 ° C. Determine an average plate count of each set of plates. Calculate the % die off using the calculation: ((No UV) – (With UV) / (No UV)) *100. The reduction in counts after UV exposure should be 99%.

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TABLE 5-2

ANALYTICAL INSTRUMENTATION

ANALYTICAL INSTRUMENTATION

KEY INSTRUMENTATION	DATE IN SERVICE	USED FOR ANALYSIS	Instrument Identification
Agilent 6890/5973 GC/MS with EPC, Centurion WS Autosampler with foam sensor option and EST ENCON Evolution Purge and Trap Concentrator with heated purge capability	**2008**	5030/8260, 5035/8260, 624	C
Agilent 7890/5975 GC/MS with EPC, Archon 5100 Autosampler and EST ENCON Evolution Purge and Trap Concentrator with heated purge capability	**2013/2015**	5030/8260, 5035/8260, 624 & 524.2	D
Hewlett Packard 5890/5972 GC/MS with EPC, Centurion autosampler and Tekmar Purge and Trap concentrator.	**1993**	5030/8260, 5035/8260, 624	F
Agilent 6890/5973 GC/MS with EPC, Archon Autosampler capable of low soils per Method 5035 and EST ENCON Evolution Purge and Trap Concentrator with foam sensor option.	**2006/2011**	5030/8260, 624 & 524.2	T
Hewlett Packard 6890/5973 GC/MS with EPC, Archon autosampler capable of low soils per Method 5035 and ENCON Purge and Trap concentrator.	**2013**	5030/8260, 5035/8260, 624 & 524.2	S
Agilent 6890/5973 GC/MS with EPC, Archon 5100 Autosampler with foam sensor option and ENCON Evolution Purge and Trap concentrator.	**2014**	5030/8260, 5035/8260, 624 & 524.2	P
Agilent 6890/5973 GC/MS with EPC, Centurion WS Autosampler with foam sensor option and EST ENCON Evolution Purge and Trap Concentrator with heated purge capability	**2014**	5030/8260, 5035/8260, 624	W
Agilent 6890/5973 GC/MS with EPC, Entech Instruments 7100AR Preconcentrator, 7410 10-position Robotic Headspace/Canister Inlet System and 3100A Canister cleaning system	**2006/2011**	TO-15 / MADEP APH	AIR

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TABLE 5-2, cont'd

ANALYTICAL INSTRUMENTATION

ANALYTICAL INSTRUMENTATION

KEY INSTRUMENTATION	DATE IN SERVICE	USED FOR ANALYSIS	Instrument Identification
Hewlett Packard 5973 GC/MS with EPC and Model 6890N GC and Agilent 7673 autosampler.	**2008**	8270, 625	G
Hewlett Packard 5975B GC/MS with EPC and Model 6890 GC and Agilent 7683 autosampler.	**2011**	8270, 625	N
Hewlett Packard 5973 GC/MS with EPC and Model 6890 GC and Agilent 7673 autosampler.	**1999/ 2001**	8270, 625	U
Agilent Model 6890 gas chromatograph with one EPC injection ports and micro electron capture detectors; Agilent Model 7673 autosampler	**2008**	608, 8081, 8082 (including congeners), 8151	GC01
Hewlett Packard Model 6890 gas chromatograph with flame ionization detector and photo ionization detector; Tekmar LSC 3000 purge and trap, ALS 2016 autosampler.	**1988/2010**	8015 MOD., MAVPH, GRO	GC02
Hewlett Packard Model 5890 gas chromatograph with a flame ionization detector; Agilent Technologies G1888 Network Headspace Analyzer.	**1991/ 2005**	Methane, Ethane and Ethene	GC05
Hewlett Packard Model 5890 gas chromatograph with nitrogen-phosphorous detector; Hewlett Packard Model 7673 autosampler.	**1993**	DMF 8141 (method development)	GC06
Agilent Model 6890 gas chromatograph with dual EPC injection ports and micro electron capture detectors; Agilent Model 7683 autosampler	**2000**	608, 8082 (including congeners)	GC07

TABLE 5-2, cont'd

ANALYTICAL INSTRUMENTATION

ANALYTICAL INSTRUMENTATION

KEY INSTRUMENTATION	DATE IN SERVICE	USED FOR ANALYSIS	Instrument Identification
Agilent Model 6890 gas chromatograph with one EPC injection ports and micro electron capture detectors; Agilent Model 7683 autosampler	**2009**	504, 556, 608, 8011, 8081, 8082 (including congeners), 8151	GC08
Hewlett Packard Model 6890 gas chromatograph with flame ionization detector and photo ionization detector; Tekmar ALS 2016 autosampler; Tekmar LSC 3000 purge and trap.	**2008/2015**	8015 MOD., GRO, MAVPH	GC09
Hewlett Packard Model 6890 gas chromatograph with EPC and dual flame ionization detectors; Hewlett Packard Model 7673 autosampler.	**2013**	8015 MOD., MAEPH, DRO	GC10
Hewlett Packard Model 5890 gas chromatograph with flame ionization detector; Hewlett Packard Model 7673 autosampler.	**1992/ 1996**	ALCOHOLS, GLYCOLS	GC11
Hewlett Packard Model 5890 gas chromatograph with EPC and dual flame ionization detectors; Hewlett Packard Model 7673 autosampler.	**1987**	8015 MOD., MAEPH, DRO	GC12
Hewlett Packard series 1100 HPLC with Quaternary pump, Multiwavelength detector and autosampler	**2008**	8330, 8332	HPLC02
HP Series 1100HPLC Quaternary pump, autosampler, and Foxy R2 fraction collector.	**2010/2013**	EPH Fractionation	HPLC03
J2 Scientific AccuPrep MPS™ GPC with internal UV detection	**2009**	GPC-3640 Current versions of CLP SOWS (OLM, OLC, & SOM)	GPC01
J2 Scientific AcPrepLine™ GPC with internal UV detection	**2014**	GPC-3640 Current versions of CLP SOWS (OLM, OLC, & SOM)	GPC03

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TABLE 5-2, cont'd

ANALYTICAL INSTRUMENTATION

Katahdin ANALYTICAL SERVICES

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ANALYTICAL INSTRUMENTATION

KEY INSTRUMENTATION	DATE IN SERVICE	USED FOR ANALYSIS	Instrument Identification
Horizon SPE-DEX 3000 Automated Extractor System equipped with 3 extractors.	**2006**	1664, 9070, 9071	Horizon #2
Dionex Accelerated Solvent Extractor ASE 200.	**2003**	3545	ASE #1
Milestone Ethos EX Microwave Extraction System	**2011**	3546	MW01
Organomation 24-position N-Evap systems (2)	**1998/2010**	GC and GC/MS Extractables	EXT01 & 02
Organomation 8-position S-Evap system	**2001**	GC and GC/MS Extractables	EXT03
Thermo ICAP 6500 ICP Emission Spectrometer with autosampler.	**2006**	6010, 200.7, ILM05.4	I
Agilent 7500a ICP-MS with autosampler.	**2007**	6020, 200.8, ILM05.4	J
CETAC M-6100 Automated Mercury Analyzer with Autosampler	**2004**	7470/7471, 245.1, 245.5, ILM05.4	H
Tekran Series 2600 automated mercury analyzer with gold amalgam preconcentration and atomic fluorescence detector; Model 2620 autosampler.	**2000**	Ultra-trace level mercury (1631)	G
CPI ModBlock™ Metals Digestion Unit – Two 48 Place Units.	**2000**	Metals Aqueous Digestions	Digestion Unit #1 Digestion Unit #2
LACHAT Quickchem 8500 Series Z – Automated Ion Analyzer and autosampler.	**2013**	Various	WC1

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TABLE 5-2, cont'd

ANALYTICAL INSTRUMENTATION

ANALYTICAL INSTRUMENTATION

KEY INSTRUMENTATION	DATE IN SERVICE	USED FOR ANALYSIS	Instrument Identification
Shimadzu TOC-V Combustion Analyzer, PC Controlled, High Sensitivity, Auto-Aqueous TOC Autosampler w/ 40 mL vials; Model SSM-5000A Solid Sample Module.	**2002**	TOC	TOC1
Shimadzu TOC-V Combustion Analyzer, PC Controlled, High Sensitivity, Auto-Aqueous TOC Autosampler w/ 40 mL vials; Model SSM-5000A Solid Sample Module.	**2015**	TOC	TOC2
Dionex ICS-2000 with pump, degasser, AS-DV automated sampler, anion self - regenerating suppressor, continuously regenerated anion trap column.	**2011**	Ion chromatography – Various Anions and VFAs	IC2
Dionex ICS-2100 with pump, degasser, AS-1 automated sampler, anion self -regenerating suppressor, continuously regenerated anion trap column.	**2015**	Ion chromatography – Various Anions	IC3
10 position Lab Crest Cyanide Midi-Distillation system.	**2012**	Cyanide	WC3
HF Scientific Micro 100 Turbidimeter	**2010**	Turbidity	WC6
Accumet pH/Conductivity Meter, Model 20.	**1998**	Various	WC8
Mettler T50 Autotitrator & Mettler Rondo 60 sample changer.	**2013**	Alkalinity	WC12
Orion 5-Star Multiparameter Meter	**2011**	Dissolved Oxygen & Biochemical Oxygen Demand	WC11
Konelab 20 Multi-Wavelength Photometric Analyzer.	**2003**	Various	Konelab #1

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TABLE 5-2, cont'd

ANALYTICAL INSTRUMENTATION

ANALYTICAL INSTRUMENTATION

KEY INSTRUMENTATION	DATE IN SERVICE	USED FOR ANALYSIS	Instrument Identification
Thermo Spectronic Genesys 10uv spectrophotometer	**2005**	Wet Chemistry and Food Testing	Food #1
HP Series 1050 HPLC System	**2011**	Food Testing	HPLC01
Biomerieux Vitek® Immuno Diagnostic Assay System (VIDAS®)	**2010**	Food Testing	Food #2
Biomerieux Tempo Preparation Station – Barcode reader, Media stand, Dispensers, Tempo filler and filling racks.	**2013**	Food Testing	Food #3
Biomerieux Tempo Reading Station – Tempo Reader and incubator/Reader racks	**2013**	Food Testing	Food #4

6.0 SAMPLE CUSTODY

Chain-of-Custody encompasses three major elements: field sampling, laboratory analysis and final data file. A Chain-of-Custody (COC) documents possession of a sample from time of receipt through the analytical process. Katahdin Analytical Services has implemented standard operating procedures to ensure that sample custody objectives of traceability and responsibility are achieved for every project. This section covers quality related activities from the receipt of samples at the laboratory through the issuance of final analytical data and the storage of data in its final data file.

All areas of the laboratory in which samples are received, stored, processed, or analyzed shall be kept in a condition that minimizes the risk of samples becoming lost or accidentally destroyed, contaminated, degraded, mis-identified, improperly handled or otherwise compromised.

6.1 Chain-of-Custody

The National Enforcement Investigations Center (NEIC) of EPA defines evidence of custody in the following manner:

- It is in your actual possession, or
- It is in your view, after being in your physical possession, or
- It was in your possession and then you locked or sealed it up to prevent tampering, or
- It is in a secure area.

Katahdin Analytical Services sample custody and sample control procedures ensure that:

- All samples are uniquely identified;
- Samples are analyzed as requested and are traceable to their records;
- Important sample characteristics are preserved;
- Samples are protected from loss or damage;
- Any alteration of samples (e.g., filtration, preservation) is documented; and
- A record of sample integrity is established for legal purposes.

Samples may be physical evidence and should be handled according to certain procedural safeguards. In order to facilitate documentation of sample monitoring from collection through analysis, several forms are used by Katahdin Analytical Services personnel. Field personnel document field activities on standardized field data records

and laboratory personnel record sample handling activities on internal chain-of-custody forms and/or sample control records.

A Chain-of-Custody Form (Figure 6-1) is completed by field personnel or client representatives for all samples received by the laboratory; the form accompanies the samples received by the laboratory. The completed Chain-of-Custody Form should include the following information:

- Client and project name
- Project location
- Field sample number/identification
- Number and type of containers
- Date and time sampled
- Sample matrix
- Preservative
- Analysis requested
- Sampler signature
- Signature of person relinquishing samples
- Date and time relinquished
- Sampler remarks
- Custody Seal Number (if applicable)

The record is filled out completely and legibly. Errors are corrected by drawing a single line through and initialing and dating the error. The correct information is then recorded with indelible ink. All transfers of samples except to and from commercial couriers must be recorded on the Chain-of-Custody via the "relinquished" and "received by" sections. All information except signatures may be printed.

When samples are received by the laboratory (refer to Section 6.3), Sample Management Personnel sign and note date/time received on the accompanying airbill, if present. The Chain-of-Custody is signed after Sample Management Personnel have verified the contents of the sample shipment. Sample Management Personnel verify the integrity of samples as they are unpacked, ascertain whether a Custody Seal is present and intact, whether the samples are received intact or broken, whether the samples are appropriately preserved and properly identified, what packing material was present in the shipping container, the temperature of the container, and any other notable observations. This information is explicitly documented on the Sample Receipt

Condition Report (SRCR) and the project manager (PM) is notified if any discrepancies or problems are found. The PM then contacts the client to receive further instructions pertaining to the affected samples. If the integrity requirements are met or after any discrepancies are resolved, the sample is assigned a unique laboratory identification number and transferred to the appropriate storage location for storage until preparation and analysis. Pertinent information concerning each sample is entered into the Katahdin Information Management System (KIMS); refer to Section 6.3 for more information on log-in procedures.

Once samples are in the laboratory, an internal custody record is generated to track the transport and status of each sample from storage to the laboratory and back to storage. After sample log-in, a project file containing the external Chain-of-Custody record and all sample receipt documentation is started by a client services representative. Further detail on internal laboratory custody procedures is provided in subsequent subsections.

6.2 Sampling Kits

In general, sampling kits are comprised of the following:

- Sampling containers
- Preservatives (upon request) and appropriate MSDSs
- Chain-of-Custody forms
- Custody Seals (upon request)
- Sample labels
- Packing Material
- Shipping containers
- Ice Packs (upon request), although ice is preferred
- Temperature blanks

Sample kit requests are received by the laboratory personnel from a project manager or sampling team members via telephone request, memo, or facsimile.

Based upon the specific request, the Sample Custodian or Project Manager determines the appropriate containers, preservatives and the necessary volume/quantity to specify for the analysis. This information is outlined in Table 6-1. The pertinent information is recorded on a Container Request Form. Refer to the current revision of Katahdin Analytical Services SOP QA-901, Sample Container Preparation and Shipping, for further information on this form.

6.2.1 Sample Containers

All volatile organic analysis (VOA) vials (40 mL) and sample containers for other analyses are purchased pre-cleaned from a commercial source. In some cases pre-cleaned containers are received with certificates of analysis documenting the concentration levels of applicable analytes for each container type and lot. Certificates of analysis accompanying container lots are maintained by the laboratory, and a record is kept of sample container lot numbers utilized for each project. All sample containers are purchased from reputable suppliers with products meeting project or protocol requirements.

Under no circumstances are used bottles sent out to the field.

Sampling containers are stored in an area of the Katahdin Analytical Services laboratory designated for staging sampling events and separate from the analytical laboratories. The containers are stored by lot number in the boxes in which they are received. Refer to the current revision of Katahdin Analytical Services SOP QA-901, Sample Container Preparation and Shipment, for more information.

6.2.2 Assembling Kits

All glass containers are surrounded with packing material to prevent damage.

Bottles requiring preservative may be pusrchased already preserved or the preservative may be added in the laboratory. All pre-preserved bottles must be labeled with the preservative added.

The appropriate number of labels and COCs are enclosed in the ziplock plastic bag that is included with the kit.

All the above contents are placed inside a cooler with an appropriate cooling medium (if requested) and a temperature blank. Field personnel are responsible for packing the shipping container to maintain the proper temperature. Ice packs may be provided upon request, however, ice is preferred for shipment of samples back to the lab. Sample containers are secured for shipment using appropriate packing materials.

Sample kits are delivered to the sampling team via the appropriate courier or personally picked up by the sampling team.

Refer to current revision of Katahdin Analytical Services SOP QA-901, Sample Container Preparation and Shipment, for further information on sampling kits.

6.3 Sample Receipt and Log-In

Refer to the current revision of Katahdin Analytical Services SOP SD-902, Sample Receipt and Internal Control.

Typically, samples are received by the laboratories during normal business hours (8:00 am to 6:00 pm), Monday through Friday.

Shipments for after hours and weekend delivery are prearranged with laboratory personnel to ensure that personnel will be available to sign the airbill, record the date and time of sample receipt and place the cooler in the appropriate location in the sample management area (under refrigeration) until the next business day.

Upon sample receipt, the coolers are inspected for the general condition of the Custody Seal, if present. The coolers are then opened and each sample is inspected for damage. The sample containers are removed from the packing material and identities are verified against the Chain-of-Custody. All information regarding sample condition upon receipt is documented on the Sample Receipt Condition Report (SRCR). The report documents:

- Name of person if hand delivered;
- Presence/Absence of COC forms and Custody Seals;
- Condition of the custody seals if present;
- Discrepancies noted;
- Holding times;
- Proper preservation (i.e. pH of all samples, except volatiles samples, is verified). The pH of volatile samples is checked at analysis and recorded in the analytical run log. If additional preservative is added, a sticker with the type of preservative, date and time added, final pH and custodian's initials must be placed on the sample container. Samples must be preserved for at least 24 hours for trace metals analysis.
- Proper sample containers, properly labeled according to the COC and unbroken;
- Appropriate sample volume; and
- Cooler temperature

The Sample Receipt Condition Report is completed by signing and recording the date and time of sample receipt. If there are any discrepancies or problems with the samples or accompanying documentation, the Sample Custodian immediately notifies the client or the appropriate Katahdin Analytical Services project manager for resolution.

The samples are logged into the Katahdin Analytical Services Information Management System (KIMS) by the Sample Custodian or Project Manager. Each group of samples received is assigned a unique laboratory number (work order number) at log-in. Each sample within the group is assigned a unique Sample Number by appending to the work order number a numerical suffix serialized to account for the number of samples in the sample group. All pertinent sample information, as detailed on the Chain-of-Custody,

SRCR, and other project related documentation, is entered into the KIMS and dispatched to the analytical groups for KIMS generation of preparation and analysis worklists. Upon completion of the log-in process, samples are placed into the appropriate storage area. Transfer of the samples from the Sample Custodian to each storage location is documented by the Sample Custodian on internal chain-of-custody records. Refer to the current revision of Katahdin Analytical Services SOP SD-902, Sample Receipt and Internal Control, for more information.

6.4 Sample Preservation and Storage

Samples are preserved according to the EPA's recommendations (refer to Table 6.1), unless there are overriding considerations, e.g. QAPP, and stored to minimize sample contamination and degradation. The laboratory must rely upon information supplied by the sampling team to document any known hazards. If it is known from past experience that samples contain high levels of contamination, those samples are segregated. For sample log-in procedures and supporting documentation, see Section 6.3 and the current revision of Katahdin Analytical Services SOP SD-902, Sample Receipt and Internal Control.

A holding blank comprised of deionized (DI) water is placed into the volatiles storage refrigerators in the volatiles lab to monitor the ambient concentration of analytes of concern in that storage unit. The Sample Custodian creates holding blanks on a bimonthly basis. The QAO is responsible for dispatching holding blanks for analysis of volatile organics by GC or GC/MS. Holding blank reports are monitored and maintained by the QA department.

6.5 Initiation of Testing Program

Once samples have been logged into the laboratory system, the external Chain-of-Custody, Sample Receipt Condition Report, and other related documentation are assembled into a project file. If a sample group is a priority or rush order, or if samples have short holding times, Sample Management Personnel will immediately provide notification to the appropriate laboratory personnel that samples have arrived and are ready for processing; the Sample Custodian may deliver the samples directly to the lab. KIMS-generated worklists for each laboratory section list all samples requiring preparation and analysis, the type of quality control samples required, the priority status, and test(s) required.

6.5.1 Internal Chain-of-Custody

A bar code system for tracking the status and chain-of-custody of samples within the laboratory is in place once sample processing begins. The bar code system is used by sample receipt, sample preparation and analysis (as applicable) personnel to electronically document the transfer of samples to and from storage locations and to and from the preparation/analysis labs. Hardcopy Internal Chain-of-Custody records are used to document the transfer of prepared sample extracts and/or digestates from sample preparation through analysis. Each electronic internal chain-of-custody record documents the following:

- Who removed the sample or extract from storage;
- When the sample or extract was removed from storage;
- Which sample(s) was removed from storage;
- If the sample was entirely consumed; and
- When and by whom the remainder of the sample was returned to storage.

Completed hardcopy internal chain-of-custody records are archived by the Quality Assurance department.

6.5.2 Subsampling for Sample Preparation or Analysis

In almost all cases, the laboratory receives more sample than is typically used for a specific analytical method. Therefore, a smaller aliquot, or subsample, must be obtained from the container for sample preparation or analysis. Obtaining a representative subsample, i.e. one that has the same characteristics and chemical composition as the original sample, can be difficult without employing complex techniques. In general, the following techniques shall be used.

Soil Samples

Soil samples must be physically mixed well prior to removal of the first aliquot for analysis. All visible foreign objects such as sticks, rocks, or leaves should be removed. The sample should be mixed with a scupula until it is visually homogenous. This process should not be used on soil samples for volatile analysis. For those volatile samples not preserved with methanol, an aliquot should be obtained from the middle of the jar (when possible), not the top, without any mixing.

Aqueous Samples

Aqueous samples must be mixed by inverting the sample several times prior to pouring off an aliquot. This inversion must be performed for each subsequent test requiring an aliquot.

Multiphasic Samples

Whenever the laboratory receives a multiphasic sample, the Katahdin Project Manager must be informed immediately prior to any subsampling. The Katahdin Project Manager will contact the client for further instructions. Depending on the end use of the data and prior knowledge of the sample, the client can provide the best information on the subsampling procedure. In some cases, the client may want the laboratory to provide their scientific judgment of which subsampling technique may be more appropriate. One of three options will typically be available:

1. Shaking the sample to form an emulsion layer so that the sample can be treated as a homogenous sample- the limitations to this method are the length of time that the emulsion will remain and how quickly a homogenous aliquot can be obtained and whether or not a complete emulsion can be formed. An analysis that cannot be performed immediately after subsampling (i.e. a subsample that may sit on an autosampler for a period of time) may not employ this technique. The biphases would likely reform if the emulsion were allowed to sit for a period of time.

2. Separating the two layers – this technique may be difficult near the interface of the two layers. This technique may involve analyzing both layers separately. The advantage is that two separate preparation methods could be employed if appropriate for the two distinct layers. However, in order to report the results properly, the layers would need to be weighted accurately.

3. Separating the two layers with analysis performed on only one layer – this technique may bias the results if there is any cross-contamination between the two layers.

In all cases, the reported data must be narrated so that the end user is aware of which subsampling method was used and which phase or phase was/were analyzed.

Note: any subsampling techniques performed on a sample for a volatile analysis would further compromise the sample by exposing the sample to the air (i.e there is the potential to lose volatile compounds) and by introducing headspace into the vial.

Other forms of subsampling may be used by the laboratory, but must be discussed with the client prior to the initiation of a project. This could include multi-icremental sampling as described in SW-846 Method 8330B.

6.5.3 Holding Time & Status Tracking

Samples are tracked through the KIMS system. Specific worklists are generated daily (at minimum) for each laboratory section. The lists contain the pertinent sample information needed to proceed with analysis including ID numbers, test codes, due dates and holding times. Each laboratory section schedules work according to these worklists. The worklists give the status for each sample batch/project within each analytical section. To update the worklist status of each sample or sample batch/project, pertinent information is entered into the KIMS once sample preparation and/or analysis has been completed. Refer to the current revision of Katahdin SOP SD-916, Tracking of Sample Status and Holding Times, for further information on worklists.

6.6 Sample Disposal

After completion of sample analysis and submission of the analytical report, unused portions of samples are retained by the laboratory for a minimum of thirty days. Unless otherwise specified by the client or analytical program, after submission of the data report, samples will be moved from the refrigerators for subsequent disposal according to the nature of the samples. The Katahdin Environmental Health and Safty Officer (EHSO) generates a KIMS sample disposal summary and uses that information to select the appropriate waste stream for the samples. Samples determined to be hazardous waste are handled by state and federally licensed hazardous waste disposal firms.

Upon disposal of samples, a record is generated by the Katahdin EHS Officer listing the sample number, inherent waste stream and date disposed. This record is maintained by the Katahdin EHS Officer. Please refer to the current revision of SOP SD-903, Sample Disposal, for further information.

6.7 Subcontracting Analytical Services

Every effort is made to perform all requested chemical analyses at Katahdin Analytical Services for our clients. There are, however, instances where subcontracting of analytical services is necessary. Currently, the following analyses most commonly require subcontracting by Katahdin Analytical Services, but are not necessarily limited to: Asbestos, Dioxins, Radiological, Perchlorate, and TOX.

When subcontracting becomes necessary, a preliminary verbal communication with an appropriate laboratory is undertaken. No work is subcontracted without consent from the client. Work requiring specific certifications or approvals (i.e. State of Maine, NELAC, DoD, etc.) shall only be subcontracted to laboratories that possess the required certifications or approvals. All subcontract laboratories must provide proof of certification or approval prior to any sample analyses. Katahdin shall maintain a registry of subcontract laboratories including records of compliance. This registry will be maintained by the Quality Assurance Officer.

The contact and preliminary arrangements and terms of agreement are made between the Katahdin Analytical Services Project Manager and the appropriate subcontract laboratory personnel (i.e., laboratory manager, client services contact, or the appropriate laboratory section manager). The specific terms of the subcontract laboratory agreement should include (when applicable):

- Method of analysis (including method reference, e.g., EPA SW-846, Standard Methods, etc.);
- Target analyte list required;
- Number and type of samples expected;
- Project specific QA/QC requirements (including reporting limit considerations);

- Deliverables required (including electronic deliverable if applicable);
- Applicable laboratory certification status;
- Price per analysis; and
- Turn around time requirements.

In the case of Federal Programs work, the subcontractor approval is completed as a joint effort between the prime laboratory and the Prime Contractor and through approval by the controlling Federal program office (i.e DoD, NFESC, AFCEE or ACOE). Work completed under these programs is contracted and involves a working Quality Assurance Plan. The prime laboratory and subcontracted laboratory both have a chance to review and comment on the QA Plan. The criteria listed in the QA Plan is the criteria that the laboratories are contracted to follow.

Chain-of-Custody forms shall be generated for samples that require subcontracting to other laboratories. The sample management personnel repackage the samples for shipment, create a transfer chain-of-custody form and record the following information:

- Katahdin Analytical Services Sample Number(s);
- Sample matrix;
- Requested analysis;
- Special instructions (quick turn around, required detection limits, unusual information about the samples or analytical procedure); and
- Signature in "Relinquished By".

All subcontracted sample data reports are reviewed for completeness after receipt by Katahdin Analytical Services. The subcontracted data results may be reported through Katahdin Analytical Service's KIMS or the subcontracted data report may be appended in whole to Katahdin Analytical Service's analytical data report. The final report format is determined through communication between the Katahdin Analytical Services Project Manager, Data Management Group, and the client. The contents of a subcontracted report are never altered. Please refer to Katahdin SOP, SD-900 (current revision), Subcontracting Analyses, for further details.

TABLE 6-1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER – AQUEOUS MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GENERAL CHEMICAL ANALYSES					
Acidity	SM 2310B, 305.1	100 mL	P,G	1,2	14 days
Alkalinity- Titrimetric	SM2320B, 310.1	100 mL	P,G	1,2	14 days
Ammonia-Nitrogen with distill-Auto. Phenate	350.1/350.2 SM4500NH3 B&H	100 L	P,G	1,3	28 days
Ammonia-Nitrogen-Automated Phenate	350.1, SM4500NH3 H	100 mL	P,G	1,3	28 days
Anions (F, Cl, Br, SO4, NO2, NO3)	300.0	250 mL	P, G	1	48hr/28days
Bicarbonate, Carbonate (calculation from alkalinity)	SM4500-CO_2 D				
Biochemical Oxygen Demand-Carbonaceous	SM 5210B, 405.1	1 L	P,G	1	48 hours
Biochemical Oxygen Demand-Total	SM 5210B, 405.1	1 L	P,G	1	48 hours
Chemical Oxygen Demand-Manual Colorimetric	410.4	100 mL	P,G	1,3	28 days
Chloride-Automated Ferricyanide	SM4500-Cl E, 325.2	100 mL	P,G	1	28 days
Chlorine, Total Residual	SM4500-Cl G, HACH 8167	100 mL	P,G	1,9	ASAP
Chromium, Hexavalent	SM3500Cr D / SW7196	200 mL	P,G	1,9	24 hours
Color, Apparent	SM2120B, 110.2	100 mL	P,G	1,2	48 hours
Cyanide, Amenable-Spectrophotometric	SM4500CN G, 335.1	100 mL	P,G	1,5	14 days
Cyanide, Total-Spectrophotometric	SM4500CN C 335.4	100 mL	P,G	1,5	14 days
Dissolved Oxygen(Lab)-Membrane Electrode	SM4500-O G, 360.1	500 mL	G	1	ASAP
Ferrous Iron - Colorimetric	SM3500-Fe D	250mL	P	1	24 hrs
Fluoride with distillation, Potentiometric ISE	SM4500F B/C, 340.2	500 mL	P only	1	28 days
Fluoride, Potentiometric ISE	SM4500F C, 340.2	200 mL	P only	1	28 days
Free CO_2	SM4500-CO_2 C	250mL	P	1	24 hrs.
Hardness, Total-Manual Titrimetric	130.2, SM2340C	250 mL	P,G	4	6 months
MBAS, Extraction-Colorimetric	SM5540C	1 L	P,G	1	48 hours
Nitrate+Nitrite-Automated Cadmium Reduction	SM4500-NO3 F, 353.2	100 mL	P,G	1,3	28 days
Nitrate-Automated Cadmium Red./Diazotization	SM4500-NO3 F, 353.2	100 mL	P,G	1	48 hours
Nitrite-Automated Diazotization	SM4500-NO3 F, 353.2	100 mL	P,G	1	48 hours
Oil & Grease-Total Recoverable, Gravimetric N-Hexane extractable material N-Hexane extractable material w/ silica gel cleanup	1664	(2) 1 L	glass only	1,11	28 days
pH (Laboratory)	SM 4500H B 150.1	100 mL	P,G	1,2	24 hours
Phenolics, Total Recoverable-Manual 4AAP	420.1	1000 mL	glass only	1,3	28 days
Phosphate, Ortho- Ascorbic Acid	SM4500-P E, 365.2	100 mL	P,G	1	48 hours
Phosphate,Total	365.4	100 mL	P,G	1,3	28 days
Solids-Filterable Residue (TDS),Gravimetric180	SM 2540C, 160.1	250 mL	P,G	1	7 days
Solids-Nonfilterable Residue (TSS)	SM 2540D, 160.2	1 L	P,G	1	7 days
Solids-Settleable Solids (SS)	SM2540F, 160.5	1 L	P,G	1	48 hours

TABLE 6-1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER – AQUEOUS MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GENERAL CHEMICAL ANALYSES (cont'd)					
Solids-Total Solids	SM 2540B, 160.3	250 mL	P,G	1	7 days
Solids-Total Volatile (TVS)	SM 2540E, 160.4	250mL	P,G	1	7 days
Solids-Volatile Filterable Residue (VDS)	SM2540C/E, 160.1/160.4	250 mL	P,G	1	7 days
Solids-Volatile Nonfilterable Residue (VSS)	SM 2540 F	500 mL	P,G	1	7 days
Specific Conductance	SM2510B, 120.1	100 mL	P,G	1,2	28 days
Sulfate-Turbidimetric	ASTM D516-02, 375.4	100 mL	P,G	1	28 days
Sulfide-Iodometric	SM4500-S2 F, 376.1	500 mL	P,G	1,7	7 days
Sulfite-Titrimetric	SM4500-SO3 B, 377.1	500 mL	P,G	1,9	ASAP
Tannin/Lignin-Colorimetric	SM 5550 B	100 mL	P,G	1	7 days
TKN-Auto Block Digest, Spect.	351.2	100 mL	P,G	1,3	28 days
Total Inorganic Carbon	SM 5310B, 415.1	(2) 40 mL	VOA vial	1	28 days
Total Inorganic Carbon	SM 5310B, 415.1	(2) 40 mL	VOA vial	1	28 days
Total Organic Carbon	SM 5310B, 415.1	(2) 40 mL	VOA vial	1,3	28 days
Total Organic Halogen	9020	500 mL	Amber Glass	1,3	28 days
Turbidity	SM2130B, 180.1	100 mL	P,G	1	48 hours
Volatile Fatty Acids	SOP CA-776	(2) 40 mL	VOA vial	17	14 days
ELEMENTAL ANALYSES					
Chromium, Hexavalent	7196/6010	500 mL	P,G	1,9	24 hrs
ICP Elements	200.7/6010	500 mL	P,G	4	6 months
ICP MS Elements	200.8/6020	500 mL	P,G	4	6 months
Low Level Mercury	1631	500 mL	G	NA	90 days
Mercury	245.1/7470	500 mL	P,G	4	28 days
GC ORGANIC ANALYSES					
EDB, DBCP & 1,2,3-TCP	8011 & 504.1	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Extractable Petroleum Hydrocarbons	MADEP/EPH	(2) 1000 mL	Amber Glass	12	14days/40days
Formaldehyde	556	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Fuel Oil in Water	8015Modified	(2) 1000 mL	Amber Glass	1,8	7days/40days
Fuel Oil in Water	ME HETL 4.1.25	(2) 1000 mL	Amber Glass	1,8	7days/40days
Gasoline in Water	8015Modified	(2) 40 mL	VOA vial	1,8	14 days
Gasoline in Water	ME HETL 4.2.17	(2) 40 mL	VOA vial	1,8	14 days
Petroleum Range Organics	FL-PRO	(2) 1000 mL	Amber Glass	12	7days/40days
Total Petroleum Hydrocarbons	TX1005	(2) 40 mL	VOA vial	12	14days/14days
Extractable Total Petroleum Hydrocarbons	CT-ETPH	(2) 1000 mL	Amber Glass	1	7days/40days
Glycols	8015Modified	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Herbicides	8151	(2) 1000 mL	Amber Glass	1	7days/40days
Methane, Ethane & ethene	RSK 175	(2) 40 mL	VOA vial	1,8,9	14 days(~)
PCB's	608 & 8082	(2) 1000 mL	Amber Glass	1	7days/40days
PCB Congeners	8082	(2) 1000 mL	Amber Glass	1	7days/40days
Pesticides	608 & 8081	(2) 1000 mL	Amber Glass	1	7days/40days

TABLE 6-1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER – AQUEOUS MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GC ORGANIC ANALYSES (cont'd)					
Pesticides and PCB's	608 & 8081/8082	(2) 1000 mL	Amber Glass	1	7days/40days
Solvents (Direct Injection)	8015M	(2) 40 mL	VOA vial	1	14 days
Volatile Petroleum Hydrocarbons	MADEP/VPH	(2) 40 mL	VOA vial	11	14days
HPLC ANALYSES					
HPLC-Explosives	8330A/B/ B Mod.	(2) 1000 mL	Amber Glass	1	7days/40days
GC/MS ORGANIC ANALYSES					
Acid Extractables	625	(2) 1000 mL	Amber Glass	1	7days/40days
Acid Extractables	8270	(2) 1000 mL	Amber Glass	1	7days/40days
Base Neutral Extractables	625	(2) 1000 mL	Amber Glass	1	7days/40days
Base Neutral Extractables	8270	(2) 1000 mL	Amber Glass	1	7days/40days
Drinking Water Volatiles - Low Level	524.2	(3) 40 mL	VOA vial	1,8,9,10	14 days(~)
Polyaromatic Hydrocarbons	8270/8270 SIM	(2) 1000 mL	Amber Glass	1	7days/40days
Semivolatile Extractables	625	(2) 1000 mL	Amber Glass	1	7days/40days
Semivolatile Extractables & (SIM)	8270/8270 SIM	(2) 1000 mL	Amber Glass	1	7days/40days
Volatile Organics & (limited SIM)	8260/8260 SIM	(3) 40 mL	VOA vial	1,8,9	14 days(~)
Volatile Organics	624	(3) 40 mL	VOA vial	1,8,9	14 days(~)
MICROBIOLOGICAL ANALYSES					
Coliform, Fecal (wastewater)	SM 9222D	100 mL	P,G	1,6	6 hours
Coliform, Fecal (wastewater)	Colilert-18 w/ Quantitray	100 mL	P,G	1,6	6 hours
Coliform, Total (wastewater)	SM 9222B	100 mL	P,G	1,6	6 hours
Coliform, Total (drinking water)	SM 9222B	100 mL	P,G	1,6	30 hours
Coliform and E-coli, Total (drinking water)	SM9223B, Colitag	100 mL	P,G	1,6	30 hours
E-coli (wastewater)	SM9213D	100 mL	P,G	1,6	6 hours
E-coli (wastewater)	SM9223B Colilert w/ Quantitray	100 mL	P,G	1,6	6 hours
Heterotrophic Plate Count	SM9215B, SIMPlate	100 mL	P,G	1,6	30 hours

PARAMETER – SOLID MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GENERAL CHEMICAL ANALYSES		**4 oz=100 g**			
% Carbon	9060 mod.	4 oz	Soil Jar	1	28 days
Ammonia-Nitrogen-Automated Phenate	350.1/350.2 SM4500NH3 B&H mod.	4 oz	Soil Jar	1	28 days (^)
Anions (F, Cl, Br, NO3, NO2, SO4)	9056	4 oz	Soil Jar	1	48hrs to 28 days (^)
Cation Exchange Capacity	9081	4 oz	Soil Jar	1	14days/7days (^)
Chloride-Automated Ferricyanide	9251/9056	4 oz	Soil Jar	1	28days (^)
Cyanide, Amenable-Spectrophotometric	9012	4 oz	Soil Jar	1	14 days
Cyanide, Total-Spectrophotometric	9012	4 oz	Soil Jar	1	14 days
Fluoride, Potentiometric ISE	SM4500F B/C, 340.2 mod.	4 oz	Soil Jar	1	28 days (^)
Lime Equivalency	310.1 mod.	4 oz	Soil Jar	1	28 days (^)

TABLE 6-1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER – SOLID MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GENERAL CHEMICAL ANALYSES (cont'd)		**4 oz=100 g**			
Nitrate+Nitrite-Automated Cadmium Reduction	9056 mod./353.2	4 oz	Soil Jar	1	28 days (^)
Nitrate-Automated Cadmium Red./Diazotization	9056 mod./353.2	4 oz	Soil Jar	1	48 hrs (^)
Nitrite-Automated Diazotization	9056 mod./353.2	4 oz	Soil Jar	1	48 hrs (^)
Oil & Grease-Total Recoverable, Gravimetric N-Hexane extractable material N-Hexane extractable material w/ silica gel cleanup	9071	4 oz	Soil Jar	1	28 days (^)
Organic Nitrogen-Auto. Block Digest.,Spectro.	350.1/351.2 mod.	4 oz	Soil Jar	1	28 days (^)
pH (Laboratory)	9045	4 oz	Soil Jar	1	28 days (^)
Phenolics, Total Recoverable-Manual 4AAP	Mod. 9065	4 oz	Soil Jar	1	28 days (^)
Phosphate, Ortho- Ascorbic Acid	9056 mod./365.2	4 oz	Soil Jar	1	48 hrs (^)
Phosphate,Tot.-Auto Ascorbic Acid/Block Dig.	Mod. 365.4	4 oz	Soil Jar	1	28 days (^)
Solids-Ash	SM 2540 G	4 oz	Soil Jar	1	28 days (^)
Solids-Total Solids	SM2540 G, current CLP SOW	4 oz	Soil Jar	1	28 days (^)
Solids-Volatile Solids	SM 2540 G	4 oz	Soil Jar	1	28 days (^)
Sulfate-Turbidimetric	9038	4 oz	Soil Jar	1	28 days (^)
Sulfide-Iodometric	9030	4 oz	Soil Jar	1	7days (^)
TKN-Auto Block Digest,Spectro.	351.2 mod.	4 oz	Soil Jar	1	28 days (^)
Total Organic Carbon	9060	4 oz	Soil Jar	1	28 days
Total Organic Carbon	Llyod Kahn	4 oz	Soil Jar	1	14 days
Total Organic Carbon	Walkley Black	4 oz	Soil Jar	1	14 days
ELEMENTAL ANALYSES					
ICP Elements	6010	4 oz	Soil Jar	1	6 months
ICP MS ELements	6020	4 oz	Soil Jar	1	6 months
Mercury	7471	4 oz	Soil Jar	1	28 days
Chromium, Hexavalent	3060/7196	4 oz	Soil Jar	1	30dys/24hrs
GC ORGANIC ANALYSES					
Extractable Petroleum Hydrocarbons	MADEP/EPH	4 oz	Soil Jar	1	14days/40days
Fuel Oil	ME HETL 4.1.25 & 8015 mod.	4 oz	Soil Jar	1	14days/40days
Petroleum Range Hydrocarbons	FL-PRO	4 oz	Soil Jar	1	14days/40days
Total Petroleum Hydrocarbons	TX1005	4 oz	Soil Jar	1	14days/14days
Extracted Total Petroleum Hydrocarbons	CT-ETPH	4 oz	Soil Jar	1	14days/40days
Gasoline	ME HETL 4.2.17 8015 mod.	(2) 40 mL	VOA Vial	1	14 days
Herbicides	8151	4 oz	Soil Jar	1	14days/40days
PCB's	8082	4 oz	Soil Jar	1	14days/40days
PCB's in Oil	8082	4 oz	VOA Vial	1	40 days
Pesticides	8081	4 oz	Soil Jar	1	14days/40days
Pesticides and PCB's	8081/8082	4 oz	Soil Jar	1	14days/40days
Solvents (Direct Injection)	8015M	(2) 40 mL	VOA Vial	1	14 days
Volatile Petroleum Hydrocarbons	MADEP/VPH	(2)40 mL	VOA vial	13	28days
HPLC ANALYSES					
HPLC-Explosives	8330B/B Mod.	4 oz or ISM sample	Soil Jar	1	14days/40days

TABLE 6-1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER – SOLID MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GC/MS ANALYSES					
Acid Extractables	8270	4 oz	Soil Jar	1	14 days/40 days
Base Neutral Extractables	8270	4 oz	Soil Jar	1	14 days/40 days
Polyaromatic Hydrocarbons	8270/8270SIM	4 oz	Soil Jar	1	14 days/40 days
Semivolatile Extractables & (SIM)	8270/8270 SIM	4 oz	Soil Jar	1	14 days/40 days
Volatile Organics – High Soil (>200 ug/kg) (Please refer to Figure 6-2 for details on collection and preservation)	5035/8260	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2
Volatile Organics – Low Soil (<200 ug/kg) (Please refer to Figure 6-2 for details on collection and preservation)	5035/8260	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2
Volatile Organics & (limited SIM)	8260/8260 SIM	(2) 40 mL	VOA Vial	1	14 days
Miscellaneous					
Grain Size (sieve and hydrometer)	ASTM D422	8 oz	Soil jar or bag	1	none
RCRA - HAZARDOUS WASTE CHARAC.					
Corrosivity-pH	9045	4 oz	Soil Jar	1	24 hours (^)
Ignitability-Flash Point (closed cup)	1010	4 oz	Soil Jar	1	14 days (^)
Reactivity-Reactive Cyanide	7.3.3.2	4 oz	Soil Jar	1	14 days
Reactivity-Reactive Sulfide	7.3.4.1	4 oz	Soil Jar	1	7 days
TCLP					
TCLP Extraction-Volatile Organics	1311/8260	100 g	Soil Jar	1	14 days/14 days
TCLP Extraction-Semivolatiles	1311/8270	200 g	Soil Jar	1	14 days/7 days/40 days
TCLP Extraction-Pesticides & Herbicides	1311/8081 & 8151	400 g	Soil Jar	1	14 days/7 days/40 days
TCLP Extraction-Metals	1311/6010/6020	200 g	Soil Jar	1	28 days/180 days
TCLP Extraction-Mercury	1311/7470	200 g	Soil Jar	1	28 days/28 days

GC/MS ANALYSES - AIR					
Volatile Organics	TO-14/TO-15	(1) 1.4 or 6 L	Canister	16	30 days
Volatile Organics	MA-DEP APH	(1) 1.4 or 6 L	Canister	16	30 days

TABLE 6-1

SAMPLING AND PRESERVATION REQUIREMENTS

METHODS OF PRESERVATION
1 = Cool at 4 Degrees Celsius
2 = Settled
3 = H2SO4 to pH<2
4 = HNO3 to pH<2
5 = NaOH to pH>12
6 = 1 mL 0.1M Na2S2O3 or 1 10 mg pellet
7 = 1 m/L 2NZnAc/L & NaOH
8 = 2 drops 1:1 HCl
9 = No headspace
10 = Na2S2O3, if chlorinated
11 = HCl to pH < 2
12 = 5 mL of HCL
13 = 15 mL of methanol
14 = methanol
15 = sodium bisulfate
16 = None
17 = benzalkonium chloride

TABLE 6-1 Footnotes

~ Hold time for unpreserved samples is 7 days.

^ Because there are no published holding times for Wet Chemistry soil methods, these are only recommended holding times. They are not regulatory.

Project-specific (i.e. CLP, NYSDEC) hold times take precedence over these hold times as appropriate.

For solid samples, please place parameters of the same analytical group (ie. wet chemistry) in the same container whenever possible. Also, organic and inorganic parameters should be placed in separate containers. Volatile organics should always be placed in organic-free jars. Several 4 oz. soil jars may be needed when numerous parameters are required.

References:

EPA = 40 CFR 136

SW846 = Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods." SW-846 , 2nd edition, 1982 (revised 1984), 3rd edition, 1986, and Updates I, II, IIA, III, IIIA, and IIIB 1996, 1998 & 2004, Office of Solid Waste and Emergency Response, U.S. EPA

SM = Standard Methods for the Examination of Water and Wastewater", 15th, 16th, 17th, 18th, 19th, and 20th editions, 1980, 1985, 1989, 1992, 1995, 1999. APHA-AWWA-WPCF.

ASTM = American Society for Testing and Material

FIGURE 6-1

Katahdin Analytical Services, Incorporated
Chain-of-Custody Record

Katahdin ANALYTICAL SERVICES
600 Technology Way
Scarborough, ME 04074
Tel: (207) 874-2400
Fax: (207) 775-4029

CHAIN of CUSTODY

PLEASE BEAR DOWN AND PRINT LEGIBLY IN PEN

Page ____ of ____

Client	Contact	Phone # ( )	Fax # ( )
Address	City	State	Zip Code
Purchase Order #	Proj. Name / No.		Katahdin Quote #
Bill (if different than above)	Address		
Sampler (Print / Sign)			Copies To:

LAB USE ONLY WORK ORDER #:
KATAHDIN PROJECT NUMBER _____
REMARKS: _____

SHIPPING INFO: ❒ FED EX ❒ UPS ❒ CLIENT
AIRBILL NO: _____
TEMP°C _____ ❒ TEMP BLANK ❒ INTACT ❒ NOT INTACT

ANALYSIS AND CONTAINER TYPE / PRESERVATIVES

*	Sample Description	Date / Time coll'd	Matrix	No. of Cntrs.	Filt. ☐Y ☐N	Filt. ☐Y ☐N	Filt. ☐Y ☐N	Filt. ☐Y ☐N	Filt. ☐Y ☐N	Filt. ☐Y ☐N	Filt. ☐Y ☐N	Filt. ☐Y ☐N	Filt. ☐Y ☐N	Filt. ☐Y ☐N
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COMMENTS

Relinquished By: (Signature)	Date / Time	Received By: (Signature)	Relinquished By: (Signature)	Date / Time	Received By: (Signature)
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THE TERMS AND CONDITIONS ON THE REVERSE SIDE HEREOF SHALL GOVERN SERVICES, EXCEPT WHEN A SIGNED CONTRACTUAL AGREEMENT EXISTS.

ORIGINAL

FIGURE 6-2

Katahdin Analytical Services, Incorporated
Method 5035 Collection and Preservation

Method 5035 Closed System Purge&Trap

Method 5035 details the current techniques that are required to minimize the loss of volatile organic compounds (VOC's) due to sample transport, handling, and analysis. Method 5035 provides various options for sampling including the low soil method (5.0ug/kg - 200ug/kg), which uses a hermetically sealed voa vial, and procedures for high concentration soils or wastes (> 200ug/kg). Selecting the appropriate technique may depend on cleanup goals, confidence levels, and anticipated levels of contamination.

Procedure for low level soils (<200ug/kg)

40 ml VOA vials containing either 5 ml of 20% sodium bisulfate or 5 ml of DI water, and a magnetic stirring bar are pre-weighed by the lab and shipped to the field. The field samplers collect an approximate 5 gram sample, as weighed in the field at the time of collection and place the sample in the pre-weighed and preserved vial. The vial is then returned to the laboratory for analysis. Upon receipt by the laboratory, samples that are preserved with DI water must be frozen immediately until the time of analysis. All samples must be brought to room temperature prior to analysis and analyzed within 14 days from the time of collection. Samples are analyzed on a specially developed autosampler that heats, stirs, and purges the sample simultaneously without exposing the contents of the vial to the atmosphere. This procedure will help to minimize the loss of VOC's due to transport, handling, and analysis and may help minimize ambient lab contribution. The expected detection limits are consistent with the traditional low soil technique from method 5030. Soil samples must be taken in accordance with the procedures outlined in the sampling plan, and may include the use of EnCore sampling devices. Alternatively, the field samplers may collect the soils in EnCore sampling devices, or equivalent and return these to the laboratory. Depending on the specifics of the project, the laboratory will extrude the soils into the 5 ml of DI water or 5 ml of 20% sodium bisulfate within 48 hours of collection. The laboratory will proceed as described above.

Procedure for high concentration soils (> 200 ug/kg)

High concentration soils may be sampled as either a bulk sample or field preserved with a water miscible solvent such as methanol.

Bulk Sample- A sample is placed in a glass jar or vial and returned to the lab for extraction and analysis. In this approach the lab takes an aliquot of soil and extracts with purge & trap grade methanol, a portion of the methanol is then analyzed for volatile analytes.

Methanol Field Preservation- A 5 gram sample is added to a VOA vial that was charged with 5 mls of purge and trap grade methanol and weighed in the lab prior to shipment to the field. If possible the field should weigh the sealed vial to ensure that 5 +/- 0.5 grams of sample were added in the field.

Considerations

1. Samples that require multiple analyses to confirm matrix interference's or to perform sample specific QC (MS/MSD/Dup) will require multiple vials (3-9 vials) since only one analysis is permitted per vial.
2. Samples that contain VOC's over a wide range of concentrations may require additional vials with smaller amounts of sample to come from the field.
3. Separate aliquots are required for percent solids determination for low level samples and high concentration samples that are field preserved with methanol.
4. The sodium bisulfate solution is acidic and may foam on contact with alkaline matrices or highly calcareous soils.
5. Vial weights should be measured in the field and verified in the lab. Samples must be well sealed and packaged so that vial weights are not affected by shipping conditions.
6. Unless sample history is known, Katahdin suggests the following samples be taken at minimum: one 4 oz. Soil jar for solids, one methanol field preserved sample for high concentration analysis, and two field preserved samples for low level analysis.

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7.0 CALIBRATION PROCEDURES AND FREQUENCY

All instruments and equipment used in Katahdin Analytical Services laboratories must follow a well defined calibration routine. All standards and instruments are designated by a unique identifier. This identifier shall be recorded in standards logbooks, run logs and all raw data that are pertinent. Calibration may be accomplished by laboratory personnel using certified reference materials traceable to NIST or EPA certified materials or by external calibration agencies or equipment manufacturers. The discussion presented here is general in nature because the requirements for calibration are instrument (or equipment) and method specific. Details of calibrations can be found in Katahdin Analytical Services Standard Operating Procedures, analytical methods, and operations manuals.

7.1 Standards and Traceability

Analytical standards are prepared from pure compounds or are purchased prepared from reputable vendors. These standards provide the stock used to prepare serial dilutions for calibration and spiking standards. Each laboratory section is responsible for the preparation, storage and disposal of its standards. Pertinent standards preparation information is recorded into laboratory specific standards logbooks in order to document traceability of prepared standards to their source material(s).

Each standard is given an internal identification number. The preparation of all stock standards shall be documented in a standards notebook which is used to record the date of preparation, analyst's initials, source of the reference material, standard components, amounts used, final volume, final concentration(s), solvent used, expiration date of prepared standard, and the assigned serial reference number (internal identification number) of the stock solution. All standards shall be labeled, at minimum, with a unique identifier for the prepared standard, preparation date and expiration date, and, if space permits, the reference number(s) of the stock standard(s), the name of the standard, concentration, and initials of the preparer. All diluted working standards not consumed during an analytical session shall be labeled fully, including the serial reference number of any stock standard used in its preparation. Working standards, which are consumed the same day that they are prepared, do not have to be labeled on the container itself.

If no expiration date has been assigned by the manufacturer, then an expiration date of one year from the date of preparation (or the date first opened in the case of sealed ampules) is generally reported unless degradation prior to this date is observed. The expiration date assigned to a prepared standard shall not exceed the expiration date of any individual component in the solution. To help determine if a standard has degraded, one must note inconsistencies. For instance, very poor recoveries from newly prepared quality control spikes or abnormally low instrument response to a specific standard are indications of possible standard degradation. However, for some standards, degradation is more easily noted. For instance, DDT breaks down to form DDD and DDE. Here one can visually note, on a chromatogram, the degradation of DDT by the increased concentrations of DDD and DDE. If degradation is observed before the default expiration date, it should be noted in the standards notebook for that standard entry and the standard removed from service. Refer to the current revision of Katahdin

Analytical Services SOP CA-106, Standard Preparation, Documentation and Traceability for more information.

Reference standards must be traceable to national standards of measurement (e.g. NIST) whenever possible. Standards used for calibration must be traceable, when possible, to national standards of measurement, either directly through supplier documentation or by verification against a second source traceable reference standard. Lists of reference standards used are contained within individual analytical method SOPs.

7.2 Calibration Procedures

Calibration standards for each parameter are chosen to bracket the expected concentrations of those parameters in the sample, and to operate within the linear response range of the instrument. Sample concentrations that fall above calibration range are diluted and reanalyzed until they are within the calibration range. When results above the calibration range are reported, those results must be appropriately flagged. Calibration standards are prepared typically at a minimum of three concentration levels plus a calibration blank, with the exception of ICP (see section 7.5 below). The lowest calibration standard must always be at the level of the laboratory standard reporting limit or Practical Quantitation Level (PQL), except for ICP. When results below the lowest calibration standard are reported, those results must be appropriately flagged. The other levels should be chosen at the approximate mid-point of the calibration and at the highest end of the calibration, with other points following in between these points and the low standard point. Most organic analyses that do not require a calibration blank. Either an internal standard or external standard quantification technique can be utilized.

Instrumental responses to calibration standards for each parameter are subjected to an appropriate statistical test of fitness (least squares linear regression, quadratic equation, relative standard deviation of response factors, or calibration factors) or as required by the method, regulatory requirements or QAPP. The calibration must reflect an acceptable correlation of data points or linearity to be acceptable. In cases where the calibration data are outside of these criteria, the analyst must rerun the calibration standards (meeting the same criteria), changing instrumental conditions as necessary until appropriate acceptance limits for the method are achieved. It is not acceptable to exclude data points from the calibration without technical justification.

For some Wet Chemistry analyses that are performed frequently, and for which substantial calibration data are available, a complete recalibration is not required each time an analysis is performed. As long as one calibration standard (Initial Calibration Verification - ICV), analyzed at the beginning of the analysis, does not vary from the expected response (based on the most recent initial calibration curve) by no more than $\pm$25% or as specified by the method, SOP or QAPP, whichever is more stringent. If this criterion is not met, a complete recalibration is necessary.

During the course of analysis, calibration standards are routinely analyzed to ensure that the instrumental response has not exceeded the method acceptance limits. The

continuing calibration criteria stipulated in each method or SOP is used by the analyst to determine whether the instrument must be recalibrated or the instrument conditions further optimized.

The accuracy of working standards is verified by comparison with a standard from an independent source.

All organic standards are refrigerated or frozen as specified in the applicable analytical methods. Inorganic standards are refrigerated as necessary.

7.2.1 Analytical Balances

Every twelve months, calibration of the entire analytical range shall be checked by a qualified service technician. The calibration of each balance is also checked each day of use by the analyst. Each department will be equipped with ASTM Class 2, or less, weights (when supplies permit) to be stored in a desiccator. The ASTM Class 2 (or less) weights are used for daily calibration so as to prevent damage to the ASTM Class 1 weights. The ASTM Class 1 weights will used to verify the weights of the ASTM Class 2 weights annually. The QAO will verify the weights and adjust the true values of the class 2 weights as necessary. The QAO will arrange for outside verification (NIST traceable) of the class 1 weights every five years, if deemed necessary. All information pertaining to balance maintenance and calibration is found in the individual balance logbook and/or is maintained by the QA Department. Please refer to the current revision of Katahdin SOP CA-102, Balance Calibration.

7.2.2 Thermometers

Certified, or reference, thermometers are maintained for checking calibration of working thermometers. Reference thermometers are provided with NIST traceability for initial calibration and are recertified every five years, if deemed necessary, with equipment directly traceable to the NIST.

Each thermometer is individually numbered and tagged with the identification number. All working thermometers are compared with the reference thermometers on a quarterly or an annual basis depending on whether they are spirit thermometers or digital thermometers. Digital thermometers not involved with DoD work may only be checked annually as deemed necessary by the QA Officer. In addition, working thermometers are visually inspected by laboratory personnel prior to use. Calibration temperatures and acceptance criteria are based upon the working range of the thermometer and the accuracy required for its use. An inventory of thermometers, their identification, calibration status and due date of next calibration is maintained by the QA Department or designated area. Refer to the current revision of Katahdin SOP QA-809, Working Thermometer Verification, for further information.

7.2.3 pH/Electrometers

These meters are calibrated using buffer solutions before use each day, and once after each four hours of use. Refer to the current revision of Katahdin Analytical Services SOP CA-708, Hydrogen Ion Concentration Measurement (pH) in Aqueous Samples and Solutions.

7.2.4 Spectrophotometers

During use, spectrophotometer performance is checked against initial calibration verification standards (ICVs) and continuing calibration verification standards (CCVs). The instrument operating capability is also evaluated every year by an outside service. Wavelength verification occurs every 12 months.

7.2.5 Ovens

Oven temperatures are monitored using a high temperature range digital thermometer intended for oven monitoring. This thermometer is compared to a NIST traceable thermometer annually. Oven temperature is checked every day of use at the beginning of the analysis and at the end of the analysis and recorded in the appropriate logbook. Oven temperatures are also verified every 12 months by an outside source. Specific oven temperature recording requirements are described within each analytical SOP.

7.2.6 Incubators

Incubators temperatures are monitored using thermometers intended for incubator monitoring. These thermometers are compared to a NIST traceable thermometer annually. Incubator temperature is checked every day of use at the beginning of the analysis and at the end of the analysis and recorded in the appropriate logbook. Specific incubator temperature recording requirements are described within each analytical SOP.

Refer to Table 5-1 for additional support equipment requirements.

7.3 GC/MS Calibration Procedures

Calibration procedures and acceptance criteria are method specific. Refer to the individual methods (see Tables 6-1 and 8-2) or Katahdin Analytical Services SOPs for method specific requirements in addition to the generic procedures outlined here.

The following are general minimum operations necessary to satisfy analytical requirements associated with the determination of organic compounds in water and soil/sediment samples. These operations should be performed routinely in the laboratory:

- Documentation of GC/MS mass calibration and abundance pattern

- Documentation of GC/MS response factor stability
- Internal standard response and retention time

Prior to initiating data collection, it is necessary to establish that a given GC/MS meets the standard mass spectral abundance criteria. This is accomplished through the analysis of decafluorotriphenylphosphine (DFTPP) for base/neutral and acid (BNA) semivolatile compounds or p-bromofluorobenzene (BFB) for volatile compounds. Each GC/MS system used for the analysis of semivolatile organic compounds or volatile organic compounds must be tuned to meet method or program specific ion abundance criteria before analysis of standards, blanks, or samples can proceed.

Prior to the analysis of samples and after tuning criteria have been met, the GC/MS system must be initially calibrated with the method specified number (a minimum of three to six) of concentrations of each compound being analyzed to determine the linearity of response. USEPA methods typically specify the concentration levels to be used for initial calibration and the specific internal standard to be used on a compound-by-compound basis for quantification. The response factor (RF) for each compound at each concentration level is calculated using the following Equation 7.1:

$$RF = \frac{A_X}{A_{IS}} * \frac{C_{IS}}{C_X} \qquad (7.1)$$

where: A_X = area of the characteristic ion for the compound to be measured.
A_{IS} = area of the characteristic ion for the specific internal standards.
C_{IS} = concentration of the internal standard
C_X = concentration of the compound to be measured

Using the RF from the initial calibration, the percent relative standard deviation (%RSD) for compounds identified as Calibration Check Compounds (CCCs) is calculated using Equation 7.2:

$$\%RSD = \frac{S}{X} \times 100 \qquad (7.2)$$

where: **RSD** = relative standard deviation
S = std. deviation of initial 3 to 6 response factors (per compound).
X = mean of initial five response factors (per compound).

The %RSD for each individual CCC must be less than 30% or as specified by the method, QAPP or other regulatory requirements. Some criteria may require that each compound meet a specific %RSD, not just the CCC's. These criteria must be met for the initial calibration to be valid.
If the RSD of any target analyte is 15% or less using the average response factor, then the response factor is presumed to be constant over the calibration range, and the average

response factor may be used for quantitation. Due to the varied instrumental behavior of many compounds, it is often difficult to meet the 15% criteria for all compounds.

If the RSD of any target analyte exceeds 15% using the average response factor, then a calibration option outlined in section 7.0 of method 8000 will need to be employed. Please note that some options may not be allowable for certain states, federal programs, or clients.

> Option 1 (Section 7.5.2 of method 8000 - Rev. 2, 12/96), is a linear regression of instrument response versus the standard concentration. The correlation coefficient for each target analyte and surrogate must be greater than or equal to 0.99.
>
> Option 2 (Section 7.5.3 of method 8000 - Rev. 2, 12/96), is a non-linear calibration model not to exceed a third order (seven calibration points required) polynomial. The lab would use a quadratic model or second order polynomial. The use of a quadratic model requires six calibration points. In order for the quadratic model to be acceptable, the coefficient of determination must be greater than or equal to 0.99.

The initial calibration must be checked by analyzing an independant calibration verification standard. This standard contains all compounds of interest prepared from a source separate from the initial calibration. To ensure the validity of the independant check standard, new ampules of both the calibration standard and the independent calibration standard should not be opened at the same time. The independent calibration verification must be analyzed before any samples are analyzed. For volatile analyses, where no extraction is involved, this verification is essentially the same as a Laboratory Control Sample (LCS), only analyzed immediately after an initial calibration before any samples. For semivolatile analyses, the verification is not extracted as an LCS is. The criteria for this verification must meet that specified in the SOP, method or other regulatory manuals.

A calibration check standard containing all compounds of interest as well as all required internal standards and surrogates, is performed each day of analysis. The calibration check is made from the same source as the initial calibration and is not extracted for semivolatile analyses. The RF data from the standard is compared each day against the average RF from the initial calibration for a specific instrument. If the response to a calibration check standard differs from the initial calibration by more than ±20% or as specified by the method, then investigation and corrective action must be performed. Corrective actions may include injection port maintenance, reanalysis of CV, repreparation of working standards, and/or performing a new initial calibration.

When initial instrument calibration, independent calibration verification or calibration check standard results are outside established acceptance criteria, corrective actions are performed and all associated samples reanalyzed or if reanalysis of the samples is not possible, data associated with an unacceptable initial instrument calibration is reported with appropriate data qualifiers and/or narration. Client consultation is also required.

7.4 Non GC/MS Chromatography Calibration Procedures

Calibration procedures and acceptance criteria are method specific. Refer to the individual methods (see Tables 6-1 and 8-2) or Katahdin Analytical Services SOPs for method specific requirements in addition to the generic procedures outlined here.

Initially, a minimum of three points (usually five or six points), consisting of all compounds of interest is established to define the usable range of the instrument. Calibration may be accomplished as a linear calibration using an average calibration or response factor, as a linear calibration using a first order polynomial, or as a non-linear calibration using a second order polynomial, all in accordance with the applicable method. The curve is calibrated by including the origin (0,0) as a calibration point but without forcing the curve through the origin. The curve is determined to be acceptable if the correlation coefficient (first order polynomial) or coefficient of determination (second order polynomial) meets the criteria in the applicable method (usually $\geq$ 0.990). Linearity may also be determined using response factors. Response factors are calculated for each compound at each concentration level. These RFs will be averaged to generate the mean RF for each compound over the range of the standard curve. The curve is determined to be linear if the RSD of the response factors is <25% or as specified in the method or regulatory manual. The mean response factor will be used to calculate the sample concentration of the compound of interest.

The initial calibration must be checked by analyzing an independant calibration verification standard. This standard contains all compounds of interest prepared from a source separate from the initial calibration. To ensure the validity of the independant check standard, new ampules of both the calibration standard and the independent calibration standard should not be opened at the same time. The independent calibration verification must be analyzed before any samples are analyzed. For volatile analyses, where no extraction is involved, this verification is essentially the same as a Laboratory Control Sample (LCS), only analyzed immediately after an initial calibration before any samples. For extractable analyses, the verification is not extracted as an LCS is. The criteria for this verification must meet that specified in the SOP, method or other regulatory manuals.

The initial calibration and calibration verification will contain all compounds of interest except for multi-component analytes such as arochlors, total petroleum hydrocarbons or toxaphene. In these cases a representative mixture is used as described in the individual method SOPs.

A calibration check standard containing all compounds of interest as well as all required internal standards and surrogates, is performed each day of analysis. The calibration check is made from the same source as the initial calibration and is not extracted. All calibration curves are valid for thirty days provided the concentration of the calibration verification standard (CV) does not differ by more than 15%, or as specified by the method or regulatory manual, for any analyte, from the expected concentration. The calibration curve may be extended another thirty days if, after an acceptable CV, an independent source is analyzed and meets the same criteria as the CV. If the response to a calibration check standard differs from the initial calibration by more than $\pm$15% for

any analyte being quantitated or as specified by the method, then investigation and corrective action will be performed, including complete recalibration, if necessary.

Continuing Calibration and/or calibration verification are checked as described in Katahdin Analytical Services SOPs or methods.

When initial instrument calibration, independent calibration verification, calibration check standard, or continuing calibration check standard results are outside established acceptance criteria, corrective actions are performed and all associated samples reanalyzed or if reanalysis of the samples is not possible, data associated with an unacceptable initial instrument calibration is reported with appropriate data qualifiers and/or narration. Client consultation is also required.

7.5 Calibration of Inductively-Coupled Plasma Spectrophotometer (ICP) & Inductively-Coupled Plasma Mass Spectrometric (ICP-MS)

Calibration procedures and acceptance criteria are method specific. Refer to the individual methods (see Tables 6-1 and 8-2) or Katahdin Analytical Services SOPs for method specific requirements in addition to the generic procedures outlined here.

ICP-MS instruments are standardized for the metal of interest by the analysis of a set of calibration standards (four standards and a blank) prepared by diluting a stock solution of known concentration. ICP instruments are calibrated per manufacturer's instructions using a zero point and a single point calibration. Linear regression is used for both ICP and ICP-MS. A linearity range standard (LRS) is run for ICP at the time of calibration to establish the upper limit of quantitation. Subsequently, all sample measurements are made within this working range. Once the working standards are prepared, they are analyzed on the ICP and the instrument response is calibrated to provide a direct readout in concentration. ICP-MS does not employ the use of an LRS. Sample with concentrations above the highest standard are diluted and reanalyzed.

Once the instrument has been initially calibrated, the analysis of an independent check standard is performed during sample analysis to verify calibration. A typical analysis sequence is presented below.

- Working standards are prepared by dilution of a stock standard solution of the metal of interest.

- A calibration curve within the working range of the instrument is established by analysis of three to five working standards for ICP-MS and a single point and blank for ICP. The calibration curve is analyzed at least daily for every analytical batch.

- An independent standard is analyzed to confirm the calibration. If the calibration is not within acceptance limits, the instrument is recalibrated.

- Quality control samples, including interference check samples, a linear range sample and a low-level check standard are analyzed per method or regulatory requirements at the beginning and at the end of an analytical run.

- The samples are analyzed for the metal of interest.

- During sample analysis, a check standard (Continuing Calibration Verification, CCV) is analyzed to monitor instrument stability. If the CCV indicates that instrument calibration has changed by more than ±10% for ICP and ICP-MS, the instrument is recalibrated and the analysis is repeated.

- Following completion of the sample analyses, the check standard is reanalyzed to confirm calibration. If calibration verified, the analysis is completed. However, if the calibration is not verified, appropriate corrective action is taken and effected samples are reanalyzed.

Written records of all calibrations shall be kept with the raw data.

7.6 Classical (Wet) Chemistry Calibration Procedures

The minimum operations necessary to satisfy analytical requirements associated with the determination of classical wet chemistry parameters in water and soil/sediment samples is method dependent. Refer to individual methods (see Tables 6-1 and 8-2) or Katahdin Analytical Services SOPs for specific requirements.

Wet chemistry instruments are standardized for the parameter of interest by the analysis of a set of calibration standards prepared by diluting a stock solution of known concentration. The concentrations of the calibration standards are chosen to cover the working range of the instrument. Subsequently, all sample measurements are made within this working range.

Once the instrument has been initially calibrated, the analysis of a check standard is performed during sample analysis to verify calibration. A typical analysis sequence is presented below.

- Working standards are prepared by dilution of a stock standard solution of the parameter of interest.

- A calibration curve within the working range of the instrument is established by analysis of one to five working standards.
- An independent standard is analyzed to confirm the calibration. If the calibration is not within acceptance limits, the instrument is recalibrated.

- The samples are analyzed for the analyte of interest.

- During sample analysis, a check standard (Continuing Calibration Verification, CCV) is analyzed to monitor instrument stability. If the CCV indicates that

instrument calibration has changed by more than the method specified acceptance limits, the instrument is recalibrated and the analysis is repeated.

- Following completion of the sample analyses, the check standard is reanalyzed to confirm calibration. If calibration verified, the analysis is completed. However, if the calibration is not verified, appropriate corrective action is taken and affected samples are reanalyzed.

A calibration curve is not prepared for titrations. Titrants are purchased or are prepared as standards and their use is recorded in the appropriate standards logbook.

Written records of all calibrations shall be kept with the raw data.

7.7 Manual Integration Policy

The GC/MS and some of the GC group both use the data processing system, Target. The data processing system, Turbochrom is used by the rest of the GC group and Chromeleon is used for IC analysis. Target, Turbochrom and Chromeleon are designed to perform automatic identification and integration of peaks. Automatic integration is preferred because it is fast, and in most cases, very consistent. Proper instrument and integration parameter set-up facilitates automatic integration.

Consistency in integration between standards and samples is one of the most important considerations in quantitative chromatographic analysis. Split peaks, peak tailing, noisy baseline, coelution, or incomplete resolution of isomeric pairs can sometimes complicate automatic integration. In addition, the data system may incorrectly identify a peak. In these cases, analyst intervention, or manual integration, is necessary. Manual integrations are to be performed when chromatographic conditions preclude the computer algorithm from correctly integrating the peak of concern.

Appropriate manual integration is integration that can be technically justified. The following rules apply when performing manual integration:

- ♦ Integration below the baseline is not allowed.
- ♦ Inappropriate or inconsistent peak integration to meet quality control requirements is never allowed.
- ♦ Inappropriate or inconsistent peak integration to meet quality control requirements is grounds for dismissal.

When manual integration is necessary:

<u>Target</u>

Each peak of concern is examined electronically by the primary analyst to ensure that the peak was integrated properly by the computer algorithm. The manual integration option is chosen through the software and the appropriate integration technique is

applied. An "m" qualifier will automatically be printed on the quantitation report summary. For GC/MS analysis, the hard copy printout of the Extracted Ion Current Profile (EICP) of the quantitaion ion displaying the manual integration shall be dated and initialed by the analyst. A manual integration code (Table 7-1) indicating the justification for the integration shall also be applied to the raw data. Copies of the manual integrations will be sent to each client who requests a level IV QC package. In the event that this QC is not requested, the manual integrations will be filed at the laboratory and will be available for review by the client if requested.

Turbochrom & Chromeleon

Each peak of concern is examined by the primary analyst to ensure that the peak was integrated properly by the computer algorithm. The peak before manual integration must be printed followed by a copy of the peak after manual integration. An "m" qualifier will automatically be printed on the chromatogram. The analyst must also date and initial in the chromatogram. A manual integration code (Table 7-1) indicating the justification for the integration shall also be applied to the raw data. Copies of the manual integrations will be sent to each client who requests a level IV QC package. In the event that this QC is not requested, the manual integrations will be filed at the laboratory and will be available for review by the client if requested.

Reporting

For data packages that include the raw data, a narrative must accompany the package describing the samples that were manually integrated and the compounds for which the integrations were necessary. A copy of the manual integration codes must be included with the narrative.

Some states, certifying authorities or clients may require an "after" blowup of each reintegrated peak to be submitted with the raw data. Some may also require a "before" blowup. Work requiring DoD QSM compliance requires a complete audit trail for manual integrations. Raw date records shall include chromatograms of before and after manual integrations. This requirement includes all analytical runs including calibration standards and QC samples.

For further details, please refer to the current revision of Katahdin SOP QA-812, Manual Integration on GC/MS, GC, HPLC and IC Data Systems.

Table 7-1

Manual Integration Codes for GC/MS, GC, HPLC, and/or IC

Katahdin Analytical Services, Inc.

Manual Integration Codes For GC/MS, GC, HPLC and/or IC

M1	Peak splitting.
M2	Well defined peaks on the shoulders of the other peaks.
M3	There is additional area due to a coeluting interferant.
M4	There are negative spikes in the baseline.
M5	There are rising or falling baselines.
M6	The software has failed to detect a peak or misidentified a peak.
M7	Excessive peak tailing.
M8	Analysis such as GRO, DRO and TPH require a baseline hold.
M9	Peak was not completely integrated as in GC/MS.
M10	Primary ion was correctly integrated, but secondary or tertiary ion needed manual integration as in GC/MS.
M11	For GC analysis, when a sample is diluted by 1:10 or more, the surrogate is set to undetected and then the area under the surrogate is manually integrated.
M12	Manual integration saved in method due to TurboChrom floating point error.

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8.0 ANALYTICAL PROCEDURES

Katahdin Analytical Services is capable of analyzing a broad range of environmental samples from diverse media, including surface and groundwater, soil, sediment, tissue, and waste. Refer to Table 8-2 for a listing of specific analytical capabilities. Methodologies are typically used from national or regional sources such as EPA, ASTM, USGS, APHA, AOAC, BAM and in certain instances, state regulatory agencies. In some situations, Katahdin Analytical Services develops and validates methodologies that are more applicable to a specific problem or objective. In cases where specific methods are required by regulation, the most recent and approved version of the method must be used. When not required by regulation, the laboratory shall consult with the client as to which approved version of a published method shall be used. Any modifications to these published methods must be approved by the client or regulatory (i.e. DoD) agency.

Note: These modifications must be explained in the modifications table for each SOP when these modifications are performed regularly or in the case narrative for modifications for a specific project only.

In cases where the client does not specify a method or analyte list, the laboratory will propose an appropriate method and list to the client for approval. In cases where an outdated or inappropriate method may be proposed by the client, the laboratory shall inform the client of this and propose a suitable method.

Analytical procedures are detailed descriptions of any and all processing, preparation and analysis of samples in the laboratory. In some instances, data format, presentation and delivery are also described. All analytical procedures shall be conducted in strict adherence to the QA Manual and written Standard Operating Procedures that have been reviewed and approved by the Operations Manager, the QA Officer(s), the Production Manager and department managers/group supervisors. Documents from which SOPs are developed include the references listed in Table 8-1. Additional SOPs may be adapted from other sources or generated in-house as project needs require.

8.1 Project/Contract Review

To ensure that client commitments are met, a review of project documentation and contracts is performed. These documents are reviewed for technical, QC and business requirements to determine Katahdin's ability to meet them. The review process may involve the Sales & Marketing Department, Project Managers, the Laboratory Operations Manager, the IT/Production Manager, Department Managers, Group Supervisors the Quality Assurance Officer, and/or the Katahdin President. For many client projects the specific requirements may not necessarily "fit" into a standard laboratory service or product. Katahdin is committed to working with clients to customize services as needed. This may involve modification of a method, reporting limit or report format.

The review of potential projects and bids must involve a complete review and understanding of all reporting levels, precision and accuracy (P&A) requirements, corrective actions and compound lists. Refer to the current revision of Katahdin SOP QA-810, Project Management: Review and Communication of Client Bids, Contracts and Project Specific Information & Service to the Client for further details.

Incoming projects may require the work be performed in accordance with one of the following:

- Client specific Quality Assuance Project Plan (QAPP)
- Client specific Minimum Standards
- The Department of Defense Quality System Manual (DoDQSM)
- State specific requirements

For projects that are to be performed in accordance with any of the above, the laboratory limits and P&A data must be compared to the appropriate documents. In all cases, any discrepancies must be noted in the bid specifications or in the quote so that the client can make informed decisions.

In many cases, our clients will approve the use of laboratory limits and P&A, in place of other QAPP limits. It is imperative to always be sure that the client is aware of any requirements that the laboratory cannot meet before acceptance or reward of a project.

8.2 Analytical Methods

Numerous sources of information are available to offer guidance in analytical methods. Selection of the appropriate method is dependent upon data usage and/or regulatory, client or program requirements. Table 8-1 describes the analytical references routinely used by Katahdin Analytical Services. Katahdin Analytical Services may modify existing methods based on the following considerations: 1) in order to meet project specific objectives; 2) in order to incorporate modifications or improvements in analytical technology; 3) in order to comply with changing regulations and requirements; 4) in order to address unusual matrices not covered in available methods.

Katahdin Analytical Services will make every effort to disclose to its clients any instances in which modified methods are being used in the analysis of samples.

8.3 Method Validation

The laboratory demonstrates its capability of performing an analytical method through method validation. Please refer to the current revision of Katahdin SOP QA-807, Method Performance / Precision and Accuracy Requirements, for details on specific method validation. When non-promulgated methods (i.e., methods other than EPA, APHA, ASTM, AOAC, etc.) are required for specific projects or analytes of interest, or when the laboratory develops a method, the laboratory establishes the validity of the method prior to applying it to client samples. Method validity is established by meeting specified criteria for precision and accuracy or ascertaining the precision and accuracy, which is achievable.

8.4 Method Revisions

Revisions to existing methods are handled in the same manner as a new method. After review of the published method, Katahdin determines whether or not to incorporate the new version as a product offered by the laboratory. A number of issues must be considered in making this decision. The following questions may be asked:

- Do we have the resources to perform this method?
- Can we easily obtain the resources to perform this method?
- Is this method promulgated?
- Does this method replace an existing promulgated method?
- Is the laboratory getting requests for this method?
- How long will it take to bring the method on-line?

Sales and Marketing Representatives, Project Managers, the Operations Manager, the IT/Production Manager, the QAO, department managers, group supervisors and/or the Katahdin President may be consulted in deciding whether or not to adopt a revision of a method. Once the decision is made to adopt a method revision, a new product code is initiated. The SOP is written or revised, and training is initiated.

For revisions, which replace an existing Katahdin product, training may be documented on a Katahdin Retraining form. For revisions that are new to Katahdin, training is initiated as described in Katahdin SOP CA-805, Laboratory Technical Personnel Training. In both cases, Initial Demonstration of Method Proficiency shall be documented.

It is the responsibility of the QAO, the Operations Manager and the Department Managers to inform MIS personnel, Project Managers, Sales and Marketing Representatives and analysts of any changes in methodology. MIS personnel will either retire obsolete product codes (i.e. obsolete methods) and/or add additional product codes (i.e. new versions of existing methods) dependent upon each individual case. Project Managers and Sales will begin to sell the new product code. It is very important to ascertain which version of the method that clients are requesting. When clients request delisted methods, it is Katahdin's policy to inform them of this and the correct method that they should be requesting.

8.5 Method Detection Limits, Limits of Detection, and Limits of Quantitation

Method detection limit (MDL) studies, Limits of Detection (LOD) verifications and Limits of Quantitation (LOQ) verifications are performed in accoradnace with specific state, federal, method or program requirements. Refer to Katahdin Analytical Services, Inc. SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications.

Method detection limits are determined at Katahdin Analytical Services using replicate spiked analyte-free water samples or an appropriate soil matrix, if available. A minimum of seven replicates of a sample spiked with the analyte of interest is processed through the entire analytical method. The concentration of the detection limit sample should be between one and five times the anticipated detection limit.

The laboratory calculates the detection limit as the student's t (n-1, 1-$\propto$ = 0.99) times the standard deviation (n-1) of the replicate spiked sample measurements. Refer to 40 CFR Part 136, Appendix B for further discussion.

Detailed procedures and acceptance criteria for MDL studies and LOD/LOQ verifications are described in the current revision of Katahdin Analytical Services SOP SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications. Current MDLs are filed in the QA Department.

IT IS IMPERATIVE TO NOTE THAT METHOD DETECTION LIMITS ARE HIGHLY MATRIX DEPENDENT. LIMITS DETERMINED BY KATAHDIN ANALYTICAL SERVICES MAY NOT BE ACHIEVABLE IN ALL MATRICES.

8.6 Compliance

8.6.1 Definition - Compliance is the proper execution of recognized, documented procedures that are either approved or required. Adherence to these procedures is required in order to provide data products acceptable to a regulatory body of competent jurisdiction in a specific regulatory context. Compliance is separate from, but not inconsistent with, technical scientific quality. Katahdin Analytical Services 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 for the performance of tests and generation of data.

8.6.2 Understanding the Regulatory Framework - Compliance is not likely to be achieved in the absence of an understanding of the regulatory framework. Katahdin Analytical Services will attempt to ascertain, prior to the initiation of a project, what regulatory jurisdiction (USEPA, state, etc.) pertains to a project; within the regulatory jurisdiction, what body of regulation is meant to be satisfied (RCRA, SDWA, NPDES, CERCLA, MCP, etc.); and finally, within this context, what protocols/programs are required/expected (DoD, NELAC, CLP, AFCEE, NFESC, etc.). Katahdin Analytical Services will work with its clients to come to a mutual understanding of all requirements, based on our best understanding of the information available.

8.6.3 Commitment - Clients may, but often do not, fully understand their compliance needs. Clients may sometimes fail to communicate their compliance requirements to Katahdin Analytical Services. Nevertheless, Katahdin Analytical Services, in defining quality as in 8.6.1 above, accepts some responsibility for compliance.

Katahdin Analytical Services makes the following commitments to its clients:

- Katahdin will proactively attempt to identify, understand, and execute the regulatory requirements for compliance.

- Katahdin will identify and disclose to clients instances of non-compliance in a forthright fashion.

8.6.4 Resolving Compliance Contradictions and Hierarchies - It is a common occurrence that multiple regulatory jurisdictions overlap in a specific case. This causes uncertainty or even contradictions to arise in a work plan. Katahdin Analytical Services will make every effort to detect such inconsistencies, and will communicate them to clients so that the client can make an informed decision regarding execution of the project. Similarly, methods and protocols will often be prescribed in a scope of work or QAPP and may not achieve stated or implied data quality objectives (DQOs) or which are in conflict with the regulatory requirements. Katahdin Analytical Services will attempt to detect these inconsistencies, and upon detection, disclose them to our client. Katahdin Analytical Services voluntarily accepts a responsibility to provide advice to clients; however, **the primary responsibility for this issue remains with the client.**

8.6.5 Disclosure of Noncompliance - As stated previously, it is Katahdin Analytical Services' policy to disclose in a forthright manner any detected noncompliance that may affect the usability of data produced by Katahdin Analytical Services. It is not within our expertise to predict the manner in which a specific regulator or regulatory body will interpret the rules governing analysis; Katahdin Analytical Services is unable to guarantee compliance. It is Katahdin Analytical Services' 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 be useful to our client in their making the final judgment.

TABLE 8-1

ANALYTICAL PROTOCOLS

- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; National Primary Drinking Water Regulations; and National Secondary Drinking Water Regulations; Analysis and Sampling Procedures; Final Rule, Federal Register, 40 CFR Parts 122, 136, 141, 143, 430, 455, & 465, March 12, 2007.

- "Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods." SW-846. 3rd edition, 1986, Final Updates I(7/92), II(9/94), IIA(8/93), IIB(1/95), III(12/96), IIIA(4/98), and IIIB(11/04), IV(02/07), V(07/14) and “on-line methods”, Office of Solid Waste and Emergency Response, U.S. EPA.

- "Methods for Chemical Analysis of Water and Wastes", EPA 600/4-79-020, 1979 Revised 1983, U.S. EPA.

- “Methods for the Determination of Inorganic Substances in Environmental Samples”, EPA 600/R-93/100, August 1993.

- "Standard Methods for the Examination of Water and Wastewater", 15th, 16th, 17th, 18th, 19th, 20th, 21st and 22nd editions, 1980, 1985, 1989, 1992, 1995, 1999 2005, 2012. APHA-AWWA-WPCF.

- "Annual Book of ASTM Standards", Section 4: Construction, Volume 04.04: Soil and Rock; Building Stones, American Society for Testing and Materials, current revisions.

- "Annual Book of ASTM Standards", Section 11: Water and Environmental Technology, American Society for Testing and Materials, current revisions.

- "NIOSH Manual of Analytical Methods", Third Edition, 1984, U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health.

- "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water", U.S. EPA, Environmental Monitoring and Support Laboratory - Cincinnati (September 1986, & Supplements I, II, & III).

- New York State Department of Environmental Conservation. Analytical Services Protocol, June, 2000.

- Official Methods of Analysis of AOAC International, 17th Edition

- FDA Bacteriological Analytical Manual (BAM) Edition 8, Revision A, 1998

TABLE 8-2

ANALYTICAL CAPABILITIES

ORGANIC ANALYSES		
	METHODS	
ANALYTE	**WATER**	**SOIL**
Alcohols by GC-FID	SW 8015 modified	SW 8015 modified
Chlorinated Phenoxy Herbicides	SW 8151	SW 8151
Diesel Range Organics (DRO)	SW 8015 modified	SW 8015 mod/8100
EDB & DBCP by GC	EPA 504.1, SW 8011	
Explosives	SW 8330	SW 8330
Formaldehyde	SW 8015 modified	
Gas Range Organics (GRO)	SW 8015 modified	SW 8015 modified
Drinking Water Volatile Organics	EPA 524.2	
Volatile Organics	EPA 624, SW 8260	SW 8260
Volatile Organics - Air		TO-15 (air)
Volatile Organics - Air		MA-DEP APH (air)
Glycols	SW 8015 modified	
GRO/DRO - Maine HETL	HETL 4.2.17, 4.1.25	HETL4.2.17, 4.1.25
GRO/DRO - Massachusetts Risk Assessment	MA DEP VPH/EPH	MA DEP VPH/EPH
Low Level Select Volatiles	8260 SIM	8260 SIM
Methane, Ethane & Ethene	RSK 175	
Oil & Grease (Gravimetric)	EPA 1664, SW 9070	SW 9071 modified
Organochlorine Pesticides & PCBs	EPA 608, SW 8081/8082	SW 8081/8082
Organochlorine Pesticides & PCBs (Tissue)		SW 8081/8082
PCB Congeners	SW 8082 modified, SOP CA-334	SW 8082 modified, SOP CA-334
PCBs in oils		EPA 3580/SW 8082
PCBs wipes/filters		EPA 3580/SW 8082
Polynuclear Aromatics (PAH)	EPA 625, SW 8270	SW 8270
Polynuclear Aromatics (PAH) & select Semivolatile Organics	SW 8270 SIM	SW 8270 SIM
Semivolatile Organics - Extractables	EPA 625, SW 8270	SW 8270
SPLP Extraction	SW 1312	SW 1312
Total Petroleum Hydrocarbons	FLO-PRO, TX1005, CT-ETPH	FLO-PRO, TX 1005, CT-ETPH
Grain Size (sieve & hydrometer)		ASTM D422

METALS ANALYSES		
ANALYTE	**REQUIRED DIGEST**	**METHODS**
ICP ANALYSES		
Aluminum	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Antimony	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Arsenic	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Barium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Beryllium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020

TABLE 8-2

ANALYTICAL CAPABILITIES

ANALYTE	REQUIRED DIGEST	METHODS
ICP ANALYSES		
Boron	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Cadmium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Calcium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Chromium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Cobalt	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Copper	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Iron	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Lead	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Magnesium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Manganese	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Molybdenum	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Nickel	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Potassium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Selenium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Silica as SiO2	EPA 200.7	EPA 200.7
Silver	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Sodium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Strontium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Thallium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Tin	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Titanium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Vanadium	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
Uranium	EPA 200.8	EPA 200.8
Zinc	EPA 200.7, 200.8, SW 3010, 3050	EPA 200.7, 200.8, SW 6010, 6020
COLD VAPOR ATOMIC ABSORPTION (CVAA)		
Mercury	EPA 245.1, SW 7470, 7471	EPA 245.1, SW 7470, 7471
Mercury (Tissue)	SW 7470, 7471	SW 7470, 7471
COLD VAPOR ATOMIC FLUORESCENCE (CVAF)		
Mercury - Low Level	EPA 1631	EPA 1631
CALCULATION		
Hardness	EPA 200.7/SM 2340B, SOP CA-628	

INORGANIC ANALYSES	
ANALYTE	**METHODS**
Acidity	EPA 305.1, SM2310B
Acid Volatile Sulfides	EPA 376.3
Alkalinity	EPA 310.1, SM 2320B
Bicarbonate & Carbonate	SM 4500-CO2
Biochemical Oxygen Demand-total	EPA 405.1, SM5210B

TABLE 8-2

ANALYTICAL CAPABILITIES

INORGANIC ANALYSES	
ANALYTE	**METHODS**
Biochemical Oxygen Demand-carbonaceous	SM5210B
Bromide	EPA 300.0, SW 9056
Carbon - Total Inorganic (water)	EPA 415.1 modified, SW 9060 modified, SM5310B
Carbon - Total Organic (water)	EPA 415.1, SW 9060 modified, SM5310B
Carbon - Total (soil)	modified Lloyd Kahn, Walkley Black
Cation Exchange Capacity	SW 9081
Chemical Oxygen Demand	EPA 410.4, HACH 8000
Chloride	EPA 325.2, EPA 300.0, SW 9251, SM 4500 Cl E, SW 9056
Chromium - Hexavalent	SW 7196, SM3500Cr-D
Color	EPA 110.2, SM 2120B
Cyanide - Total	SM 4500CN⁻C Mod, 335.4, SW 9012 Mod
Cyanide - Total & Amenable	SM 4500CN⁻-C/G Mod, EPA 335.1 Mod, SW 9012 Mod
Ferrous Iron	SM 3500Fe D
Fluoride	EPA 340.2, SM 4500F⁻B/C
Free Liquid Content (Paint Filter Test)	SW 9095
Hardness (Titrimetric)	EPA 130.2, SM 2340C
Lime Equivalence	EPA 310.1 modified
Nitrogen - Ammonia	EPA 350.1, EPA 350.2, SM 4500NH3 B & H
Nitrogen - Nitrate plus Nitrite (combined)	EPA 300.0, 353.2, SM4500-NO3 F, SW 9056
Nitrogen - Nitrate	EPA 300.0, 353.2, SM4500-NO3 F, SW 9056
Nitrogen - Nitrite	EPA 300.0, 353.2, SM4500-NO3 F, SW 9056
Nitrogen - Total Kjeldahl	EPA 351.2
Nitrogen - Total Organic - TKN minus NH_3	EPA 351.2/350.1
Odor	SM2150 modified
Paint Filter	SW 9095
pH	EPA 150.1, SW 9040, 9045, SM 4500H B
Phenols - Total	EPA 420.1 SW 9065
Phosphorus - Total	EPA 365.4, SM 4500P-E
Phosphorus - Ortho	EPA 365.2, EPA 365.1, SM 4500-P-E, EPA 300.0, SW 9056
Practical Salinity	SM 2520B
Residual Chlorine	SM4500 Cl G
Sample Prep - Compositing	
Sample Prep - Filtration	SM 3030B
Solids - Total	EPA 160.3, SM2540 B
Solids - Suspended	EPA 160.2, SM2540 D
Solids - Dissolved	EPA 160.1, SM2540 C
Solids - Volatile Aqueous	EPA 160.4, SM2540 E
Solids - Suspended Volatile	EPA 160.2, 160.4

TABLE 8-2

ANALYTICAL CAPABILITIES

INORGANIC ANALYSES	
ANALYTE	**METHODS**
Solids - Settleable	EPA 160.5, SM2540 F
Specific Conductance	EPA 120.1, SM 2510B
Specific Gravity	EPA/COE 1981
SPLP Extraction	SW 1312
Sulfate	EPA 375.4, 300.0, SW 9056, 9038, SM 4500SO4 E, ASTM D516-02
Sulfide	EPA 376.1, SW 9034
Sulfite	EPA 377.1, SM4500-SO3 B
Surfactants - MBAS	SM5540C
Tannins and Lignins (as tannic acid)	SM 5550B
Turbidity	EPA 180.1, SM 2130B
Volatile Fatty Acids	SOP CA-776
% Moisture	SM 2540G

TCLP ANALYSES	
ANALYTE	**METHODS**
Extraction for Volatiles (ZHE)	SW 1311
Extraction for Metals, Semivolatiles,Pesticides & Herbicides	SW 1311
Volatiles - TCLP List	
Benzene	SW 8260
Carbon Tetrachloride	SW 8260
Chlorobenzene	SW 8260
Chloroform	SW 8260
1,2-Dichloroethane	SW 8260
1,1-Dichloroethylene	SW 8260
Methyl Ethyl Ketone	SW 8260
Tetrachloroethylene	SW 8260
Trichloroethylene	SW 8260
Vinyl Chloride	SW 8260
Semi-Volatiles - TCLP LIST	
Pyridine	SW 8270
M-Cresol (3-Methyl Phenol)	SW 8270
O-Cresol (2-Methyl Phenol)	SW 8270
P-Cresol (4-Methyl Phenol)	SW 8270
1,4-Dichlorobenzene	SW 8270
2,4-Dinitrotoluene	SW 8270
Hexachloro-1,3-Butadiene	SW 8270
Hexachlorobenzene	SW 8270
Hexachloroethane	SW 8270
Nitrobenzene	SW 8270
Pentachlorophenol	SW 8270

TABLE 8-2

ANALYTICAL CAPABILITIES

Semi-Volatiles - TCLP LIST	
2,4,5-Trichlorophenol	SW 8270
2,4,6-Trichlorophenol	SW 8270
Pesticides - TCLP LIST	
Chlordane	SW 8081
Endrin	SW 8081
Heptachlor	SW 8081
Heptachlor Epoxide	SW 8081
Lindane	SW 8081
Methoxychlor	SW 8081
Toxaphene	SW 8081
Herbicides - TCLP LIST	
2,4-Dichlorophenoxyacetic Acid	SW 8151
2,4-5-Trichlorophenoxypropionic Acid	SW 8151
Metals - TCLP LIST	
Arsenic	SW 6010
Barium	SW 6010
Cadmium	SW 6010
Chromium	SW 6010
Lead	SW 6010
Mercury	SW 6010
Selenium	SW 6010
Silver	SW 6010

WASTE CHARACTERIZATION	
ANALYTE	**METHODS**
Corrosivity - pH	SW 9040, 9045
Reactivity – Releasable Cyanide	SW 7.3.3.2
- Releasable Sulfide	SW 7.3.4.2
Ignitablitity	SW 1010

APPENDIX NINE ANALYSES	
Analyte	**Methods**
Volatile Organics (extended list 19 Compounds)	SW 8260, 5030, 5035
Acid and Base Neutrals (extended list 48 Compounds)	SW 3510, 3520, 3540, 3545, 3550, 8270
Pesticides and PCBs	SW 3510, 3520, 3540, 3545, 3550, 8081, 8082
Herbicides	SW 8151
Total Cyanide	SW 9012
pH	EPA 150.1, SW 9040/9045
Metals: Arsenic	SW 6010, 6020

TABLE 8-2

ANALYTICAL CAPABILITIES

APPENDIX NINE ANALYSES	
Analyte	**Methods**
Antimony	SW 6010, 6020
Barium	SW 6010, 6020
Beryllium	SW 6010, 6020
Cadmium	SW 6010, 6020
Cobalt	SW 6010, 6020
Chromium	SW 6010, 6020
Copper	SW 6010, 6020
Mercury	SW 7470, 7471
Nickel	SW 6010, 6020
Lead	SW 6010, 6020
Selenium	SW 6010, 6020
Silver	SW 6010, 6020
Tin	SW 6010, 6020
Thallium	SW 6010, 6020
Vanadium	SW 6010, 6020
Zinc	SW 6010, 6020
Metals Digestion	SW 3010, 3020, 7470, 7471

Appendix IX is derived from Appendix VIII Hazardous Constituents. These parameter lists are intended to apply to groundwater monitoring at hazardous waste storage and disposal sites and are applied to uncontrolled site investigations and remediations.

MICROBIOLOGY	
ANALYSIS	**METHOD**
Total Coliform	SM9222B
Fecal Coliform	SM9222D, Colilert 18 w/Quantitray
Fecal Coliform	m-tec modified
Total Coliform and E-coli	SM9223B, Colitag
E-coli	SM9213D
E-coli	SM9223B Colilert w/ Quantitray
Heterotrophic Plate Count	SM9215B, SIMPlate

FOOD ANALYSES	
TEST	**METHODS**
Aerobic Plate Count (APC)	AOAC 986.33/990.12
Total Colifroms	AOAC 991.14
e-Coli	AOAC 991.14
Listeria Species - Vidas	AOAC RIN 100501
Listeria Species/Listeria Monocytogenes - Biorad	AOAC 030406

TABLE 8-2

ANALYTICAL CAPABILITIES

FOOD ANALYSES	
TEST	**METHODS**
Yeast & Mold	AOAC 997.02
Staphylococcus	AOAC 2003.07
Salmonella	AOAC 2001.09
Shigella	MPN Screen
Water Phase Salt	AOAC 937.09
Water Activity	AOAC 978.18
Clostridium Botulinum	AOAC 977.30 Mod.
Clostridium Perfringens	Screen AOAC 974.38 Mod.
Lactobacillus	SM 9215B Mod - Anaerobic
Histamine	Screen
Deoxynivalenol (DON)	USDA GIPSA 2002-106
Nitrofuran	ELISA by Ridascreen
Chloramphenical	ELISA by Ridascreen
Malachite Green	ELISA
Gentian Violet	ELISA
Bacillus Cereus	AOAC 980.31
Trans Fatty Acids	CLA by HPLC
Caffeine Content	AOAC 980.14 Mod.
BRIX	ICUMSA SPS-3
Specific Gravity	AOAC 955.37 Mod.
Campylobactor	BAM 8th Edition
Vibrio - Parahaemolyticus	BAM 8th Edition Chapter 9
Vibrio - Vulnificus	BAM 8th Edition Chapter 9
Shelf Life Studies and Challenge Studies	Various
Lactic Acid Bacteria	AOAC 990.12 anaerobic
Anaerobic Bacteria	SM9215 Mod - Anaerobic
Various Allergens – soybean, hazelnut, almond, milk, peanut, shellfish	Alert

9.0 DATA REDUCTION, VALIDATION AND REPORTING

All analytical data generated within Katahdin Analytical Services laboratories undergo a well-defined, well-documented multi-tier review process before being reported to the client. (Refer to Figure 9-1)

Each department shall have written procedures incorporated into the working SOPs for data validation which incorporate the quality assurance goals of traceability, accountability, completeness, precision and accuracy.

No written reports shall be issued which have not undergone the data validation process. Refer to the current revision of Katahdin Analytical Services SOP SD-904, Data Reduction, Review and Reporting, for more information.

9.1 Data Reduction

Primary analytical data, otherwise known as "raw data", may be manually generated or captured in electronic format. When raw data are manually generated, they are recorded either in bound logbooks with numbered pages or on preprinted forms. Records of analysis indicate the method used, raw data, calculations, and final results. Entries are made in black ink and are initialed and dated by the individual making the entry. It is acceptable to initial and date once for an entire page. Errors are corrected by drawing a single line through the entry; corrections are initialed and dated by the individual making the change. An explanation for the change must be indicated on the raw data when possible. If space is limited, errors may be coded using the descriptive codes listed in Figure 9-2. Raw data may not be obscured in any way. The use of white-out is prohibited on all raw data, including instrumental hardcopy.

The analyst who completes the analysis assembles all relevant raw data and results together with chromatograms, strip chart recordings, instrument settings and other information essential to data interpretation. For data that are reduced by manual calculations, the calculations are documented in a laboratory notebook or in an Excel spreadsheet. All raw results are manually entered or imported into the Laboratory Information Management System (KIMS). Electronic batch sheets and all pertinent reporting forms (refer to Figure 9-3) are generated.

9.2 Data Validation

Data validation is the internal process of review by which data are shown to be valid as evidenced by the soundness of the analytical system and successful meeting of the DQOs (not to be confused with data validation by an outside independent source). In this process, the Laboratory makes no judgment as to the usability of the data by the end-user except with respect to the methodology applied.

Analysts performing an analysis and subsequent data reduction have the primary responsibility for the quality of the data produced. The primary analyst initiates the data validation process by reviewing and accepting the data, provided the associated quality control criteria have been met for the samples being reported. All reduced data must be

evaluated using the QA Acceptance Criteria tables found within individual analytical method SOPs (please refer to Appendix B of Section 11 of this manual for examples of these tables. These tables give acceptance criteria and corrective actions for criteria that are not met. Data review checklists may be used to document the data validation process (these checklists, if applicable, may be found within individual method SOPs).

Depending on the corrective action taken, data may or may not be flagged with the appropriate qualifier. Quality control excursions and any analytical discrepancies and/or matrix-related problems discovered during sample preparation or analysis, are documented in the Report of Analysis through the use of data flags.

The initial reviewer drafts any narrative comments. The narrative briefly describes any issues or discrepancies relating to the condition of the samples upon receipt, sample holding time performance, instrument calibration information, or quality control results. Any corrective actions pertaining to the samples are also addressed. Any items noted during technical and QC review are included in the narrative if deemed to impact the quality of the data. Narratives are always required for all level 3 and level 4 reports (see Figure 9-3, Levels of Data Deliverables) and only when necessary to document an issue for level 1 and level 2 reports.

The completed data package is then sent to the Department Manager or designated senior technical data reviewer. The Department Manager or designated data reviewer provides a technical assessment of the data package and technical review for accuracy according to methods employed and laboratory protocols. The review includes a thorough evaluation of manual calculations. For data that are reduced via computer, calculations are checked by the analyst (or designee) assigned to this task at a frequency designed to assure that the final data generation is valid. This data validation step is documented by the analyst's initials on the hardcopy of the raw data. The narrative is also checked during this stage of review.

Once the data have been technically reviewed and approved, authorization for release of the data from the analytical section is indicated by initialing and dating the data review checklist or otherwise dating and initialing the data.

All analytical data segments and other relevant paperwork pertaining to a particular Katahdin Analytical Services data report are channeled to the Data Management Department for assembly into the final report format and compilation of the analytical narrative.

9.3 Data Reporting

The sample results are tabulated by test method and department. Katahdin Analytical Services number, client identification, method number, and dates of sample preparation and analysis are presented along with the concentrations detected for each parameter analyzed and corresponding reporting limits and units. Katahdin Analytical Services is also able to provide alternate report formats if requested and additional deliverables (e.g., quality control reports, electronic diskette deliverable). Please refer to

Figure 9-3 for a list of Katahdin data deliverables. All reports are processed through the data validation and reporting steps described in Sections 9.2 and 9.3.

Some states or programs may have more strict reporting requirements. Some may require a copy of the certification parameter list and certification ID for work originating in their state, i.e. Massachusetts. For drinking water samples, a copy of the MCL from the state where the samples originated must be included in the report. It is Katahdin's policy to indicate on the report when drinking water parameters are above the MCL. Some states (MA) also require verbal notification to the client within 24 hours when MCLs are exceeded.

The Data Management Department assembles all data from a sample set, generates the final report, checks for completion, and checks that all client requests have been met.

The final review and signing of reports is completed by a qualified individual as necessary. The final reviewer may be the Operations Manager or the Quality Assurance Officer.

The final reviewer may examine the report for method appropriateness, detection limits, completeness and accuracy and whether or not QC criteria were satisfied, as deemed necessary. Any deviations from the referenced methods are checked for documentation and validity, and QC corrective actions are reviewed for successful resolution. The final reviewer signs the cover letter, authorization line within the report and/or the narrative, indicating acceptance of the report prior to its release to the client.

When an amendment to a report is required after the issue of the report, a separate document or electronic data deliverable (EDD) is provided. The revised report must be clearly identified as reissued. A "reissued" stamp is used in the lower right-hand corner of the report page. Reissued reports may involve the entire report or just specific pages. In both cases, the pages shall be stamped as "reissued", either manually, or through pagination on the copier/scanner. A cover letter indicating the date of revision, the revised pages, and the reason for revision must accompany every revised report. The original version of the report must be kept intact and the revisions and cover letter included in the work order project file.

Refer to the current revision of Katahdin Analytical Services SOP's SD-914, Assembly of Level I and Level II Reports and SD-915, Assembly of Level III and Level IV Reports, for more information.

9.4 Subcontractor Reports

Subcontracted data must be clearly identified as such. The name of the subcontractor laboratory must be documented in the report. All subcontracted sample data reports are reviewed to ensure all analyses requested have been received by Katahdin Analytical Services. The subcontracted data report may be appended in whole to Katahdin Analytical Services' analytical data report. The final report format is determined through communication between the Katahdin Analytical Services Project

Manager, Data Management/Reporting Group, and the client. Please refer to Katahdin SOP, SD-900 (current revision), Subcontracting Analyses, for further details.

9.5 Electronic Data Deliverables

Electronic Data Deliverables (EDDs) are routinely offered as part of Katahdin's services. Katahdin offers a variety of standard formats including Excel, Dbase, GISKEY, EQUIS and Text files. Katahdin will work exclusively with clients to produce client-specific EDD formats. EDD specifications must be submitted to the Management Information Systems (MIS) Department by Katahdin project managers for review. Katahdin management and the MIS department will determine whether the EDD format can be provided.

Data Management personnel and MIS are responsible for creating any EDDs requested by the client. Once an EDD is created, at least 10% (typically 50%) is reviewed to ensure its accuracy and completeness. Any hand entered data must be checked by a secondary reviewer.

9.6 Data Archive

Once the final report has been approved and signed it is submitted to the client via email, upload or hardcopy mail. Hardcopies of the supporting data and review checklists associated with each report are stored in the data archive under the control of the Office Manager. Additionally, all raw data and supporting documents, that are not included with the client report, are scanned and saved as a pdf file on the server along with the electronic copies of the preliminary and final reports. The purpose of the data archive is to ensure the continued integrity of all documentation generated in support of laboratory analyses.

Once the scanned reports and supporting documentation have been saved to CD ROM (twice), and confirmed, any hardcopy data is disposed of. CD ROM records are maintained indefinitely. All other records including bound logbooks and QA/QC records are saved on-site (either an electronic copy or hard copy) for a minimum of five years. Any electronic data retained by the laboratory is saved on 2 CD's. One is stored on site for laboratory use and one is stored off site. Some states, clients or specific program regulations require longer retention times than five years. These records will be noted with specific storage instructions. Records maintained off-site are protected against fire, theft, loss, deterioration, and vermin. These archived records may only be retrieved by designated personnel. A member of management may designate an employee to retrieve data files from the archive storage facility.

9.7 Quality Assurance Review

The Quality Assurance Officer or designee shall review at a minimum 10% of all data packages for technical completeness and accuracy. This review is part of the oversight program and does not have to be completed in "real time". Documentation of this review will be recorded in a designated logbook.

FIGURE 9-1.

MULTI-TIER REVIEW PROCESS

DATA FLOW CHART

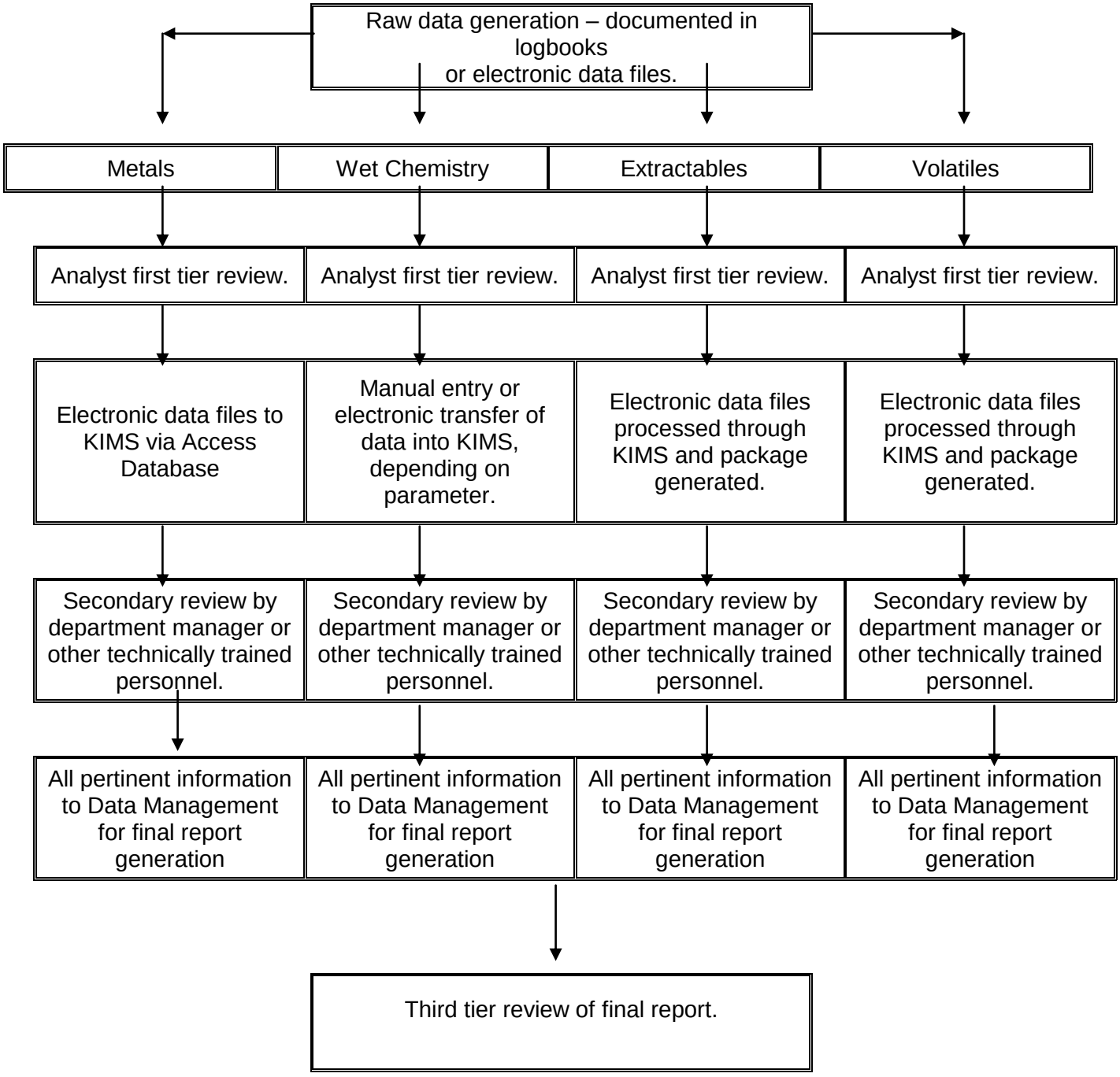

FIGURE 9-2

Error Codes

1	(or E1)	Misspelled
2	(or E2)	Mathematical Error
3	(or E3)	Wrong Entry
4	(or E4)	Transposition or Sequencing Error
5	(or E5)	Transcription Change (copy error)
6	(or E6)	Procedural Change
7	(or E7)	Wrong Conclusion
8	(or E8)	Illegible Entry
9	(or E9)	Unnecessary Entry
10	(or E10)	Footnoted Explanation
11	(or E11)	Additional Comment
12	(or E12)	Instrumentation Error/Failure

FIGURE 9-3

LEVELS OF DATA DELIVERABLES

Deliverable	Data Reporting Level								
	I				II(+)	III	IV		
	FM	HO	DW Comp	STD	STD	STD	STD	DoD	CLP
Footnotes and Definitions Pages		√	√	√	√	√	√	√	√
Narrative (if needed)	√	√	√	√	√	√	√	√	√
Report of Analysis (Form 1 or equiv -- TICs optional)	√	√	√	√	√	√	√	√	√
External chains of custody	√	√	√	√	√	√	√	√	√
Drinking Water MCL Information		√	√						
State Forms			√						
E-mail Client Correspondence Regarding Data Issues						√	√	√	√
Blank Results (Org Form 1/Ino Form 3 or equiv)				√*	√	√	√	√	√
Surrogate Recoveries (Org Form 2 or equiv)						√	√	√	√
Laboratory Control Sample Recovery (Org Form 3/Ino Form 7 or equiv)					√	√	√	√	√
Dup/MS/MSD if performed on client sample (Org Form 3/Ino Form 5A&6 or equiv)					√(+)	√	√	√	√
Blank Summary (Org Form 4 or equiv)				√*	√	√	√	√	√
Tune Summary (Org Form 5 or equiv)						√	√	√	√
Initial Calibration (Org Form 6/Ino Form 2A&3 or equiv)						√	√	√	√
Continuing Calibration (Org Form 7/Ino Form 2A&3 or equiv)						√	√	√	√
Internal Standard Area Summary (Org Form 8 or equiv)						√	√	√	√
Run Logs						√	√	√	√
Sample Preparation logs						√	√	√	√
Raw data							√	√	√
Before & After Manual Integration Raw Data								√	√

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FIGURE 9-3, CONT"D

LEVELS OF DATA DELIVERABLES

Deliverable	Data Reporting Level								
	I				II(*)	III	IV		
	FM	HO	DW	STD	STD	STD	STD	DoD	CLP
Florisil cartridge check (Org Form 9A or equiv) - (CLP only)									√
GPC calibration if performed (Org Form 9B or equiv)							√	√	√
Dual column ID summary (Pesticide Form 10 or equiv) - (if requested)						√	√	√	√
Instrument Sensitivity Check (Ino Form 2B or equiv)						√	√	√	√
Interference Check Sample (Ino Form 4 or equiv)						√	√	√	√
Post Digest Spike Sample – if performed (Ino Form 5B)						√	√	√	√
Standard Addition Results Summary – if performed (Ino Form 8 or equiv)						√	√	√	√
ICP Serial Dilutions – if performed (Ino Form 9 or equiv)						√	√	√	√
IDLs (Ino Form 10 or equiv)						√	√	√	√
Interelement Correction Factors (Ino Form 11A&B or equiv)						√	√	√	√
ICP Linear Ranges (Ino Form 12 or equiv)						√	√	√	√
Standard Preparation logs - (if requested)						√	√	√	√
Internal chains of custody - (if requested)						√	√	√	√

/ Data included in reporting level.
* Blank results provided for organics data.
+ Dup/MS/MSD provided if requested on client sample.
FM Food Microbiology Report
HO Homeowner Report
DW Drinking Water Compliance Report
STD Standard Report
DoD Report in accordance with the DoD QSM

10.0 DOCUMENTATION & RECORDS MANAGEMENT

Records are the means by which an organization documents its operations and activities. They are an integral part of the Quality Assurance program since they provide documented evidence for program functionality and necessary information for performance evaluation and quality assurance audits. All information related to the administration and operations of the laboratory and quality assurance practices outlined in this manual shall be contained in records. This shall include, but is not limited to, standard operating procedures, results of instrument calibrations, analysis of quality control samples, analysis of samples, sample custody and disposal, preparation of standards, COC documentation, analytical reports, corrective action reports, audits and inspections. Refer to Table 10-2 for a more complete list of records.

All laboratory records are the property of Katahdin Analytical and shall not be removed from the premises without the permission of a member of management. All records are confidential and must be handled in that manner. Unauthorized distribution, changes, loss or destruction of records can be grounds for dismissal from the laboratory. All records are filed, maintained, stored, archived and disposed of as described in this SOP. All records shall only be made available to the original client or to a third party designated by the client. Refer to the current revision of Katahdin SOP AD-004, Laboratory Facility Security and Confidentiality, for further information. All records shall be made available to regulators, auditors or accrediting authorities as required by regulation.

Records shall be stored to be readily retrievable in environments that prevent damage to the records. All records shall be stored to allow historical reconstruction of all laboratory activities that produced the analytical data. The historical reconstruction must be understood and must include information on receipt, chain-of-custody, preparation, analysis, corrective actions and client communication, report content and reissues. Stored electronic files shall be named to facilitate the retrieval of working and archived files.

10.1 General Recordkeeping

- All documentation must be accurate, legible, complete and recorded in a timely manner using indelible ink. No measurements are to be filled in ahead of time even if the measurement is always the same. During the actual analysis it may be determined that a different quantity is needed.
- All data and/or results that are recorded and/or entered must be a true and accurate representation of the measured values and must be validly quantitated.
- If an error is made, a single line is used to cross out the incorrect entry. The original entry must remain readable. The correction must be initialed and dated and may be given an error code (see Figure 1) or explanation for the change. The use of white out is prohibited on all raw data, including instrumental hardcopy.
- If a change is made to a record, a single line is used to cross out the incorrect entry. The original entry must remain readable. The correction must be initialed and dated and may be given an error code (see Figure 1) or explanation for the change. The use of white out is prohibited on all raw data, including instrumental hardcopy. For electronic changes, all audit trails must be maintained.

- When blank space is left after all information has been recorded on a logbook page or on other forms of documentation, the blank space must be "Z'd" out. Draw a line in the shape of a "Z" starting at the top of the blank space and ending at the bottom of the blank space; initial and date the "Z" out.

- All blocks must be filled in on pre-printed forms. Header information must be complete. All columns, signatures and units of measure must be identified.

10.2 Standard Operating Procedures

Standard Operating Procedures (SOPs) are written for specific procedures or operations. Complex tasks of inspection, testing, calibration, monitoring, maintenance, data handling, and quality control as well as methods utilized in the laboratory are specified and documented by SOPs.

As a minimum requirement, each SOP must include a title, the purpose or application, list of materials or references, and detailed procedures. SOPs are reviewed and/or updated annually. If annual review is not possible for all SOP's, the QA Officer shall prioritize the SOP's for a timely review. Each has a Katahdin Analytical Services reference number and revision date at the upper right corner of each page. More detailed information regarding SOPs can be found in Section 12.0 and in the current revision of Katahdin Analytical Services SOP QA-800, Preparation of SOPs.

All personnel are required to follow SOPs when a specific operation or method is being utilized. It is the responsibility of the Department Managers/Group Supervisors to make sure that employees are aware of and follow the SOPs. Any suggestions for additional SOPs or changes to existing SOPs should be directed to the appropriate Department Manager, the Operations Manager or the QA Department.

10.3 QA Records

QA Records shall include, but are not necessarily limits to, SOPs (described above), the QA Manual, audits and responses, corrective action forms, training forms and demonstrations of capability, employee qualifications and/or transcripts, logbooks, PT results, internal COCs, a record of all employee initials and signatures responsible for signing laboratory records and MDL/IDL studies/verifications. All hardcopy current and past QA records are filed with the QA Officer for 1-3 years, depending on space. Hardcopy QA records are logged and filed off site after this for at least five years. QA records are maintained and backed up on the company server indefinitely.

10.4 Sample Tracking

Samples are tracked from the time they are received, through storage, preparation, analysis, and final disposition. More information on the following discussion can be found in the current revision of Katahdin Analytical Services SOP SD-902, Sample Receipt and Internal Control.

Proper sample identification must be established during sample collection. This information must be clearly and permanently written on a label and attached to the sample. In addition, a Chain-of-Custody must be initiated with the appropriate information recorded. Samples should also be properly preserved and stored.

Sample Management personnel verify the samples' integrity, as they are unpacked. The Katahdin Analytical Services Project Manager and/or the client are notified of samples that are received broken or have not been properly stored or preserved. The sample identification label must also be checked against Chain-of-Custody identification. Any discrepancies must be verified by the client or sampler. All these checks and any discrepancies or changes must be documented on the Sample Receipt Condition Report.

Sample Management Personnel assigns each group of samples, or job, a Work Order number and each sample within the job a sequential laboratory identification number, which is placed on the sample container. Samples are stored in the appropriate locations. A laboratory data file is initiated for the entire job.

Upon receipt the Sample Management Personnel also initiate an internal custody record for the sample set. These forms are used to document sample removal from and return to sample storage. The final disposition of a sample is documented on the hazardous waste disposal spreadsheet.

10.4.1 Chain-of-Custody

The Chain-of-Custody (COC) Form traces the possession of a sample from the time the sample is obtained in the field through receipt by and analysis in the laboratory. To initiate a Chain-of-Custody, the field sampler must fill in the appropriate information: Client or Project Name, Signature of Sampler, Sample Identification, Date and Time Sampled, Type of Sample, and Analysis Requested. After the sample is brought into the laboratory, sample integrity, preservation, and identification are checked. Any inconsistencies are noted in the sample management documentation. For samples accepted into the laboratory, the Sample Custodian verifies that the sample label IDs are consistent with the sample IDs provided on the Chain-of-Custody, signs in the space marked "Received for Laboratory" and records the date and time received.

10.4.2 Internal Sample Custody Record

The internal custody record is a mechanism for tracking samples from sample management (sample storage) to sample preparation and/or analysis and back to the appropriate storage location, unless the aliquot is depleted. When laboratory personnel remove samples from sample storage, the sample transfer is recorded electronically using bar codes. Upon returning any remaining sample, the individual electronically scans the bar code for the appropriate samples as returned. For analyses that have an immediate analytical holding time (48 hours or less) or for rapid turn around work, the sample custodian will enter this information into a Google docs internal web page that is constantly monitored in the lab. Upon

completion, the original internal custody records are archived by the QA Department.

10.5 Standards

Standards preparation is documented in the Katahdin Analytical Services laboratories in standards logbooks maintained by each laboratory section. All information needed to maintain proper traceability of standards is recorded in the appropriate standards logbook by the individual preparing the standard. More complete information regarding standards is provided in Section 7.1 and in the current revision of Katahdin Analytical Services SOP CA-106, Standard Preparation and Documentation.

10.6 Maintenance Logbooks

Maintenance logbooks are kept for each instrument. Each instrument has a unique maintenance logbook. In the logbook, an analyst records initial instrument setup, routine preventive maintenance, outside contractor services, instrumental malfunctions and repair performed, dates taken in and out of service, and resolutions. Instrument logs not only describe the instrument's history, but also can be helpful when troubleshooting. Alternatively, instrument runlogs may be used to document problems noted, routine maintenance performed and return to control. Refer to the current revision of Katahdin Analytical Services SOP CA-101, Equipment Maintenance, for more information.

10.7 Preparation Logbooks

All data pertinent to sample preparation shall be recorded by the laboratory staff in bound notebooks with numbered pages and/or in the Katahdin Information Management System (KIMS). During the sample preparation process, a preparation record shall be prepared for the project by the preparation analyst. It shall contain the following information:

- Sample identification numbers
- Date and time of preparation
- Method reference
- Analyst’s initials
- Preparation weights and/or volumes (initial and final)
- Reagent/solvents used including manufacturer and lot number
- Relevant blank
- Spike and surrogate data including the serial reference number
- Clean-up performed on sample extracts
- Instrumental analysis to be performed on each extract
- Notable observations

10.8 Run Logbooks/Instrument Logbooks

A run logbook (or computer-generated run sequence) or an instrument logbook is maintained for all instruments and/or analytical procedures. Each run log contains the entire sequence of samples, including the calibration curve. All data documented in the run log shall include reference to the person(s) who performed the analysis, the date of

analysis, the method used, the identification of the instrument, instrument operating conditions/parameters or an analytical method file to reference these and the acceptability of the results in the context of the QC system.

At the time of sample analysis, the laboratory identification number, amount injected or otherwise analyzed, any dilution of the original sample and/or extract and other relevant sample data shall be entered into the run log and/or instrument logbook, or if possible into the instrument header. All standard and reagent unique IDs must be included for traceability purposes.

All data relevant to the calculations should, where possible, be entered onto the instrument header including sample weight or volume, final volume, dilution, and spike level.

10.9 Raw Data

Raw data includes any information needed to reconstruct how analytical results are obtained. This includes standards logbooks, preparation logbooks and instrument runlogs as described above. Raw data also includes all instrument printouts, calibrations, quantitation reports, chromatograms, strip charts, summary reports, and KIMS batch sheets. Raw data shall contain all original observations that would have indicated all applicable analytical conditions that may have affected the outcome of the test. These conditions may include temperature, sample receipt condition, instrument ID's, etc. Raw data must also include original observations including dates, analyst/prep initials, any volumes or weights not already recorded in the appropriate logbooks, instrument identification and instrument operating conditions/parameters, manual calculations and manual integrations, standard and reagent information, calibration criteria and acceptability, QC sample batch identification and QC criteria and data interpretation, flags and review information.

The raw data is included with the data package as described below, when requested by the client. Not all raw data is filed with a data package if not requested by the client. Refer to Table 10-1 for a summary of raw data filed with the data report. However, all raw data is stored and retained by the laboratory for a specified amount of time. Refer to Table 10-2 for a summary of data retention times and means of retention.

10.10 Data Report/Raw Data Package

A Data Report contains the results of analyses as presented to the client. The Data Report also includes Chain-of-Custody documentation and a narrative and/or cover letter describing the general condition of the samples and a summary of any discrepancies encountered during sample analysis. For more information see Section 9.3.

The Raw Data Package contains information needed to reconstruct how the results of the analysis of a batch of samples including QA/QC samples were derived. Information such as inorganic or organic preparation, chromatograms or strip chart recording, and regression analysis data are usually included.

10.11 Electronic Data Management

Katahdin maintains security procedures in order to ensure the integrity of its network and computer systems. Katahdin maintains its database and reporting systems on dedicated resources within the company system.

All Katahdin personnel are assigned login names and passwords in order to access the computer systems. As described in the current revision of the Katahdin QA Manual and in Katahdin SOP, QA-811, Ethics in the Laboratory, all employees are required to sign a Code of Ethics. This agreement requires the proper use and maintenance of computers and software at Katahdin. Katahdin utilizes dedicated computer work stations, which are used only by a group of cross-trained employees. This prevents the accidental "changing" of data. Additionally, Katahdin's policy is for a software user to log-in under their unique log-in so that all software audit trails are accurate. Using a software program for which another user is already logged on is not acceptable.

The Katahdin Information Management System (KIMS) and the organics data acquisition system are designed with audit trail functions to track the changing and/or manipulation of records. Additionally, individual accounts for the KIMS system are set-up so that certain functions (i.e. the ability to edit data) are only given to certain authorized individuals. Coupled with unique login, these safe guards ensure the integrity and confidentiality of data entry, collection, processing and storage. Passwords for both the KIMS and organics data acquisition systems are changed annually.

Changes to electronic files are allowed in order to correct mistakes or inappropriate manual integrations that are found during the tiered review process. In these cases, the original files are edited and saved as the same file name. Many of these changes can be tracked through the system audit trails. When samples are reanalyzed for organics, the original files are never overwritten. The data system will always automatically create a new file. When changes are made electronically in the metals data system, the system will always prompt the user to save the changes as a new file.

All spreadsheet calculation cells must be locked to prevent unauthorized amendment.

Electronic records are maintained so that historical reconstruction of analytical data can be accomplished. All instrument file naming is standardized and described within each individual analytical SOP. Refer to the current revision of Katahdin SOP SD-913, Data Back-up, Archival and Restoration, for more information.

10.12 Software Quality Assurance

An integral part of the Katahdin Quality Assurance Program is the documented procurement, development, validation, verification, configuration control, modification control and maintenance of all software used in the generation, compilation, reduction and reporting of analytical measurements. The requirements of this program apply to purchased software as well as software that is developed or modified internally. All software and spreadsheets used for data reduction will be managed under Katahdin Analytical Services Information Systems Life Cycle Process (Figure 10-1) prior to use. This includes the validation and verification of that software. Further information is provided in the current revision of Katahdin SOP SD-906, Software Quality Assurance.

10.13 Records Retention

Refer to the current revision of Katahdin SOP, SD-913, Data Back-up, Archival and Restoration and to Table 10-2 of this section for further details.

Client reports are archived onto CDs and kept indefinitely. One copy is kept on site for lab use and one copy is kept off site.

Quality Control records including controlled documents are kept archived for a minimum of 5 years.

Raw data and logbooks are scanned and archived onto CD and kept indefinitely. One copy is kept on site for lab use and one copy is kept off site.

Project records are maintained by Project Management and the Sales Department. Generally, bids are retained for 1 year, client correspondence is retained for 5 years, BOAs and MSA's are retained for the defined lifespan.

Administration Records are retained for a period of 3 to 6 years.

Some states, clients or specific program regulations require longer retention times than five years. These records will be noted with specific storage instructions.

Records pertaining to compliance drinking water samples must be retained for 10 years.

Records maintained off-site are protected against fire, theft, loss, deterioration, and vermin. Electronic records are protected from deterioration caused by magnetic fields and/or electronic deterioration. These archived records may only be retrieved by designated personnel. A member of management may designate an employee to retrieve data files from the archive storage facility.

In the event that the laboratory goes out of business, all clients will be contacted and given the opportunity to claim their pertinent records. In the event that the laboratory transfers ownership, record retention requirements will be addressed in the ownership transfer agreement and the responsibility for maintaining archives will be clearly established.

TABLE 10-1

SUMMARY OF RAW DATA HANDED IN WITH DATA PACKAGE

	Raw Data Handed into Data Management (HC and/or electronic)	
	Sent to Client with Data Package	Retained by Laboratory
Organics – Level 1/2	Sample results form, QC forms	Sample raw data, QC raw data, runlogs, review checklist
Organics – Level 3	Sample results form, QC forms, calibration forms, runlogs	Sample raw data, QC raw data, calibration raw data, review checklist.
Organics – Level 4	Sample results form, QC forms, calibration forms, runlogs, Sample raw data, QC raw data, calibration raw data	Review checklist
Metals – Level 1/2	Sample results form, QC forms	Review checklist
Metals – Level 3	Sample results form, QC forms, calibration forms, runlogs	Review checklist
Metals – Level 4	Sample results form, QC forms, calibration forms, runlogs, Sample raw data, QC raw data, calibration raw data	Review checklist
Wet Chemistry – Level 1/2	Sample results form, QC forms	Review checklist
Wet Chemistry – Level 3	Sample results form, QC forms, Sample raw data, QC raw data, calibration raw data	Review checklist
Wet Chemistry – Level 4	Sample results form, QC forms, Sample raw data, QC raw data, calibration raw data	Review checklist
Food/Microbiology- all levels	Sample results form	Review checklist

TABLE 10-2

SUMMARY OF RECORDS & RETENTION TIME/MEANS

Records	Hardcopy Retention	Electronic Retention
QA Manual	At least 5 years	Server or PC, refer to SOP SD-913
SOPs	At least 5 years	Server or PC, refer to SOP SD-913
Audits & Responses	At least 5 years	Server or PC, refer to SOP SD-913
Certifications	At least 5 years	NA
Corrective Action Reports	At least 5 years	NA
Logbooks	1-2 years or until scanned	Indefinitely once scanned and archived onto CD (2 copies) - refer to SOP SD-913
PT Data/Results	At least 5 years	NA
MDL/IDL Studies & Verifications	At least 5 years	NA
Internal COCs	At least 5 years	NA
Raw Data to Data Mgt.	Current year or longer until scanned	Indefinitely once scanned and archived onto CD (2 copies) - refer to SOP SD-913
Raw Data not to Data Mgt.	At least 5 years	Indefinitely once scanned and archived onto CD (2 copies) - refer to SOP SD-913
Instrument Files	At least 5 years	Indefinitely once scanned and archived onto CD (2 copies) - refer to SOP SD-913
Data Reports & Reissues	Current year or longer until scanned	Indefinitely once scanned
Field Records	At least 5 years	NA
Contracts, BOAs, MSAs & Amendments	At least 5 years or through the term of the contract	PC - refer to SOP SD-913
Bids	At least one year	PC - refer to SOP SD-913
Client Correspondence	At least 5 years	PC - refer to SOP SD-913
Client QAPPs/tables	At least 5 years	Server or PC - refer to SOP SD-913
PM Telephone Logs	At least 5 years	NA
EH&S manuals, records, disposal logs	At least 5 years	Server or PC - refer to SOP SD-913
Employee transcripts & training files	At least 5 years from when employee ends employment	NA
Administrative Records	At least 5 years	PC - refer to SOP SD-913
Compliance drinking water records	At least 10 years	Indefinitely once scanned and archived onto CD (2 copies) - refer to SOP SD-913

Two copies of all CDs or DVDs are burned, one to be stored on-site and one to be stored off-site.

FIGURE 10-1

INFORMATION SYSTEMS LIFE CYCLE PROCESS

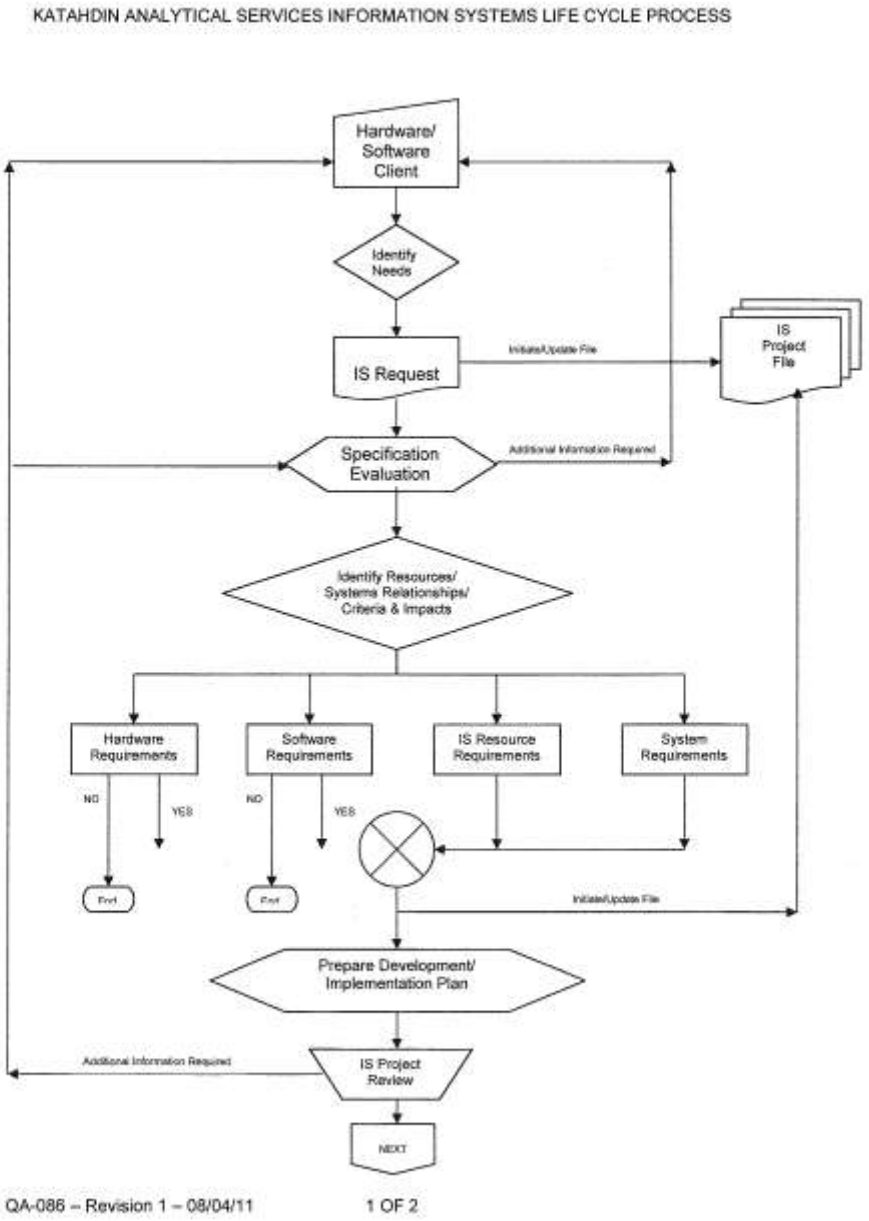
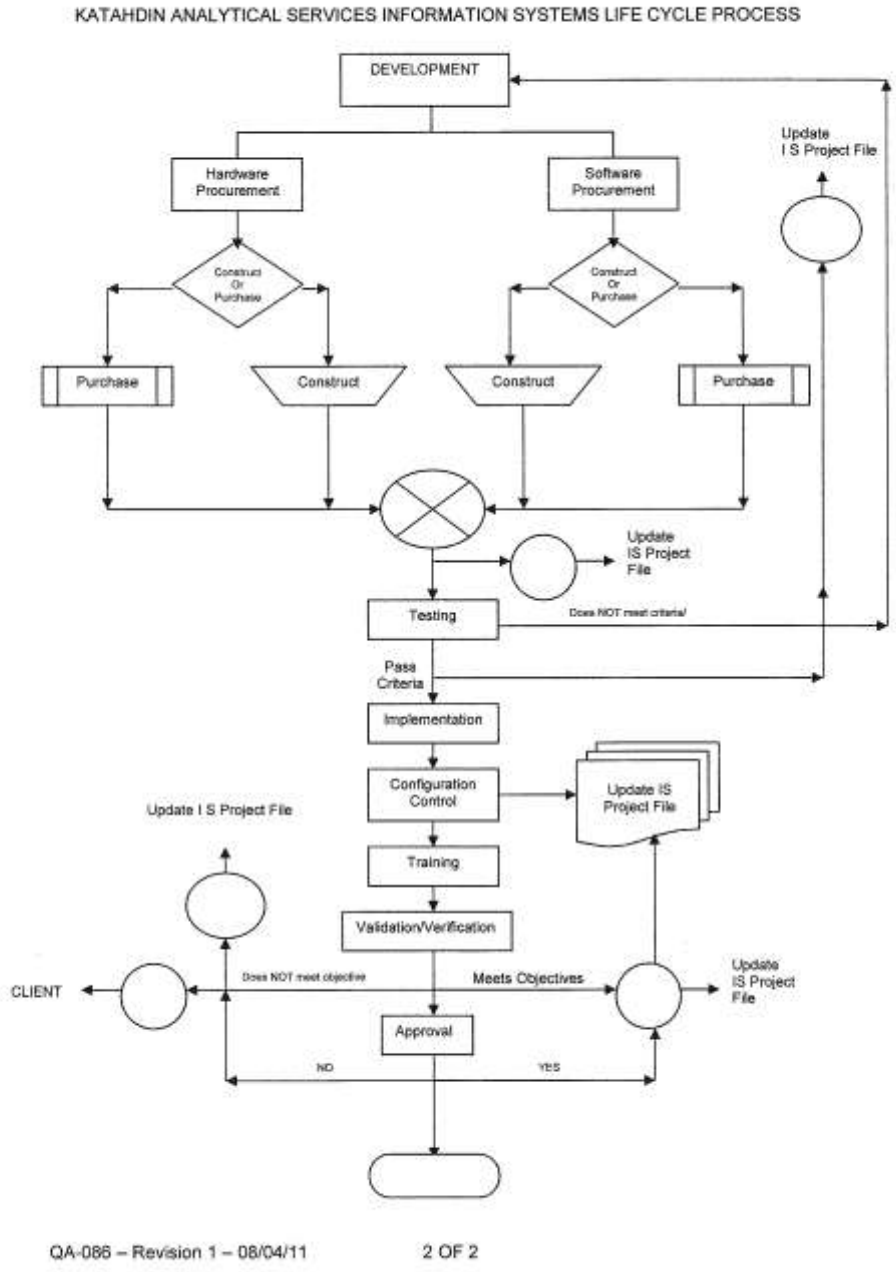


FIGURE 10-1, continued

INFORMATION SYSTEMS LIFE CYCLE PROCESS



11.0 QUALITY CONTROL

A quality control program is a systematic process that controls the validity of analytical results by measuring the accuracy and precision of each method and matrix, developing expected control limits, using these limits to detect errors or out-of-control events, and requiring corrective action techniques to prevent or minimize the recurrence of these events.

Individual method SOPs contain the specific quality control criteria required for each method. In most cases, these criteria are method, program or regulatory requirements. Individual client or project required quality control criteria are handled through client driven Quality Assurance Project Plans. Refer to section 3.0 of this manual. When no method or other quality control criteria exists, the laboratory shall set nominal acceptance limits that are consistent with other similar methods. These limits shall be determined and approved by Department Managers/Group Supervisors, the Operations Manager, the IT/Production Manager and the Quality Assurance Officer. When a discrepancy exists between method and/or regulatory quality control acceptability, the most stringent criteria shall be used. If it is not apparent which criteria are more stringent, the regulatory criteria shall be used. All quality control samples are prepared and/or analyzed in the same manner as client field samples.

11.1 Holding Times

There is no topic that is perhaps more critical to the successful operation of any laboratory, than running samples within the accepted holding time for each analysis. The holding time for analytes reflects the allowable time span permitted before the analysis must begin. Due to the sensitive nature or volatility of certain compounds, this permitted time frame within which an analysis must begin is critical to ensuring that target compounds have been verified within a certain margin of accuracy.

Holding times are set by method and/or regulation and must be followed. Refer to Table 6-1 of this manual for a listing of required holding times. Holding times are determined from the time of collection of a grab sample or from the ending of a composite sample to the beginning of preparation and/or analysis.

11.2 Accuracy and Precision Measurements

The results of quality control samples created in the laboratory represent estimates of accuracy and precision for the preparation and analysis steps of sample handling. This section describes the quality control information provided by each of these analytical measurements. Information on the procedures to follow in preparation of the samples or spiking solutions is described for each method and matrix in the respective method Standard Operating Procedure.

Method Blank

A method blank is a volume of analyte-free matrix (e.g. deionized and/or distilled laboratory water for water analyses, or a purified solid matrix for soil/sediment analyses) carried through the entire analytical procedure. The volume or weight of the blank must be approximately equal to the sample volume or weight processed. A method blank is performed with each batch of samples or one with every 20 field samples whichever is

more frequent. Analysis of the blank verifies that method interferences caused by contaminants in solvents, reagents, glassware, and other sample processing hardware are known and minimized. Optimally, a method blank should contain no greater than five times (5X) the practical quantitation limit for common laboratory solvents and phthalate esters or less than the PQL for all other parameters unless otherwise specified in the method or project QA plan. Results of method blank analyses are maintained with other QC data in the respective laboratories. If requested by the client, these data will be included in the report.

Accuracy Measurements

Laboratory Control Samples (LCSs) or **Laboratory Fortified Blank** (LFB) consist of aliquots of analyte-free matrices (water, sand, etc.) spiked with all target analytes or well-characterized materials, e.g. NBS river sediment. Laboratory pure water is used to prepare most LCSs for methods for analysis of water. Highly characterized solids, where available, are used for LCSs for methods for analysis of solids. Where no such solid LCS is available, spiked laboratory pure water or spiked reagent blanks may be substituted. LCSs provide an estimate of accuracy based on recovery of the compounds from a clean, control matrix. They provide evidence that the laboratory is performing the method within accepted guidelines generally in the absence of matrix interferences. They are prepared at a rate of one per batch of twenty or fewer samples.

Matrix Spikes/Matrix Spike Duplicates are similar to Laboratory Control Samples except the analytes used for spiking are added to a second and third separate aliquot from the client samples in a batch of analyses. They incorporate sample matrix effects and field conditions. Matrix spikes are routinely prepared at a frequency of one set (MS/MSD) per twenty samples for organic analyses and one MS per twenty samples for inorganic analyses when adequate sample volume is provided.

Clients may specifiy certain samples for matrix spike and matrix spike duplicate analysis to meet the requirements of their project. In these cases, additional volume is almost always provided. If no samples are specified, the choice is left to the analyst performing the method. The sample volumes available may restrict the choice of samples used for matrix spike and duplicate analysis. Field blank samples should never be chosen for matrix spike and matrix spike duplicate analysis.

Surrogates provide an estimate of accuracy for each sample analyzed by GC/MS and most GC analyses. The accuracy measurement incorporates sample matrix effects and field conditions and is based on recovery of compounds similar to the target analytes, but not expected to be present in the sample as received. Surrogates are added to all samples analyzed by GC/MS, certain GC, and certain HPLC analyses prior to sample preparation.

An **Internal Standard** is an analyte that has the same characteristics as the analyte(s) of interest, but is added to each sample in a batch, just prior to analysis and is used for quantitation. It corrects for bias or change in instrument performance from sample to sample, incorporating effects associated with the analytical process only.
Accuracy is expressed as Percent Recovery (%R). For LCSs and surrogates, percent recovery (**%**R) is calculated using the following equation:

$$\%R = (SR / SA) * 100$$

where: **SR** = the concentration determined
SA = the concentration spiked

For matrix spike samples, the percent recovery is calculated using the following equation:

$$\%R = (SSR-SR)/SA \times 100$$

where: **SSR** = the spiked sample determined result
SR = the original sample determined result
SA = the amount of spike added (expected)

Precision Measurements

A **Sample Duplicate** is a sample that has been homogenized and split into two equal portions before the method specified sample preparation process. It measures sample precision associated with the preparation through analysis and is prepared and analyzed at a rate of one per batch or one per twenty samples (if a batch is less than twenty samples) in the inorganic laboratories. For most organic analyses the MS/MSDs fill this function and provide a measure of overall precision.

Clients may specifiy certain samples for duplicate analysis to meet the requirements of their project. In these cases, additional volume is almost always provided. If no samples are specified, the choice is left to the analyst performing the method. The sample volumes available may restrict the choice of samples used for duplicate analysis. Field blank samples should never be chosen for duplicate analysis.

The comparison of the values determined for a sample and its duplicate (S/DUP or MS/MSD) is expressed as relative percent difference (RPD). RPD is calculated using the following equation:

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

where: **S** = the determined result of the original sample
D = the determined result of the duplicate sample

The vertical bars in the above equation indicate the absolute value of the difference, hence RPD is always expressed as a positive value.

11.3 Statistical Control Limits

Statistically derived laboratory limits serve as a tool for evaluating method performance, for evaluating individual analyst performance and for monitoring the effects of changes to the analytical methods. Current lab policy states that statistically derived QC limits are to be calculated as $\pm$ 3 standard deviations from the mean recovery of a minimum of

twenty data points. It is the policy of Katahdin Analytical Services to generate statistical limits for those methods and/or programs that require their generation. This is done on an annual basis for Surrogates, Laboratory Control Samples and/or matrix spike/matrix spike duplicates if sufficient data is available. A minimum of twenty data points are required for a given analytical procedure and sample matrix prior to generating statistical control limits. Until twenty data points are available, recommended EPA recovery limits must be used if available. Data points shall be chosen at random, either manually or through the applicable database. All data points used in the determination must be taken from data where all routine applicable QC criteria have been met for the analysis.

The percent recovery is calculated for each spiked analyte. The average percent recovery (X) and the standard deviation (s) are calculated for the group of samples.

Refer to the current revision of Katahdin SOP, QA-808, Generation and Implementation of Statistical QC Limits and/or Control Charts, for further details.

11.3.1 Limits

Both upper and lower warning limits and upper and lower control limits are established to interpret performance. Warning limits express a narrower confidence interval and are used to warn the analyst or department manager of possible system inconsistencies or failures, before an out-of-control event occurs. Control limits express the outer limits of accepted method variability. Control limits and warning limits are reviewed periodically against performance. Based on statistical considerations, an evaluation is made to determine whether the control limits need to be revised.

Warning Limits

When not mandated by the method, Katahdin Analytical Services adopts warning limits to be the mean ±2 standard deviations or a 95% confidence interval, where:

The mean percent recovery and standard deviation are calculated as follows:

Mean(P) = $$\frac{1}{n}\sum_{i=1}^{n} X_i$$

Standard Deviation(s) = $$S^2 = \frac{\sum_{i=1}^{n} X_i^2 - \left(1/n\right)\left(\sum_{i=1}^{n} X_i\right)^2}{n-1}$$

where: X = individual values
N = total number of values

Recovery warning limits are to be calculated using the following formulas:

$$UWL = P + 2s$$
$$LWL = P - 2s$$

where: UWL = Upper Warning Limit
LWL = Lower Warning Limit

Control Limits

Unless otherwise specified by the analytical method in use or by the project QA plan, Katahdin Analytical Services uses the 99% confidence interval as the control limits, which is defined as the mean ±3 standard deviations. Where the method specific ranges have been determined, Katahdin Analytical Services' goal is for their control limits to fall within the method limits. Control limits are established as follows using the mean and standard deviation as above:

$$UCL = P + 3s$$
$$LCL = P - 3s$$

where: UCL = Upper Control Limit
LCL = Lower Control Limit
P = Mean Percent Recovery
s = Standard Deviation

The control limits and warning limits used to evaluate a sample should be those in place at the time that the sample was analyzed. Once limits are updated, the limits should apply to all subsequent analyses. It is the responsibility of the department managers or Operations Manager to inform the QAO when new limits need to be derived. The QAO, or designated person, will derive the new limits, update the appropriate database and ensure that all associated personnel are aware of the updated limits.

11.4 Control Charts

Although data points are evaluated daily against QC limits, it is sometimes necessary to view the data. Control charts are quality control tools that graphically display the QC parameters over time. The lab shall generate control charts as a means to identify method or analyst performance issues. Control Charts are generated using Oracle Graphics, selecting the last 30 data points available for a particular Method and Matrix combination.Katahdin has chosen representative analytes from each type of technology to control chart.

Control charts may be evaluated by plotting and connecting successive data points to enable the laboratory to detect suspicious and out-of-control situations. These events can be caught by monitoring the following: outliers (out-of-control), runs (suspicious), trends (suspicious), and periodicity (suspicious). Please refer to the current revision of Katahdin SOP QA-808, Generation and Implementation of Statistical QC Limits and/or Control Charts, for further information.

11.5 Measurement Uncertainty

Once a method is validated through method development and the determination of sensitivity and precision and accuracy, the measurement uncertainty must be determined. There are many aspects of environmental measurements that contribute to the calculated uncertainty of that measurement. These aspects include field sampling, sub-sampling for analysis and the actual analysis. Unless all information is obtained, it is impossible to calculate a true uncertainty of measurement. However, given the individual SOPs, analysts can perform the methods as specified with approximately the same degree of uncertainty. This analytical uncertainty will be expressed as the measurement uncertainty of the LCS/LCSD.

The LCS/LCSD limits must be determined statistically as described in the current revision of Katahdin SOP QA-808, Generation and Implementation of Statistical QC Limits and/or Control Charts, for further information. Until enough data points can be compiled to generate statistical limits, the laboratory must use estimated or nominal limits. These limits must take into consideration other similar methods, method sensitivity, method interferences, method selectivity, analyst error, etc. Department Managers/group supervisors, the IT/Production, the Operations Manager and the Quality Assurance Officer must reach a consensus on what estimated limits to use.

The uncertainty measurement, whether estimated or statistically derived from LCS/LCSD data must be reported to the client when requested. This would include reporting the LCS/LCSD results with the statistical or estimated acceptance limits.

11.6 Utilization of Quality Control Data

The purpose for preparing and analyzing quality control samples is to demonstrate, through the known entities, how accurate and precise the investigative sample data are. QC tables are included within each analytical method SOP summarizing typical quality control assessment criteria for the methods.

These criteria are intended to be guidelines for analysts. The criteria does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in the tables, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in the tables may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations, client and project specific Data Quality Objectives and on review of chromatograms. The Department Managers/Group Supervisors, Operations Manager, Production Manager and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases “qualified” data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in the tables may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems

Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

12.0 STANDARD OPERATING PROCEDURES

12.1 Purpose and General Provisions

Standard Operating Procedures (SOPs) are formal, revision-controlled documents that:

- provide standard methods for execution and documentation of work, to maximize consistency, uniformity and reliability of products;
- establish the basis for similar training of personnel and set a standard for assessment;
- facilitate coordination among individuals performing separate, but interdependent tasks; and
- define, to Katahdin Analytical Services' clients and to regulatory agencies, the methods used by Katahdin Analytical Services in the performance of tasks having an effect on the quality of data, findings or conclusions;

SOPs describe standard methodologies that may at times be inappropriate for a specific project. In such cases, exceptions to the SOPs are stated in the raw data or the analytical narrative with rationale.

Refer to the current revision of Katahdin SOP QA-800, Preparation of SOPs, for further detailed information on SOPs.

12.2 Responsibilities

Department Managers, Group Supervisors and analysts are responsible for determining, through consultation with the Quality Assurance Officer and Management, the activities that require SOPs. Department managers are also responsible for working with the appropriate technical personnel to develop the SOPs.

The Quality Assurance Department is responsible for obtaining technical review and approval of SOPs, for maintaining control of new SOPs and revisions, and for maintaining an up-to-date distribution list for SOPs.

Katahdin Analytical Services personnel are responsible for performing tasks in accordance with applicable SOPs, except as explicitly directed by a relevant Quality Assurance Project Plan, contract, or Health and Safety policy. Katahdin Analytical Services personnel are also responsible for assisting in designing accurate and practical SOPs and in keeping the SOPs up-to-date.

Technical reviewers of SOPs are responsible for providing review of drafts sent to them within the schedule indicated in the request.

12.3 Minimum Contents of SOPs

Each Standard Operating Procedure shall contain at a minimum, the following information:

Title - The name of the concerned task

SOP Number - The internal document control number assigned and tracked by the QA Department

Acceptance - The signature of the originator(s), Quality Assurance Officer and appropriate operations management authority to officially adopt the procedure

Date - Date of issue of most recent revision

Scope and Application - An explanation of the objectives of the procedure, typical applications and limitations

Definitions - A listing of any terms, expressions, or acronyms found in the procedure

Responsibilities - Identification of the individuals (by title or organizational position) and their responsibilities in performing and facilitating the tasks governed by the SOP

Safety Considerations - A discussion of specific Health and Safety issues that must be considered prior to and during the performance of the procedure described.

Pollution Prevention/Waste Disposal - A discussion of waste disposal and minimization procedures applicable to the method.

Summary of Method - A short synopsis of the chemistry involved in the procedure.

Interferences - Any factors that may interfere with the proper performance and/or outcome of a procedure and that could compromise the results.

Apparatus and Materials - A complete list of the equipment, apparatus, etc. needed for the procedure

Reagents - A complete list of the reagents, standard solutions, solvents, etc. needed for the performance of this procedure

Sample Collection, Preservation and Handling - Any special considerations needed to assure the integrity of the sample and, consequently, the analytical process.

Method/Procedure - A clear description of the task on a step-by-step basis. The method description should be written clearly enough, and in sufficient detail, to ensure that any

two persons performing the procedure will achieve equivalent results, and to provide clients and reviewing agencies with a thorough understanding of the procedure. Acceptable and equivalent alternatives should be addressed whenever possible, and described in the same detail. Where applicable to the SOP, the procedure should include a discussion of sample preparation and calibration requirements, a discussion or reference for equipment/instrument maintenance, computer hardware and software and troubleshooting, and a summary of the automated and manual calculations performed as well as reporting requirements, including data flow charts as appropriate. The SOP should address differences between a published method and Katahdin Analytical's performance of that method if any exist.

Quality Control Requirements and Acceptance Criteria and Corrective Actions - An outline of quality control requirements, including, procedures, frequency requirements, and acceptance criteria. Corrective actions include a description of what must be done, when and by whom in instances when the QC requirements are not met. This section may be in the form of a table.

Applicable Documents/References - A listing of pertinent, supporting procedure or reference documents such as methods, manuals and/or SOPs

12.4 SOP Development and Approval

Laboratory SOPs are developed by the laboratory's technical staff, working with the QA Department. The QA Department will also assist by assigning SOP numbers and by coordinating word processing, review and approval. Laboratory SOPs must be reviewed and approved by the management of the laboratory operations to which the SOPs apply. Thus, the following people must review and approve each laboratory SOP:

- the Department Manager of the specific operation to which the SOP pertains - This signature indicates that the written SOP reflects the current practice in the laboratory and that the SOP is technically adequate to handle the analysis of environmental samples expected to be received at Katahdin Analytical Services.

- the Laboratory Operations Manager - This signature signifies a management review and approval of the practices detailed in the SOP.

- the Quality Assurance Officer - This signature indicates that the SOP has been reviewed for compliance with the referenced methods and that discrepancies between the method and practice have been resolved.

12.5 Numbering

Each SOP is assigned a unique Katahdin Analytical Services number from the inventory of Katahdin Analytical Services SOPs maintained by the QA Department.

12.6 Revisions

SOP revisions may be necessitated by regulatory requirements, technological advancements or other causes, but not by the requirements of a single project alone. Contradictions between standard procedures and the requirements of a specific project are resolved in the quality assurance plan for that project.

Revisions may be proposed initially by the Quality Assurance Department or they may be recommended by users. Recommendations for revisions must be sent to the Quality Assurance Department. Revisions must not be made by an individual to only his/her personal copy. Recommendations for minor revisions will be accumulated by QA until sufficient to warrant a document revision.

Recommendations for revisions must be made on a Katahdin "SOP Request For Change" Form (Figure 12-1). All pertinent information must be filled in. Proposed changes must be indicated on the form. Alternatively, revisions can be initiated electronically. Per analyst request, the QA Officer will place an electronic copy of an SOP on the company server for revision. The revisions should be marked so that the changes can be tracked and approved electronically by the QAO or by a member of management.

Server_a\QAQC\QAQC\SOP's in Revision

The QA Officer is authorized to approve minor revisions. Revisions that affect the technical approach or content will also require review and approval of the Operations Manager, Department manager or other technical staff. Once formally accepted, the revised document replaces the previous version and is distributed to controlled copy holders with instructions as to what document(s) it replaces.

Occasionally, revisions are significant enough to warrant a complete rewrite. In such cases, the changes are not listed on the cover page. Instead the words "complete rewrite" are entered and the new document must undergo review and approval as for a new SOP. The judgement as to whether a complete rewrite is required shall be made by the Quality Assurance Officer or qualified technical person.

Technical revisions and complete rewrites will necessitate training recertification for all personnel involved. The QA Department is responsible for distributing Katahdin Retraining Forms and instructions with the SOPs. The QA Officer will ensure that all pertinent personnel are made aware of the significant changes and their effective dates through this retraining documentation. The laboratory group department manager is responsible for ensuring that training is accomplished and documented. The QAO may conduct laboratory audits to ensure that new procedures are being executed properly.

In some situations, changes to a procedure may require immediate implementation in the lab. A formal revision must be initiated by the analyst or department manager as described above. In addition, steps must be taken to document the procedural changes in the interim while the SOP is under revision. These steps include initiating a Katahdin SOP Request for Change. The QAO will distribute controlled copies of this form to all controlled

copy holders of the affected SOP. This form will act as the revision until the formal revision is completed.

Some SOPs may not require revisions if no changes have been made. At a minimum, though, SOPs should be reviewed annually to ensure that no revisions are required. A SOP No Change Form (Figure 12-3) should be filled out. This form must be signed by the Department Manager and the QAO. It is filed with the hardcopy of the SOP. Additionally, the No Change Form should be scanned and attached as an addendum to the Adobe file of the SOP.

If annual review is not possible for all SOPs, then the QA Officer shall prioritize the SOPs for a timely review. An inventory of SOP review dates is maintained by the QAO.

The QAO will determine whether a new training form will need to be initiated for employees. This will be based on whether there are major changes to the SOP. If a new training form is not deemed necessary, training for the revised SOP may be documented on a Katahdin Retraining Form (Figure 12-2). Minor changes will not necessitate the use of either form. It is the department manager's responsibility to assure that the proper training forms are completed.

12.7 Document Control and Distribution

SOPs must reflect current operating conditions and be compliant with applicable method and program requirements. To meet these needs, all Katahdin Analytical Services SOPs and SOP revisions used within the laboratory must be controlled documents that are administered by the QA Department. Each page of a controlled copy is marked as such in contrasting ink (typically red or blue) to prevent the use of un-controlled photocopies. The QA Department maintains an inventory of all SOPs developed by the laboratory and their revision status.

The QA Department distributes SOPs to technical staff as required, maintains distribution lists to ensure that revisions and new SOPs are distributed to all appropriate individuals, periodically verifies that SOPs in use in the lab are current, controlled copies and ensures that obsolete versions are removed from use and destroyed. A Receipt Acknowledgment Form is completed for each SOP for tracking and distributing updates of the documents. Refer to Katahdin Analytical Services SOP QA-804, Document Control for Standard Operating Procedures.

12.8 SOP Archive

An archive of all laboratory SOPs, in the form of both hard-copy (Title Page only) and electronic masters of current revisions, is maintained by the Quality Assurance Department within Katahdin Analytical Services. The archive also contains a hard-copy master of all obsolete versions of each revised SOP.

SOPs are distributed from the archive. Access to originals is obtained through QA personnel.

FIGURE 12-1

SOP REQUEST FOR CHANGE FORM

KATAHDIN ANALYTICAL SERVICES, INC.
QAM/SOP REQUEST FOR CHANGE FORM

Name of Person Requesting Change:	**Date:**
SOP Number & Title:	
Reason for Change:	
Complete and Concise Description of Change (may include attachments):	
Effective Date of Change:	
Department Manager Signature:	
Operations Manager Signature:	
QAO Signature:	

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FIGURE 12-2

KATAHDIN RETRAINING FORM

KATAHDIN ANALYTICAL SERVICES RETRAINING FORM

RETRAINING FORM #

PART 1 – RETRAINING

TRAINER: _____

TRAINEE: _____

PROCEDURE:

REFERENCES: Please review the following:

QA MANUAL: _____

SOP: _____

PUBLISHED METHOD: _____

OTHER: _____

REASON FOR RETRAINING:

REFRESHER: _____

NON-CONFORMANCE: _____

PROCEDURAL MODIFICATIONS: _____

OTHER: _____

TRAINER SIGNATURE: _____ **DATE:** _____

TRAINER SIGNATURE: _____ **DATE:** _____

TRAINEE SIGNATURE: _____ **DATE:** _____

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FIGURE 12-2, CONT'D

KATAHDIN RETRAINING FORM

KATAHDIN ANALYTICAL SERVICES RETRAINING FORM

RETRAINING FORM #

PART 2 – QAO OBSERVATION OF RETRAINING

COMMENTS:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

QAO SIGNATURE:_____**DATE:**_____

FIGURE 12-3

SOP NO CHANGE FORM

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP:

Review Date:

SOP Number:

SOP Title:

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: _____ **Date:** _____

QAO Signature: _____ **Date:** _____

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13.0 PERFORMANCE AND SYSTEM AUDITS

Katahdin Analytical Services participates in a variety of interlaboratory and intralaboratory tests and performance checks to provide periodic assessment of the effectiveness of the overall quality control program. Refer to the current revision of Katahdin SOP, QA-803, Laboratory QA: Self Inspection System, for more detailed information.

Proficiency Test samples (PTs) are analyzed periodically to verify method accuracy. These PT samples may be external (e.g., WP, WS, S&HW, air, and food microbiology) or internal (prepared or purchased by the QAO). External Proficiency Test samples are received and analyzed twice per year for each of the following studies: Water Pollution (WP), Water Supply (WS) and Solid & Hazardous Waste (S&HW), and Air. External Proficiency Test samples are received and analyzed once per year for food microbiology. PT samples are ordered and analyzed for all NELAC required parameters and/or as required by individual state or federal regulations (State of Maine, DoD, ISO, etc). The QAO retains information regarding required PTs. External PT samples are also analyzed routinely for a number of state and federal program certifications. Internal PT samples are prepared by the laboratory QAO on a case by case basis. The samples may be identified as PT samples or they may be "blind", i.e., disguised as client samples.

13.1 Interlaboratory Performance Surveys – (including, but not limited to)

- Proficiency Test (PT) Samples - Water Supply - Semiannual
    - Trace Metals
    - Nitrate/Nitrite/Fluoride/Chloride/Sulfate/ortho-phosphate
    - Volatile Organics – Regulated, Unregulated & Trihalomethanes
    - EDB/DBCP
    - Turbidity
    - Total Dissolved Solids
    - Calcium (as $CaCO_3$)
    - pH
    - Alkalinity
    - Sodium
    - Conductivity
    - Total Cyanide
    - Total Organic Carbon
    - Uranium
    - Perchlorate
    - Total Coliform, e-coli and HPC
- Proficiency Test (PT) Samples - Water Pollution - Semiannual
    - Trace Metals
    - Minerals
    - Nutrients
    - Demand
    - PCBs
    - Pesticides

- Herbicides
- Volatile Halocarbons & Volatile Aromatics
- Semivolatile Organics and Low-Level PAH's
- Total Cyanide
- Solids
- Oil and Grease
- Total Phenolics
- Hexavalent Chromium
- Explosives
- DRO/GRO
- Nitrite
- Specific Conductance
- TPH
- Surfactants
- EPH/VPH
- pH
- Total Alkalinity
- Sulfide
- Turbidity
- Color
- Total Residual Chlorine
- Acidity
- Fecal Coliform and e-coli

- Proficiency Test (PT) Samples – Solid & Hazardous Waste (solids) - Semiannual

  - Metals
  - PCBs
  - Pesticides
  - Herbicides
  - Volatile Halocarbons & Volatile Aromatics & Medium Level Volatiles
  - Semivolatile Organics & Low-Level PAH's
  - Total Cyanide
  - Hexavalent Chromium
  - Explosives
  - TCLP
  - pH/corrosivity
  - DRO/GRO
  - Oil and Grease
  - Anions
  - Nutrients

- Proficiency Test (PT) Samples – Air - Semiannual

  - Volatile Organics

- Proficiency Test (PT) Samples – Microbiology (food) - Annual

    * E-coli
    * Total coliform
    * Salmonella
    * Listeria
    * Yeast & Mold
    * Staphylococcus
    * Aerobic Plate Count

PT requirements may differ from state to state or for different regulations. Generally, all states and regulations require at least one study per year. NELAC and DoD require two studies, so Katahdin participates in this more stringent program. Less stringent state requirements are filed with individual state files in the QA office.

To obtain initial certification for a parameter, in accordance with NELAC and DoD, the laboratory must successfully analyze two sets of PT studies, the analyses to be performed at least 15 calendar days apart from the closing date of one study to the shipment date of another study for the same field of proficiency testing. To maintain continuing certification for a parameter, in accordance with NELAC and DoD, the laboratory must successfully analyze two out of the last three sets of PT studies, the analyses to be performed with completion dates of successive proficiency rounds for a given field of proficiency testing being approximately six months apart. Failure to meet the semiannual schedule is regarded as a failed study.

For analyte groups, i.e. purgeable organics, the laboratory must perform acceptably for 80% of the analytes in the analyte group PT study. If the laboratory does not perform acceptably for at least 80% of the analytes, then the entire analyte group will be scored as unacceptable. An unacceptable PT score for two out of the last three studies for any analyte will result in a failure for that analyte.

Performance on PT samples is communicated to the appropriate laboratory staff. Any analytes demonstrating unacceptable results (i.e., falling outside the sponsoring agency's acceptance limits) require a thorough investigation of the associated analytical data, including quality control data. Causes for error are identified, if possible, and corrective measures are implemented for those parameters reported unacceptably. The laboratory QAO maintains copies of all PT results and corrective action plans in the QA files. These records are reviewed by the QAO and communicated (by memo or photocopy) to Department Managers, Group Supervisors, the IT/Production Manager, the Operations Manager as appropriate prior to analysis of subsequent PT samples. PT results are sent directly by the PT provider to the pertinent accreditation authorities (as identified by the laboratory when PT results are submitted back to the provider). PT records and corrective action files are made available to any other accreditation authority or client upon request.

If a laboratory fails two out of the three most recent environmental PT studies for a given field of proficiency testing, its performance is considered unacceptable and the laboratory must then meet the requirements of initial acceptability for the fields of testing before analyzing any further applicable samples.

13.2 Periodic Internal Audits

Internal auditing is conducted by the QA Department or designee on an annual basis. Internal audits take two forms – Technical Audits and Systems Audits. Technical Audits verify the laboratory's compliance with method specific requirements. Systems audits verify the laboratories compliance with this Manual, SOPs and that adequate documentation exists to satisfy the project requirements. Both types of audits are also designed to assess laboratory compliance with certification and regulatory requirements such as those for NELAC and the DoD.

Audit checklists may be used to ensure that all salient points are addressed and documented. The checklists are filled out legibly and reproducibly, in ink, by the auditor, and are signed and dated by the auditor when completed. The audit checklist is based on EPA laboratory evaluation criteria, the provisions of the Laboratory Quality Assurance Manual and Katahdin Analytical Services SOPs. Project audit checklists are drawn from the applicable QAPPs, as well as relevant provisions of the QA Manual.

13.2.1 Technical Audits

Technical Audits address the laboratories compliance with method specific requirements.

Technical Audit Procedures

Technical audits are performed by the QA Department or their designee. The audit should cover the following areas:

* Method Standard Operating Procedures
* Initial and continuing calibration procedures, including independent calibration verification.
* Demonstration of Capability
* Method Quality Control Samples – Method Blanks, Laboratory Control Spikes, Matrix Spikes, Sample Duplicates.
* Surrogates and Internal Standards
* Method Detection Limit determination.
* Corrective Action Procedure

13.2.2 Systems Audits

System audits address general laboratory operations and conformance to the Laboratory Quality Assurance Manual. System audits of laboratory operations are performed at a minimum frequency of once per year per laboratory group (i.e. wet chemistry, metals, organic extractions, GC, GC/MS). These system audits may be performed in conjunction with an outside system audit (i.e. the QAO will accompany the outside auditor and record any findings as appropriate).

Systems Audit Procedures

Systems audits are performed by the QA Department. The audit should cover the following areas:

- Personnel qualifications and training records
- Adequacy of laboratory facilities, including work space, lighting, ventilation, and supplies
- Maintenance and calibration recordkeeping for analytical equipment
- General operations, including glassware cleaning, inventory and checking of reagents and standards, and storage procedures
- Recordkeeping, including sample log-in and tracking, traceability of standards, control charts, and raw data recording and tracking.
- Corrective Action follow through from past audits

13.2.3 Internal Performance Evaluations:

Performance audits involve submittal of blind spikes to the laboratory by the Quality Assurance Department for assessment of analytical accuracy. Due to the high number of Performance Evaluation studies that Katahdin Analytical Services participates in, the Quality Assurance Department does not routinely conduct internal performance audits. However, the Quality Assurance Department may provide internal performance standards if required on specific projects or warranted by the laboratory. Performance standards may be purchased as whole sample volumes or prepared in the laboratory.

13.2.4 Project Audits:

Some quality assurance project plans, QAPPs, may require project-specific laboratory Projects Audits.

13.2.5 Audit Reports & Follow-Up

The QAO will prepare internal audit reports, within approximately 30 days of the audit, summarizing any findings and required corrective actions. Reports are disseminated to the Department Managers/Group Supervisors, the IT/Production Manager, the Operations Manager, and the Katahdin President. The appropriate managers are responsible for immediately investigating the finding. The root cause of the finding shall be determined and the impact of the finding on a released data shall be determined. The appropriate managers are responsible for immediately notifying the Katahdin Project Manager of any data issues so that the client(s) can be contacted. Managers must submit a response to the findings, including corrective actions plans, root cause analysis and implementation dates to the QAO within 21 days of receiving the summary of findings. The QAO will review the responses and determine if the corrective actions and implementation dates are adequate.

Once the responses are accepted, the QAO shall communicate any changes in procedure or other corrective action plans to all appropriate personnel. Any additional training shall be documented on a Katahdin Retraining Form. The non-conformance, the correct procedure and the reference for the requirement shall be indicated on the form. Each employee receiving the training shall sign the form. A copy of the form will become part of the employee's training records.

It is the responsibility of section department managers to ensure that all corrective actions documented on the retraining forms are implemented. Any problems should be communicated to the QAO or Operations Manager. The QAO or Operations Manager shall conduct follow up audit inspections to ensure that corrective actions are implemented. This is documented on part 2 of the Katahdin Retraining Form. All Katahdin Retraining Forms shall be numbered systematically and a record kept with dates of closure. Closure is indicated by a QAO follow-up audit.

If an event is discovered which casts doubt on the validity of any test results, an internal investigation will be initiated within 24 hours of the discovery. If it is determined the validity of the test results is uncertain, the client shall be notified within 24 business hours of the conclusion of the investigation.

13.3 External Audits

In addition to internally conducted systems audits, the laboratory is regularly audited by clients, potential clients, state and federal program regulators, and other organizations. These audits may be specific to program or project requirements, encompass a complete review of laboratory systems, or both.

External audits usually begin with an opening meeting in which the audit team states the purpose of the audit and how the audit will be conducted. The laboratory may have auditors sign a Confidentiality Agreement to protect its clients and business. All records and documentation will be made available on-site for the audit team to review as required and necessary. Auditors will tour the laboratory and interview analysts to assess the lab's compliance with the requirements. A closing meeting is usually held at the end of the audit to summarize the audit findings and to discuss a timeframe for receipt and response to the audit.

Katahdin Analytical Services uses these external audits to additionally evaluate laboratory function and performance. The QA Department distributes audit reports to department managers and management, coordinates corrective actions to any findings, formalizes and documents the responses required, and may use external audit findings as the basis for future internal audits.

13.4 QA Reporting and Corrective Action

Each systems audit (internal or external) may be followed by a debriefing, in which the auditor discusses his/her findings with the laboratory representatives. The debriefing serves a two-fold purpose. First, laboratory management is afforded an early summary of findings, which allows them to begin formulating corrective actions, and second, the auditor has a chance to test preliminary conclusions and to correct any misconceptions before drafting his/her report.

The systems audit report (which may or may not contain performance audit findings) is issued to the Operations Manager, the IT/Production Manager and the appropriate Department Managers/Group Supervisors and personnel for corrective action. Responses to the findings are forwarded, in writing, to the QA Officer. The QAO then circulates the report to Katahdin President.

14.0 PREVENTIVE MAINTENANCE

The laboratory is equipped with all equipment needed for analysis and support activities. All equipment is maintained in working condition through a schedule of preventive maintenance and/or outside service contracts or appointments as needed. All maintenance, including internal maintenance and outside service calls, is documented. Any out-of-service equipment is marked as such until it can be repaired and shown by calibration or testing to perform correctly. In cases where outside equipment is rented or borrowed, any records necessary to demonstrate equipment calibration or maintenance will be requested from the provider.

To minimize downtime and interruption of analytical work, preventive maintenance is routinely performed on each analytical instrument. Designated laboratory personnel are trained in routine maintenance procedures for all major instrumentation. When repairs are necessary, they are performed by either trained staff or instrument manufacturer service personnel.

All equipment must be maintained so that its performance is acceptable for its intended use. For example, an instrument that does not have sufficient sensitivity should not be used for low-level analysis or a balance not verified above 100 grams should not be used to weigh items over 100 grams.

SOPs are written for each instrument that cover basic operation and maintenance procedures. Refer to Katahdin Analytical Services SOPs CA-101, Equipment Maintenance, and CA-102, Balance Calibration for further information. Detailed logbooks documenting preventive maintenance, non-routine maintenance and repairs are also maintained for each instrument. Logbook requirements are detailed in SOP CA-101. The following are brief summaries of maintenance for each major instrument.

14.1 Preventive Maintenance - **GC/MS Instrumentation**

Regularly performed maintenance includes, but is not limited to, the following:

- Check to ensure the pressure on the primary regulator never runs below 100 psi
- Check to ensure the gas supply is sufficient for the day's activity, and delivery pressures are set as described in the SOP.
- Change septa weekly or as needed.
- Replace/cut GC column as needed.
- Replace GC injector glass liner weekly or as needed.
- Replace glass jet splitter as needed.
- Replace pump oil as needed.
- Change gas line dryers as needed.
- Replace electron multiplier as needed.

14.2 Preventive Maintenance – **GC Instrumentation**

Regularly performed maintenance includes, but is not limited to, the following:

- Check to ensure the pressure on the primary regulator never runs below 100 psi.
- Check to ensure the gas supply is sufficient for the day's activity, and delivery pressures are set as described in the SOP.
- Change septa weekly or as needed.
- Replace/cut GC column as needed.
- Replace GC injector glass liner as needed.
- Change O_2/moisture traps as needed
- Clean/replace GC detector as needed.

14.3 Preventive Maintenance – **Purge and Trap Sample Concentrator**

Regularly performed maintenance includes, but is not limited to, the following:

- Check to ensure the gas supply is sufficient for the day's activity and delivery pressures are set as described in the SOP.
- Replace trap as needed.
- Decontaminate the system after running high concentration samples or as required by blank analysis.
- Check system for leaks when problem suspected.

14.4 Preventive Maintenance – **Archons**

Regularly performed maintenance includes, but is not limited to, the following:

- Visually inspect sampler for corrosion or significant water seepage past plunger.
- Check system pressure (denotes leaks).
- Check for sufficient standard materials in standard vials.
- Recalibrate x,y,z component, i.e. robotic arm, as needed.

14.5 Preventive Maintenance – **ICP Instrumentation**

Regularly performed maintenance includes, but is not limited to, the following:

- Clean torch assembly and spray chamber when discolored.
- Clean nebulizer as needed.
- Check to ensure that the argon supply is sufficient for the day's activity, and that delivery pressures are set as described in the SOP. Change argon tanks as necessary.
- Replace peristaltic pump tubing when it becomes stretched or develops flat spots.
- Check coolant water level weekly; replenish as necessary.
- Check rinse solution level daily; replenish as necessary.
- Check waste container level daily; empty as necessary.
- Check instrument computer date and time at the start of each day; correct as necessary.

14.6 Preventive Maintenance – **Mercury Analyzer**

Regularly performed maintenance includes, but is not limited to, the following:

- Replace drying tube as necessary
- Replace peristaltic pump tubing when it becomes stretched or develops flat spots.
- Replace mercury lamp as necessary.
- Clean optical cell quarterly or as needed.
- Clean liquid/gas separator when it becomes cloudy. Replace as needed.
- Check waste container level before each use; empty as necessary.
- Check exhaust system integrity before each use; correct as necessary.
- Check instrument computer date and time at the start of each day; correct as necessary.

14.7 Preventive Maintenance – **Lachat Autoanalyzer**

Regularly performed maintenance includes, but is not limited to, the following:

- Check pump tubing; replace as needed.
- Clean interference filter with Kimwipe.
- Check reagent levels and expiration dates; refill or replace as needed.

- Rinse manifolds with water after analysis.
- Check manifold board surfaces; clean as needed by running under tap water.
- Check supplies and reagents; order as needed
- Check for leaks
- Check autosampler and autosampler trays; clean and/or lubricate as needed.
- Check fittings and o-rings on boards; replace as needed.
- Check peristaltic pump rollers; clean and lubricate as needed.
- Inspect manifold tubing for kinks and/or stains; replace as needed.
- Inspect valve flares; clean or replace as needed.
- Inspect reagent and waste lines; replace as needed.
- Check flow cell; clean as needed with Kimwipe.

14.8 Preventive Maintenance - **General Laboratory Areas**

- Clean and calibrate balances annually (minimum).
- Check balance calibration each day of use.
- Clean balance pan prior to each use.
- Calibrate automatic pipettes with each use.
- Calibrate spirit thermometers yearly against an NIST traceable thermometer; calibrate digital thermometers quarterly.
- Record refrigerator, freezer, and oven temperatures each weekday.
- Clean, check, calibrate to manufacturers' specifications all pH, DO, conductivity, and Turbidity meters annually (minimum); clean, check, calibrate to manufacturers' specifications all spectrophotometers annually.
- General housekeeping: keep counter tops, hoods, and floors clean.
- Check airflow in hoods once a week.

14.9 Preventive Maintenance – **Konelab AutoAnalyzer**

Regularly performed maintenance includes, but is not limited to, the following:

- Rinse and refill distilled water container weekly.
- Check cleanness of segments weekly.
- Wash reagent tubes monthly.
- Change lamp as needed.
- Change dilutent and wash tubes as needed.
- Change mixing paddles as needed.
- Change syringes as needed.
- Change dispensing needles as needed.
- Change drain and waste tubes as needed.
- Check used cuvettes and waste daily.

14.10 Preventive Maintenance – **Accelerated Solvent Extractor (ASE)**

Regularly performed maintenance includes, but is not limited to, the following:

- Check for leaks at the pump solvent reservoir, valves and other components.
- Inspect needle alignment of source needle.
- Check alignment of autoseal arms.
- Change peek seals and o-rings on cell caps after about 50 extractions per cell.
- Inspect cell edges for nicks and gouges on cell body.
- Inspect stainless steel frits and sonicate in solvent if needed.

14.11 Preventive Maintenance – **ICP/MS Instrumentation**

Regularly performed maintenance includes, but is not limited to, the following:

- Clean torch assembly and spray chamber when discolored.
- Clean nebulizer as needed.

- Check to ensure that the argon supply is sufficient for the day's activity, and that delivery pressures are set as described in the SOP. Change argon tanks as necessary.
- Replace peristaltic pump tubing when it becomes stretched or develops flat spots.
- Check coolant water level weekly; replenish as necessary.
- Check rinse solution level daily; replenish as necessary.
- Check waste container level daily; empty as necessary.
- Check cleanliness of instrument air filters weekly; clean or replace as necessary.
- Check instrument computer date and time at the start of each day; correct as necessary.

14.12 Preventive Maintenance - **Horizon SPE Automated Extractor System**

Regularly performed maintenance includes, but is not limited to, the following:

- Check and clean sensors with a KIMWipe.
- Change sensors as needed.
- Purge system with solvent before use and after use.
- Clean system with hot water by running method 15 after samples are analyzed and before purging system.

14.13 Preventive Maintenance – **HPLC Instrumentation**

Regularly performed maintenance includes, but is not limited to, the following:

- Check and sonicate pump valves as needed.
- Backflush column as needed.
- Replace analytical column or guard column as needed.
- Sonicate and replace solvent with every use.
- Replace the UV lamp as needed.
- Check and replace seal-pak as needed

14.14 Preventive Maintenance – **GPC Instrumentation**

Regularly performed maintenance includes, but is not limited to, the following:

- Fill solvent reservoir as needed.
- Empty waste container as needed.

14.15 Preventive Maintenance - **TOC Combustion Analyzer**

Regularly performed maintenance includes, but is not limited to, the following:

- Check level of dilution water, drain vessel water, humidifier water, autosampler rinse water, and phosphoric acid vessel and fill as needed.
- Replace oxygen cylinder as needed.

14.16 Preventive Maintenance – **IC Instrumentation**

Regularly performed maintenance includes, but is not limited to, the following:

- Check regenerate pump tubing and replace as needed.
- Clean or regenerate column as needed.
- Replace analytical column or guard column as needed.
- Change suppressor as needed.

14.17 Preventive Maintenance - **Miscellaneous Instrumentation (including field testing equipment)**

Regularly performed maintenance includes, but is not limited to, the following:

- Replace spectrophotometer lamps as needed.
- Inspect DO probe membrane for tears and check for air bubbles under the membrane.
- Replace the DO probe membrane cap and electrolyte solution as needed.
- Clean pH electrode as needed.
- Change the autotitrator filling solution as needed.
- Clean, check, calibrate to manufacturers' specifications all pH, DO, conductivity, and turbidity meters annually (minimum); clean, check, calibrate to manufacturers' specifications all spectrophotometers and balances annually. All calibrations must be NIST traceable.

14.18 Preventive Maintenance - **Milestone Ethos EX Microwave Extraction System**

Regularly performed maintenance includes, but is not limited to, the following:

- Reshape caps after each use.
- Check probe vessel for cracks.
- Check seals for disfigurement. Replace as necessary.
- When vessels are dirty, run through methylene chloride cycle.

14.19 Unscheduled Maintenance & Troubleshooting

In addition to preventive maintenance, analysts are often required to perform unscheduled maintenance due to sporadic instrument problems. The instrument problems could be obvious, such as those cause by “nasty” samples, or not so obvious. The problem could be more mechanical, such as an autosampler jamming or a needle clogging, or the problems could be more technical such as failing QC for no apparent reason. In all cases, analysts shall proceed through a series of troubleshooting steps to investigate the problem. Analysts should consult the manufacturer’s guidelines for troubleshooting certain equipment problems. Changing only one parameter and/or part at a time is critical to ascertain which change may improve or correct a problem.

All troubleshooting steps and outcomes must be recorded in the applicable instrument maintenance logbook for future reference and guidance. The steps taken, which correct the problem should be noted as such. If it is determined that a problem with the equipment exists, and that the problem has had an impact on the quality of past completed data, an immediate Corrective Action Report (CAR) must be initiated. A thorough investigation of all impacted data must be completed and corrective action must be implemented. Refer to the current revision of Katahdin SOP, QA-803, Laboratory Quality Assurance Self Inspection System, for further details.

14.20 Service Contracts

Katahdin will maintain service contracts for major instrumentation as needed. The need for a service contract will depend on factors such as the cost, the estimated down time, the availability of back-up instrumentation, and the availability of skilled analysts to perform non-routine maintenance. The decision to purchase a service contract is made by the management team of the President, the Operations Manager, the IT/Production Manager and the Department Managers.

In cases where a service contract is not in place, and a problem with an instrument or piece of support equipment cannot be corrected in-house, Katahdin will use reputable service companies to perform the repair and/or troubleshooting work. Relationships are maintained with several companies to perform these services.

Occasionally, equipment may need to be sent out to the service company for repair. All equipment must be packaged in large enough boxes to leave room for at least four inches of bubble wrap on every side, including the top and bottom. Any small movable parts must be removed and wrapped separately. When available, a manufacturer’s box with appropriate

Styrofoam inserts should be used. All equipment returning to the laboratory must be checked and recalibrated to be sure all instrument capabilities and conditions have been maintained.

A preventive maintenance contract is in place for all support equipment and thermometers for cleaning, calibrating to manufacturer's specifications and verifying against NIST traceable sources. The support equipment includes all pH meters, conductivity meters, turbidity meters, balances, spectrophotometers, autoclaves, ovens, and incubators. Field equipment meters are included in this annual verification. All equipment supported under this contract are labeled by the outside calibration company with the last calibration date, and when the next calibration is due. All additional comments of the outside calibration are maintained in files with the QA Officer.

Records of all service contract visits, third party services and preventive maintenance services are maintained to document support equipment performance. All equipment not meeting manufacturer's specifications or those required by the test are removed from service until appropriate corrective actions can be taken.

15.0 NON-CONFORMANCE & CORRECTIVE ACTION

When problems are identified, whether at the bench level before results have been issued, or at some point after the results have been issued, certain steps must be taken to ensure the consistent control of non-conforming work or test results. Investigation of the non-conformances must be initiated by the affected Department Manager/Group Supervisor, the IT/Production Manager, the Operations Manager and/or the Quality Assurance Officer. When corrective action can be taken without affecting the data quality, immediate action must be taken to implement the corrective action. After reviewing the impact to data quality, if it is determined that the quality will be impacted (i.e. missed hold time, failing QC), the client must be contacted for consultation. All joint decisions must be documented and/or narrated as appropriate. If results have been sent or are ready to be sent when a non-conformance is discovered, the affected clients must also be notified, and any reports held or resubmitted as appropriate. If the cause of a problem cannot be immediately identified, and the probability of other work being affected exists, the QAO has the authority to halt work until the non-conformance can be corrected.

For most laboratory situations, problem identification, corrective action, and resumption of operation and/or return to control occurs at the bench, with documentation written directly in the appropriate logbooks. These occurrences include events where laboratory quality control criteria have been exceeded but which can be corrected without compromising the analytical results or delaying the preparation or analytical process.

For other situations, non-conformances may affect data quality and will require client notification. These situations may involve narration of data, re-analysis and/or re-preparation, or flagging of data. Non-conformances that must be documented on a Non-Conformance Report (NCR) (Forms QA-006, QA-007, and QA-008) (Figure 15-1) include, but are not limited to the following:

1. **When Quality Control criteria are not met** - These QC criteria include, but are not limited to, blanks, LCSs, surrogates, spikes, ICVs/CCVs. CARs do not necessarily have to be initiated in each case, especially if data is rejected, but the corrective action should be documented on the raw data, logbook or other analyst records.

2. **When laboratory SOPs are not followed** - This includes all aspects of laboratory operations from receipt to reporting. If SOPs are in the draft format, or if they are not written, it should be understood that lab operations will proceed at the direction of your department manager or Operations Manager, rather than what may be written down (since this is in draft form and may not be adequate information). For this reason, communication is vital.

3. **When we do not meet client expectations** - Some aspects of this may be narrated, Other aspects will come in the form of client complaints.

The underlying purpose of this process is to identify instances that may adversely affect the data. This process may also help to:

1. **To help standardize the laboratory's procedure for handling events that require corrective action** - Every situation should be evaluated individually, but there are some basic guidelines that should be followed.

2. **To record actions taken when SOPs are not followed so that the data produced is supported with a documented sequence of events.**

3. **To document occurrences in the lab that may affect the integrity of laboratory records.**

4. **To provide a learning tool for individuals involved in the problem investigation and corrective action plan.**

5. **To provide a means for tracking recurring problems that may need further investigation into the root cause of the problem.**

15.1 Problem Identification

15.1.1 Laboratory Identification

The analyst generating the data is responsible for reviewing all results against the established limits. Any deviations are immediately evaluated as potential out-of-control events. Specific examples of some out-of-control events may be: LCS failures, blank contamination, poor precision, prep errors, missed holding times, login errors, calibration failures, retention time window problems, matrix spike failures and surrogate failures. The review process may include the application of statistics. Please refer to the current revision of Katahdin SOP SD-904, Data Reduction and Validation. If data are outside accepted limits, the analyst should review and evaluate the data and all associated Quality Control elements together before making a decision as to the acceptability of the data. Each individual method SOP contains corrective action tables to help guide analysts in making these decisions. Once all QC items have been considered, the analyst should immediately take the appropriate actions including documenting the problem on an NCR (Figure 15-1).

15.1.2 Client Complaints

In the event that problems are not evident or identified prior to reaching the client, the Katahdin Project Manager would receive notification. All conversations must be recorded in the project manager phone log. Events that would require non-conformance reports are: inaccurate reports, incomplete reports or that the client is requesting additional information. At Katahdin, such inquiries are handled as client “complaints”. The Project Manager shall obtain all of the pertinent information from the client. When the client “complaint” concerns a data quality issue, especially one that may impact the usability of data, the Operations Manager, President, or the QAO **must** be informed. They will help to determine what corrective action, if any, should be taken. All reissued reports must be accompanied by a CAR, which documents the problem and ultimate resolution.

If a complaint or other event raises doubt concerning the laboratory’s compliance with its policies, or otherwise concerning the quality of the data, the QAO,

President, or Operations Manager shall ensure that the areas involved are promptly reviewed and/or audited to determine the appropriate course of action.

15.2 Corrective Action

In the event that the analyst is unable to achieve return to control of a non-conformance, he/she notifies their department manager. If the department manager and analyst are unable to achieve return to control, the department manager shall notify the IT/Production Manager, the Operations Manager and the Quality Assurance Officer. The IT/Production Manager, the Operations Manager and technical team are responsible for identifying the source of the problem and achieving return to control. The QAO has the authority to halt the affected work until a non-conformance is corrected. Completion of corrective action is evidenced by the documented return of control of the measurement, evidenced by data within acceptable criteria as prescribed by the manufacturer, SOP or policy.

When evaluation of non-conforming work indicates that a problem has not been corrected, that a problem could recur, or has recurred, or if there is concern that a major problem or potential problem exists in the laboratory, a Corrective Action Report (CAR) (Form QA-009)(Figure 15-2) must be initiated. The CAR will document the issue and the investigation to attempt to determine the root cause(s) of the problem.

15.2.1 Root Cause Analysis

Root cause analysis requires an investigation into the possible causes of the problem. Katahdin uses the six “M’s” to investigate the possible causes. They are: Machine, Method, Materials, Maintenance, Man and Mother Nature. These categories will lead the investigation to consider such causes as malfunctioning instrumentation, inadequate instrumentation, inadequate training, inadequate processes, or laboratory accidents. All possibilities should be considered. Once a root cause(s) has been determined, a plan for corrective action must be determined.

15.2.2 Corrective Action

Corrective actions must be well thought out and take into consideration long-term actions to reduce or eliminate the chance of recurrence. Corrective actions shall identify needed improvements or additional training. In all cases the corrective actions must be appropriate to the magnitude and the risk of the problem. Narration may be appropriate in many cases, but more involved non-conformances may require halting of work, resampling, modification of the method, etc.

CARs are initiated on the company server. The Operations Manager, QA Officer, the IT/Production Manager and the Department Managers have access to this system. If an employee wishes to initiate a CAR, they may take the request to the appropriate manager. The CARs are pre-numbered for tracking purposes.

15.2.3 Monitoring of Corrective Action

All corrective action reports must be reviewed by the appropriate management personnel (i.e. IT/Production Manager, Operations Manager and department manager) and by the QAO. Consistency and compliance with Katahdin policies and the effectiveness of the corrective actions must be reviewed.

The QAO shall approve or reject corrective action reports and/or may require additional corrective actions. The QAO will follow up at a reasonable time to determine whether the process has returned to control or whether further monitoring or additional corrective action is needed. The CAR shall indicate this and any further actions needed. A new CAR may be generated at this time with further corrective actions. This should be noted so that there is a traceablility of the related CARs.

All documentation associated with the CAR, i.e. raw data or reissued reports shall be filed with the associated samples. A copy of the CAR shall also be filed with the samples. The original CAR shall be filed in the QAO's office.

15.2.4 Preventive Action

Preventive action is a pro-active process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints. Preventive action will identify and attempt to correct a problem before it occurs. Some examples of tools used to identify potential preventive actions are control charts and internal audits. Any employee may initiate a Preventive Action Form, QA-010, with suggestions for an improvement to a process, method, system, etc. in order to avoid potential non-conformances. The form shall be reviewed by the affected managers and implemented if deemed appropriate. Once initiated, QA follow-up is necessary to document the effectiveness of the actions.

Refer to the current revision of Katahdin SOP QA-803, Laboratory QA: Self-Inspection System for further details on non-conformance and corrective action practices.

FIGURE 15-1

KATAHDIN ANALYTICAL SERVICES, INC. NON-CONFORMANCE REPORT

KATAHDIN ANALYTICAL SERVICES, INC. – ORGANICS NON-CONFORMANCE REPORT

Problem Identification (Person discovering problem) Name:				Date:	
Affected Method:					
☐ LCS Failure ☐ Blank Contamination ☐ Poor Precision (RPD) ☐ Sample out of clock ☐ Retention Time Window	☐ Prep Error ☐ Hold Time Missed ☐ Surrogate Failure ☐ Tune Failure ☐ Lab Accident	☐ ICAL Failure ☐ Independent Std Failure ☐ CV Failure ☐ Matrix Spike Failure ☐ Spiking Error	☐ Discrepancy between results ☐ Chromatographic Interference ☐ Internal Standard Failure ☐ Sample Contamination ☐ Other		
Details:					
Work Orders/Samples Affected →					
Client					
Requirements and/or Procedures Not Met: Project QAPP(Q) / Method(M) / SOP(S) / DoD QSM(D) / Client (C) / Other:					
Significance of Non-Conforming Work:	---	---	---	---	---
Corrective Action can be taken within holding time					
Corrective Action cannot be taken within holding time					
Non-Conformance not related to holding time					
Approval of Significance (Dept. Mgr., Ops. Mgr. or QAO) – Initials & Date					
Client Contacted: PM initials & Date					
Corrective Action:	---	---	---	---	---
Reanalyze with compliant QC					
Re-Extract/Re-Prep					
Report non-compliance w/Cover Letter/Narrative and/or flagging					
Date Corrective Action Completed					
By Whom?					
Re-analysis or Re-extraction results indicate?					
Approval of Corrective Action (Dept. Mgr., Ops. Mgr. or QAO) – Initials & Date					
Is Further Corrective Action including root cause analysis warranted (i.e.recurring problems)?					
By Whom?				Date:	

Form QA-007 Revision 1 – 9/22/09

FIGURE 15-2

KATAHDIN ANALYTICAL SERVICES, INC. CORRECTIVE ACTION REPORT

CAR####

Page **1** of **3**

KATAHDIN ANALYTICAL SERVICES, LLC. – CORRECTIVE ACTION REPORT

Problem Identification (Person initiating CAR) Name:		Date:
☐ Discovered by Laboratory	☐ Discovered by Client (Complaint)	☐ Other
Details of Problem:		

Associated Non-Conformances: List logbook and page numbers

Root Cause Investigation & Determination (To be completed by Department Manager, Operations Manager and/or QA Officer)	
Review the 6 "M's" below and investigate to determine whether one of them, or more than one, could be the cause of the problem.	
Possible Causes	Details
Machine (Instrument)	
Method (or Process)	
Materials	
Maintenance (Is something not working correctly?)	
Man (training, human error)	
Mother Nature (accidents, power issues, beyond our control)	

FIGURE 15-2, CONT'D

KATAHDIN ANALYTICAL SERVICES, INC. CORRECTIVE ACTION REPORT

CAR####

Page **2** of **3**

KATAHDIN ANALYTICAL SERVICES, LLC. – CORRECTIVE ACTION REPORT

Corrective Action Plan: Name:	Date:
Details of Corrective Action Plan –	

Review & Approval of Corrective Action Plan	
Supervisor Approval:	Date:
Operations Manager Approval:	Date:
Quality Assurance Officer:	Date:
Analyst (or refer to signatory list):	Date:

Additional Information:

FIGURE 15-2, CONT'D

KATAHDIN ANALYTICAL SERVICES, INC. CORRECTIVE ACTION REPORT

CAR####

Page **3** of **3**

KATAHDIN ANALYTICAL SERVICES, LLC. – CORRECTIVE ACTION REPORT

Monitoring of Corrective Action (To be completed by QA Officer and/or Operations Manager): List details of follow-up		
☐ Corrective Action Effective	Return to Control – ☐ Yes ☐ No	☐ Further Monitoring Needed/Additional Corrective Action
QA Approval:		Date:

16.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

16.1 Management Review of the Quality Assurance Program

Review of the appropriateness and adequacy of the Quality Assurance Program is ongoing. At a minimum, the President, Vice President, Operations Manager, Manager of Sales & Marketing and QA Officer will meet at least annually to review the status of the laboratory. All aspects including operations, sales, marketing and quality assurance will be discussed. Any laboratory employee may present recommended changes to the Quality Assurance Officer, Department Managers or Operations Manager at any time. Notes from these meetings and any actions taken are documented and retained by each member.

Additionally, any issues with the quality assurance program may be discussed during status meetings held at least twice per week and at most every day. These meetings may be attended by the Vice President, the President, the Operations Manager, Department Managers, The Quality Assurance Officer, Project Managers, Sales & Marketing personnel or any other representative from the lab. The meetings focus on the status of work in house, QA/QC problems, instrument problems, upcoming audits, PTs, etc and projected incoming work.

16.2 Quality Assurance Documentation

At the start of a new year a QA & Operations Meeting is scheduled to review the previous year and to plan for the new year. The meeting shall include but is not limited to:

- Lessons learned and Areas for Improvement
- Client Complaints and/or Feedback
- Status of SOP review
- Status of LOD/LOQ Verifications and MDL studies
- PT Responses and Corrective Action
- Audit Responses and Corrective Action
    - Internal Audit
    - Upcoming Audits
- Corrective and Preventive Action recommendations
- Certifications
- New Methods
- Instrumentation
- Cross-training
- Training

- EHSM
- Hazardous Waste
- Ethics
- Quality Control

- Outstanding Issues
- Changes that may affect certification and the notification of certifying states or LAB.
- Miscellaneous

This meeting is attended by the President, the Operations Manager, the IT/Production Manager, Department Managers, Group Supervisors, The Quality Assurance Officer, Project Managers, Sales & Marketing personnel or any other representative from the lab. Dates are set for any actions that need to take place. Subsequent meetings are attended by the pertinent management and a running memo is maintained by the Operations Manager to track the status of the issues discussed.

As with any corrective action, problem identification, investigation, and follow through must be completed and documented. These must be completed within 45 days of receiving the QA report, or as determined otherwise by the management team.

During any of these management activities changes for improvement may be suggested and reviewed. At a minimum, QA/QC procedures and policies shall be reviewed to determine their effectiveness and suitability.

17.0 REFERENCES

- "EPA Requirements for Quality Assurance Plans for Environmental Data Operations", U.S. EPA QA/R-5, August 1994
- "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans", U.S. EPA, QAMS-005/80, EPA-600/4-83-004, February 1983
- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act." Federal Register, 40 CFR Part 136, October 26, 1984.
- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; National Primary Drinking Water Act; and National Secondary Drinking Water Regulations; Analysis and Sampling Procedures; Final Rule" Federal Register, 40 CFR Part 122, 136, et al., March 12, 2007.
- "Guidelines Establishing Test Procedures for the Analysis of Pollutants; Analytical Methods for Biological Pollutants in Wastewater and Sewage Sludge; Final Rule", Federal Register 40 CFR Parts 136 and 503 March 26, 2007.
- "Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods." SW-846. 3rd edition, 1986, Final Updates I(7/92), II(9/94), IIA(8/93), IIB(1/95), III(12/96), IIIA(4/98), and IIIB(11/04), IV(02/07), V(07/14) and "on-line methods", Office of Solid Waste and Emergency Response, U.S. EPA.
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TITLE: **SAMPLE RECEIPT AND INTERNAL CONTROL**

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Approved By:

Group Supervisor: Andrea Colby Date: 6/6/02

Lab Operations Mgr: Jeff C. Burton Date: 6/5/02

QA Officer: Deborah J. Nadeau Date: 6.6.02

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
04	Changed cover sheet, minor changes to sections 7.1, 7.6 7.7.4 7.10 + 7.20. Complete rewrite of sections 7.11 + 7.12 to comply with new KIMS	DN	6.6.02	6.6.02
05	Added verbal date entry to KIMS. Added reference to immediate internal COC book. Added Department Manager reference. Added section 7.7.3. Updated new incoming	DN	05.04	05.04
06	Added procedure + logbook page for checking turbidity of drinking water samples. Changed wet chem shorts board to a book (included example page). Added cwatoday procedures for food/micro. Added VOA soil freezer storage.	DN	01.26.04	01.26.04
07	Added instructions to create lettered labels. Changed sample locations to reflect new building. Removed Figures B and 10. Updated Table and figures w/ current ones. Added wording to sect. 7.7.5 to clarify how pH measurements are taken.	LAD	02/07	02/07
08	Added summary stating sample acceptance policy. Deleted all references to radiation checks (not performed). Add IR gun usage. Reorganized section 7.0 to prioritize time sensitive tasks. Added wireless thermometer monitoring. Updated SRCR. Other minor changes. Added section concerning locking of coolers. Added more detail to 7.18 on unique container IDs. Added more detail on immediate COCs & a section on retention of samples.	DN	~~05/09~~ 08/09 8.4.09	~~05/09~~ 08/09

TITLE: **SAMPLE RECEIPT AND INTERNAL CONTROL**

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
09	Added new login information for bottle IDS & screen attachment. Added procedures for bar code scanning for internal custody & deleted manual forms. Added new Incoming from KIMS & deleted old. Added form controlled forms to figures.	DM	9.24.10	09/10
10	Sect. 7 - Removed F9 function in printing labels, fixed how the lab ID appears on labels, and fixed how the date needs to be entered. Updated Fig.s 6 and 13.	LAD	08/13	08/13
11	Sect. 7 - Updated WC shirts and rushes from log-book to Google Docs, updated microbiological/ food login process, updated bottle labeling. Updated Table 1 and Figures 1→7 & 12. Added Figure 17 - Sample Acceptance Policy	LAD	05/16	05/16

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SD-902-11**, titled **Sample Receipt and Internal Control**.

Recipient: _____ Date: _____

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SD-902-11**, titled **Sample Receipt and Internal Control**.

Recipient: _____ Date: _____

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

1.0 SCOPE AND APPLICATION

Katahdin Analytical Services requires the use of specific receiving, acceptance, identification, storage, and distribution procedures for samples it accepts for analyses. These procedures assure that:

- samples are uniquely identified,
- samples are protected from loss or damage,
- essential sample characteristics are preserved,
- any alteration of samples (e.g., filtration, preservation) is documented,
- the correct samples are analyzed, and
- a record of continuous sample custody and utilization is established.

The purpose of this SOP is to describe the procedures used for the receipt and tracking of samples received by Katahdin Analytical Services (Katahdin).

1.1 Definitions

SDG: Sample Delivery Group – A group of samples to be reported as one data package.

1.2 Responsibilities

It is the responsibility of all Katahdin staff who receive samples or handle samples in the course of analysis to follow the procedures set forth in this SOP, to document their understanding of the procedures in their training files (refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”), and to suggest changes and revisions when appropriate. All technical staff are responsible for monitoring their immediate areas, stopping an activity when a problem is detected or suspected, initiating corrective action when needed, documenting any actions taken, and notifying the appropriate individual (e.g., Department Manager, Operations Manager, QAO). The primary responsibility for implementing real-time corrective actions and maintaining an effective QA self-inspection system resides with Katahdin staff. When problems are identified Katahdin personnel are expected to attempt to resolve situations within the scope of their technical knowledge, and to seek assistance from peers and the Department Manager as necessary.

It is the responsibility of Department Managers to oversee the adherence to Katahdin QC practices and internal documentation of laboratory activities within their area, to take corrective actions where needed and communicate problems to the Operations Manager, QAO or President when warranted.

It is the responsibility of the Operations Manager to oversee adherence to Katahdin QA/QC practices by all laboratory groups under his/her authority, to help identify problems and assure resolution, to facilitate corrective action where needed, and to communicate problems and concerns to the QAO and President.

It is the responsibility of the Quality Assurance Officer (QAO) to oversee adherence to this SOP, to conduct periodic audits of each laboratory, to track corrective action reports, resolution, and documentation, and to communicate concerns and report findings to the President. The QA Officer shall function independently from laboratory operations and be able to evaluate data objectively and perform assessments without outside influence. The QA Officer has the authority to independently halt production operations (including data reporting) if warranted by quality problems.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical safety procedures and the Katahdin Environmental Health & Safety Manual and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Wastes generated during the receipt of samples must be disposed of in accordance with the Katahdin Environmental Health & Safety Manual and SOPs SD-903, “Sample Disposal” and CA-107, “The Management of Hazardous Waste as it Relates to the Disposal of Laboratory Process Waste, Reagents, Solvents and

Standards," current revisions. Expired standards are placed in the Katahdin hazardous waste storage area, and disposed of in accordance with these SOPs.

2.0 SUMMARY OF METHOD

Regulatory, program, and/or method requirements dictate the specifics of sample acceptance. These requirements include, but are not limited to, temperature upon receipt, chemical preservation, container type, sample amount, holding time considerations and complete and accurate documentation of all of these conditions, as well as sample identification. Katahdin's sample acceptance policy is to note any anomalies, discrepancies or non-compliances concerning the receipt of samples. The client is always notified with these issues to direct Katahdin on how and whether to proceed with analysis. All guidance from the client is recorded in the project phone logs and/or on the Sample Receipt Condition Report, which becomes part of the final report. Conditions or analyses performed which do not meet the necessary requirements are narrated or notated as described in the individual analytical SOPs.

3.0 INTERFERENCES

Not applicable.

4.0 APPARATUS AND MATERIALS

4.1 Thermometer – Oakton® Non-Contact Infrared Thermometer, or equivalent, capable of reading 0.1°C and digital probe style capable of reading 0.1°C (used for back-up).

4.2 Capillary tubes – 75 mm Hematocrit Tubes, disposable

4.3 Wide range pH test strips, pH 0 to 14 pH, EMD ColorpHast or equivalent.

4.4 Narrow range pH test strips, pH 0 to 2.5 pH, EMD ColorpHast or equivalent.

4.5 Narrow range pH test strips, pH 11 to 13 pH, EMD ColorpHast or equivalent.

5.0 REAGENTS

Preservatives - refer to Table 1, Sampling and Preservation Requirements, for specifics.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Refer to Table 1, Sampling and Preservation Requirements, for specifics.

7.0 PROCEDURES

PROCEDURES FOR SAMPLE CUSTODIAN

The following procedures include all steps to be completed for satisfactory receipt and acceptance of samples at Katahdin. These steps do not necessarily have to be performed in the exact order as described. Sample deliveries occur constantly throughout the day, so the sample custodian must multi-task and move back and forth between different procedures to accomplish the most critical tasks of checking receipt temperatures and checking for "RUSH" or quick hold time parameters.

7.1 When samples (except for non-environmental food samples) are dropped off, by either a delivery service (i.e. FEDEX or UPS) or by the client, the Chain-of-Custody (COC) should be signed immediately. The client (who is delivering or that has shipped samples with a delivery service) shall sign (at the lab upon delivery or prior to shipment of samples) that they have relinquished custody to the laboratory. The laboratory shall sign and record the date and time that custody is accepted. (Refer to Figures 1-3 for a Katahdin standard COC, a Katahdin Homeowner COC, and a Katahdin Food/Microbiology COC).

7.2 Cut custody seals and open all coolers. Remove the packets containing the client Chains-of-Custody (COCs).

7.3 Using the COCs, enter the date and time of sample receipt and the client name into the next available work order/login number in the sample receipt logbook (Figure 5). Initial each entry (line) to maintain a record of the individual who assigned each group of samples a discreet lab work order/login number. Record the assigned work order numbers in the appropriate space on the client COCs. Complete the log-in entry date and time once samples are logged in as described below.

7.4 Inventory the COCs for any "rush turn around" samples or "short hold-time" analyses. Notify the appropriate department Managers/Supervisors of these analyses.

7.4.1 Short hold-time analyses need to be entered into the "Wet Chemistry Shorts Spreadsheet" (Figure 6) on the company Google Docs system. Be sure to list the client, number of samples and date and time of the earliest sample.

7.4.2 GC or GC/MS personnel must be informed when ENCORES are received so that they may be scheduled for extrusion.

7.4.3 Notify all applicable personnel of samples with limited hold-time remaining or rush turn around samples. Appropriate supervisors and PMs must be emailed when a client has requested rush results. The email should include the work order number, the client, the matrix, number of samples, analysis requested and the turnaround time. Samples for microbiology lab should be brought to them immediately.

7.4.4 Parameters that we routinely analyze which have short analytical hold times are:

Coliforms	Color	pH
Nitrate/Nitrite	Dissolved Oxygen	Turbidity
Ferrous iron	Orthophosphate	Hex. Chromium
MBAS	TBOD	Free CO_2
Sulfite	ENCORE soil samples	Settleable Solids
Odor	Residual Chlorine	CBOD

7.5 Inspect the condition of custody seals, cooler, ice condition and samples received. Note any non-intact conditions on the Sample Receipt Condition Report (SRCR - Figure 7). Notify the Katahdin project manager (PM) of any discrepancies or problems with sample receipt. The PM contacts the client as necessary. If breakage of a potentially hazardous sample is discovered, close and seal the packing container with all the samples inside and move to a hood in the organic extractions area or to the smaller hood in the login area if space permits. One of the three Katahdin Emergency Response Coordinators or the Katahdin Environmental Health & Safety Manager must be notified. Disposition of the broken and other possibly contaminated samples will be determined on a case-by-case basis in accordance with the laboratory's handling procedures for hazardous waste as outlined in the Katahdin Environmental Health & Safety Manual. Generally, when a sample has broken and has mixed with any ice in the cooler, that liquid will be poured off into 2 liter plastic containers and labeled as "do not use". These containers will be disposed of as soon as the disposition of the appropriate samples has been determined through analysis.

7.6 If there is no breakage of a potentially hazardous sample:

Check cooler temperatures using the IR thermometer assigned to the sample receipt area. If a cooler temperature blank is present, aim the IR gun at the temperature blank; otherwise aim the IR gun at any sample in the cooler if no temperature blank is present. Be sure that the IR gun is within 6 inches of the bottle and not aimed at a label on the bottle. Press the trigger on the handle and be sure the red dot is visible on the bottle surface. The IR gun has been set to read in degrees celcius. If checking the temperature of a plastic bottle, set the emissivity at 0.90. If checking the temperature of a glass bottle (either amber or clear), set the emissivity at 0.85. Refer to Figure 8 for manufacturer’s instructions on changing the emissivity. Record the

temperature on the Sample Receipt Condition Report. Receipt temperatures should be <6 °C, without freezing. Any temperature falling outside of this range must be noted on the SRCR and reported to the appropriate Katahdin project manager.

Note: Samples received for metals analysis only do not have to meet any temperature receipt requirements.

Note: A probe type thermometer is retained as back-up in case there is a problem with the IR thermometer.

7.7 Note the condition of the ice or ice packs. If the ice has melted and the temperature is out of acceptance criteria, note this on the SRCR. For samples that are hand delivered to the laboratory immediately after collection (i.e. sample collection times are <6 hours old), the temperature blank and/or cooler temperature will most likely not meet the acceptance criteria. The samples shall be considered acceptable if there is evidence that the chilling process has begun such as arrival on ice. Note this on the SRCR. If samples (that were just collected) have not arrived on ice, note this on the SRCR, and start the cooling process as soon as possible after arrival at the laboratory.

Note: All clients must be notified when samples are received that do not meet the appropriate temperature requirements. In these cases, certain regulatory requirements may not be met and may invalidate certain data.

7.11 Notify the PM immediately if there are any discrepancies or problems with sample receipt. The PM will contact the client for information and resolution as necessary. All decisions to proceed or not to proceed with analysis associated with samples received that do not meet specified acceptance criteria (i.e. cooler temperature, preservation, container, etc.) must be fully documented on the SRCR. Although this form is included with all client reports, additional narration or flagging of data may be necessary.

7.12 Review any additional paperwork that accompanies the sample(s) submitted for analysis along with laboratory-generated information. This includes shipping forms, letters, chain-of-custody forms, sample labels, Incoming Sample Reports (generated from KIMS), quotes, memos, etc. These forms may provide details on specific client requests. The Incoming will provide information on specifics for log-in. Refer to Figure 11 for an example.

7.13 Resolve any questions or concerns raised by steps 7.1-7.14 by consulting the correspondence files or client services personnel or communicating directly with the client. Note in the notes section of the SRCR any deviations from normal sample handling or analytical procedures (e.g., client requests analysis although hold-time expired).

7.14 Samples requiring microbiological and/or food analyses are stored in the F/M laboratory walkin. For environmental tests, samples are logged in by the sample receipt department and a copy of the chain of custody is brought with the samples. For non-environmental microbiological tests, a workorder number is assigned by sample receipt but the samples are not logged in. The workorder number, the chain of custody and a copy of the chain of custody are delivered with the samples. The samples are then logged in by the F/M staff. Sample that require both environmental and non-environmental microbiological analyses are usually processed the same as non-environmental samples

7.15 The following information is documented via the Katahdin Information Management System (KIMS) and a work order/login COC report (Figure 12) is generated for the samples received:

7.15.1 Log onto KIMS by entering employee ID under “Username”, employee specific password under “Password” and KIMS under “Database”.

7.15.2 Once logged onto KIMS select “Sample Management” and then “Login”.

7.15.3 Select “New” and the next available Login ID number will automatically be entered. Select “OK” and the Sample Definition screen will open.

Note: If a Work Order number has already been opened, select “change” and type in the appropriate number to access the information.

7.15.4 In the Sample Definition Screen, enter the following information.

Top Section of Screen:

Client ID - Enter client sample description.

ReceiveDate - Enter in date that samples were received in the lab in the format Day-Month-Year (ex. August 23, 2013 is 23-AUG-13).

CollectDate - Enter in date that samples were collected in the format Day-Month-YearTime (ex. 8:30am August 23, 2013 is 23-AUG-13).

TAT - Enter TAT for hardcopy report.

DueDate - Due date will automatically be calculated based on calendar days.

VerbalDate - Manually type in verbal due date.

QuoteRef - Enter quote number if applicable.

Project - Enter project number if applicable.

Account - Enter client specific account number.

Account Name - Account name will automatically be entered.

Collected By - Enter name/initials of sampler listed on COC. If unknown, enter “Client”.

Locator - May be used for client ID information when requested by the project manager.

Site - Enter project site name.

Description - May be used for food descriptions.

Discount - No entry-not currently used.

Priority - No entry-not currently used.

Fact. - No entry-not currently used.

Expected - No entry-not currently used.

Mailed - Data Management will enter the mailed date of the report or SDG right after the report is mailed.

Comments - Enter MS/MSD, verbal due date and any sample irregularities if applicable. Also may be used for long client IDs when requested by the project manager.

OrderDate - Current date is automatically entered.

Middle Section of Screen:

Highlight the first sample in the top section of the screen and then proceed with entries in the middle section of the screen.

Matrix - Enter sample matrix code where

AQ = Aqueous	SLD = Food Solid
SL = Solid, Soil, Sludge	AR = Air
FP = Free Product	SWAB = Swab
WP = Wipe	SAL = Saline

NOAQ = NonAqueous TIS = Tissue
DW = Drinking Water

Product Code - Enter analysis code per test requested on COC. Log-in personnel should refer to Project Incomings, quotes or past Work Orders to aid in the entry of correct product codes.

Type - Product code type will automatically be entered where
S = Stand alone
P = Parent
C = Children

Fact. - No entry-default is 1.

Price - This is left as is by sample log-in. During project management review of the work order, the prices are entered based on quotes or standard prices.

Cost - No entry needed.

Lev - No entry needed.

Container Type - Container type will automatically be entered. Please change from the various choices if the automatic entry is not correct. This is especially important for volatiles in soil since there are many types of preservations.

Container Key- Make sure “Container Type” is populated. Determine how many bottles there are for each container type. Assign bottles by entering sequential letters for each bottle. For example, sample 1 has six containers, one for metals which we’ll assign container ID, “A”, two for PCBs which we’ll assign container IDs, “B” and “C”, and three for volatiles which we’ll assign container IDs, “D”, “E”, and “F”. The letters should be typed in all in a row with no commas or spaces in between. If 26 bottles per samplenum are exceeded the next ‘key’ would be, ‘A1’, ‘B1’ etc. If no container IDs are needed (i.e. for food or field) it is okay to leave the container key field blank.
After the Container Keys are entered click ‘SAVE’. This will create the containers section in the bottom

section of the screen. This will also initiate the creation of container labels.

Bottom Section of Screen:

Container # - The container ID numbers will automatically fill in for each analysis from the container key information above.

Container Type - The container types will automatically fill in for each analysis from the container key information above.

Current Location - The current location is automatically entered based on the analysis.

Cooler - Currently not used.

pH - Currently not used.

Temperature - Currently not used.

Seal - Currently not used.

Properly Preserved - Currently not used.

Comments - Comments on individual containers may be entered here, i.e. bubble in VOA vial. Comments regarding problems or breaks with internal custody scanning of bar codes are also automatically entered here.

Select Login Info tab at top of screen and proceed with entry:

Login Info - Parameter Data Screen will open. Enter following information

KAS Proj. Manager- Initials of Katahdin person overseeing the project.

Client PO#- Client purchase order.

Project- Project name.

Cooler Temperature- Temperature blanks or cooler temps.

Delivery Services- Method of delivery to the lab.

QC Level- QC Level of report

SDG ID- Sample Delivery Group ID if applicable.

SDG Status- Begin, Continue or End.

Analysis Instructions- PM will enter special instructions regarding project.

Report Instructions- PM will enter special instructions regarding project.

Regulatory List- Not used.
EDD Format- Specific KAS EDD format.

Select “SAVE” and then “CANCEL”.

Addresses - Select “Addresses” and the Address Links screen will open. The billing address is the default address of the account. Enter the client account code under “Project/Account” and select the report to contact under “Address Type”. Select the appropriate boxes for report, report CC and invoice CC. Select “SAVE” and then “CLOSE”.

Refer to Figure 13 for a screen snapshot of the log-in process in KIMS. Log-in personnel should also refer to the current revision of Katahdin SOP, SD-918, KIMS Work Order Approval & Dispatching, for further hints on log-in.

7.15.5 To print the login report, select “Reports”, “Login” and “Login COC”. Enter login number under “Login Number”. Select “OK”, “Run Report” and then “Print”.

7.16 To print labels, select “Reports”, “Login” and “Labels”. Enter login number under “Login/Prelogin”, select “Background (IDXL) (this is the default)”. Select “OK” and then “Print”. After labels print out select “Cancel”.

Note: As stated in “container key” above, each sample bottle is assigned a unique ID. The job is given a work order number. Each different client sample ID is given a numerical number following the work order number and each sample container with the same client ID is given a container ID using alphabetical letters. This

series of work order, sample number and container ID is transcribed throughout the raw data for traceability purposes.

Example: One job containing one client sample with 3 different containers:

SC9001-1A, SC9001-1B, SC9001-1C

Example: One job containing two client samples with 2 different containers for each:

SC9002-1A, SC9002-1B, SC9002-2A, SC9002-2B

7.17 Print the Label Bottle Reference report (under reports tab) for a cross reference to use during labeling. This report will list the bottle type and products related to each Container ID.

7.18 Remove samples from cooler and place them on the counter. Organize them by site ID, in the order of the chain and then by sample analysis.

7.19 Inventory the samples against the chain of custody (COC). If the COC is incomplete, the sample custodian must inform the appropriate Katahdin project manager (PM). The PM may make changes to correct or complete the COC, but all changes must be initialed and dated. Changes must be noted on the SRCR. Any discrepancies between the samples and the COC must also be noted on the SRCR.

7.20 Using the Sampling and Preservation Requirements Table (Table 1) as a reference, check if samples are in proper containers and received correct pretreatment (e.g., filtration, preservation) for the analyses requested. For aqueous parameters requiring preservation, check pH by inserting a clean capillary tube into the sample and dabbing the tube on wide range pH paper. If the pH is not clearly either less than 2 or greater than 12, the appropriate narrow range pH paper must be used. NOTE: The pH of volatile organic (VOA) samples is checked and recorded by the analyst after completion of analysis and not by sample receipt personnel. The used capillary tube is discarded and a new capillary tube is used for each sample.

Additional preservative is added to samples if the pH is not in the range specified in the Sampling and Preservation Requirements Table. No more than 10% of the original sample volume should be added as preservative. If the client has noted that the sample reacts violently (i.e., foams and bubbles) upon preservation, add no more preservative to the sample. Some clients may wish to be contacted if their samples are found to be improperly preserved. Record all preservation discrepancies on the Sample Receipt Condition Report including the lot number of the preservative added. If additional preservative is added, a sticker with the type of preservative must be placed on the sample container.

Note: Preservatives are obtained from the larger containers in the bottle preparation area.

Note: If samples are received unpreserved for 200.7 or 200.8 analysis, the samples must be preserved to pH <2 with nitric acid. Samples must be held for 16 hours after preservation before sample preparation can begin.

7.21 For samples requiring filtration as pretreatment (i.e. for dissolved metals), the work order/login numbers are recorded in the filtration logbook (see Figure 9). The samples are filtered by the Metals Group or the Wet Chemistry Group depending on which group requires the filtered samples.

7.21.1 A 500 mL filter flask and filter funnel are acid rinsed three times in a 10% nitric acid bath, then three times with Laboratory Reagent Grade Water.

7.21.2 A vacuum pump is attached.

7.21.3 A 0.45 micron filter is rinsed three times with 5% nitric acid and three times with Laboratory Reagent Grade Water. The rinsate is discarded.

7.21.4 A sufficient sample aliquot is filtered and preserved with concentrated nitric acid to pH <2.

7.21.5 The bottles are labeled with the work order/login number and other sample information and stored at <6 ° C until the time of digestion.

7.22 Using the Sampling and Preservation Requirements Table (Table 1) as a reference, determine if sufficient volume of sample is present for analysis. Note discrepancies on the SRCR.

7.23 For drinking water samples, enter the appropriate information (work order, date, etc.) into the Measured Turbidity and Preservation of Incoming Samples Logbook. Inform the appropriate analyst of the sample. The turbidity must be measured prior to sample preparation. If the turbidity is <1 NTU, the sample does not have to be digested prior to metals analysis. If the turbidity is >1 NTU, the sample must be digested prior to metals analysis. The sample must be preserved after the turbidity measurement is taken. Record the appropriate information in the logbook (Figure 10).

7.24 Affix permanent sample number labels to sample containers, assuring that sample IDs on labels correspond to sample bottle IDs. Do not obscure client ID on the bottles. 40 mL vial, 125 ml plastic bottle and 4 oz jar labels will have to be placed vertically on the sample container instead of the standard horizontal placement. Additionally, label for 2 oz jars must be placed on the cover.

7.25 Scan the containers into the appropriate storage locations using the following steps. Note that non-environmental food samples are not scanned and are taken immediately to the food/microbiology lab for storage.

7.25.1 In KIMS, click on “containers”. This can also be done at the walk-in computer or on the “D” instrument computer in the VOA lab, depending on where you are storing samples.

7.25.2 Click on “transfer/update” then “transfer” and select. This will bring you to the screen where you scan your badge. **NOTE: make sure you keep your badge available for this**. Alternatively, at the walk-in computer, click on the check-in/check-out ICON. This will also bring you to the screen where you scan your badge.

7.25.3 Scan the barcode on your badge.

7.25.4 Pick “log-in”.

7.25.5 Pick “check-in”.

7.25.6 Select the location you are checking into, i.e. walk-in, VOA Walkin, etc.

7.25.7 The sample screen will now be open. Scan each sample, so that you hear a beep and the sample pops up on the screen. The program is set so that you can continuously scan each sample without having to click anything on the screen. The samples do not have to be scanned in numerical order.

7.25.8 Hit “done/save”.

7.25.9 Hit “close/cancel”. This will return you to the badge scanning screen.

Note: An internal custody report may currently be printed, per client request, by the MIS department.

7.26 Place samples in their designated storage locations. Storage location of the samples is determined by type of sample and/or type of analysis, as outlined below. Most samples are stored in the walk-in cooler, which is organized by test type and work order/login number.

Specific storage locations are described below.

7.26.1 Aqueous samples for wet chemistry (except hardness, see 7.19.4 below) - left aisle, both sides, as you enter walk-in cooler. TOC vials are to be stored in the trays designated for TOC samples.

7.26.2 Aqueous samples for organic extractions – right aisle, left side, as you enter walk-in cooler.

7.26.3 Non-aqueous samples (all analyses except volatile organics) - to the right and towards the back as you enter walk-in cooler. Non-aqueous samples for volatile organics are stored in “VOA Refrigerator 2” located in the Volatiles Laboratory.

7.26.4 Aqueous samples for metals and/or hardness analyses – right aisle, right side towards the front as you enter walk-in cooler.

7.26.5 Samples (aqueous and solid) for volatile organics analyses (VOA) – All aqueous and soil samples in VOA vials (except those which are preserved with D.I. water) are stored in “VOA walkin” in the Volatiles Laboratory. VOA samples known or suspected to be hazardous (such that cross-contamination of other samples might occur) are placed in a “paint can” and stored in the sample receipt walk-in.

7.26.6 Soil samples for volatile organics analyses (VOA) that are preserved with Laboratory Reagent Grade Water are stored in “VOA Freezer 1” in the volatiles laboratory.

Sample storage coolers are not locked, but internal chain-of-custody is documented through the bar code system with respect to native samples. Internal chain-of-custody for extracts and digestates is documented on hardcopy batch sheets. The laboratory maintains a secure facility with respect to unauthorized personnel, as described in the current revision of Katahdin SOP, AD-004, Laboratory Facility Security and Confidentiality. All sample storage coolers are equipped with locks if specific project or regulatory requirements deem it necessary.

7.27 Sample Receipt gives the Work order/login COC report and confirmation of the job, as logged-in, to the appropriate Katahdin project manager. All chain-of-custody and other receipt documentation must accompany the job. The project manager reviews the job for accuracy and completeness. Any unresolved issues should be resolved at this time. Any project or program specific forms should be included with the paperwork at this time. These forms may include CLP forms or state-specific forms. The project manager then dispatches the work order/login to the individual department worklists. The dispatched work order/login package is then filed in Data Management where the complete package will eventually be compiled.

7.28 The temperature of all sample storage refrigerators and freezers is recorded daily by assigned individuals. Notebooks containing a record of each refrigerator and freezer temperature history are used for this purpose and are maintained by the assigned individuals. Temperatures above or below the acceptance range are to be brought to the attention of a Department Manager, Operations Manager, or Quality Assurance Officer. Such an occurrence and the actions taken to correct it must be noted in the comments column of the temperature recording notebook next to the temperature measurement. (See Figure 14).

Additionally, temperatures of storage units are monitored continuously by wireless thermometers. A temperature is recorded electronically every 10 minutes. The QAO can generate a specified report as needed, including every reading or maximum/minimum temperatures for a given timeframe. These monitoring devices ensure continual compliance seven days per week. The data can be used to check for problems.

PROCEDURES FOR CHEMISTS

7.29 When removing or returning a sample from its storage location, it must be scanned in or out using the bar code on the container.

7.29.1 In KIMS, click on “containers”.

7.29.2 Click on “transfer/update” then “transfer” and select.

7.29.3 This will bring you to the screen where you scan your badge. Alternatively, at the walk-in computer, click on the check-in/check-out ICON. This will also bring you to the screen where you scan your badge.

7.29.4 Scan the barcode on your badge.

7.29.5 Pick the department that you are bringing samples to or from.

7.29.6 Pick “check-in” or “check-out”.

7.29.7 For check-in, select the location you are checking into.

7.29.8 The sample screen will now be open. Scan each sample, so that you hear a beep and the sample pops up on the screen.

7.29.9 Hit “done/save”.

7.29.10 Hit “close/cancel”. This will return you to the badge scanning screen.

7.30 If the samples have not been logged in yet and they need to be pulled in order to analyze short holding time parameters, the analyst taking the sample must use the designated logbook (Immediate Internal COC – Figure 15) to sign the samples out. Many circumstances lead to analysts having to pull samples before they are logged into the KIMS system. It is everyone's responsibility to ensure that all samples can be accounted for at all times. Failure to do so can create confusion and bottle necks for others trying to access the samples. Samples that are pulled before log-in must be returned to the designated bin in the sample receipt area. The Immediate Internal COC Logbook must always be consulted if there is ever a question about internal custody.

7.31 If there is an error (i.e. a sample was checked out, but not checked back, and you are trying to check it out), an error screen will pop up indicating who made the error. Take note of who made the error and click "accept bottle". This will allow you to continue, and a note will automatically be applied to the record. If you notice somebody making a lot of errors, please talk to them or let a manager know.

7.32 For samples that are consumed during analysis or preparation, i.e. extractables – either log the samples out and then rescan your badge and log them back in to "consumed" or remove the labels in the lab (when finished) and stick them to your lab coat and then return to scan them into "consumed".

7.33 If a sample is not consumed by an analysis, return the remaining sample to its assigned storage location and rescan back in using the steps in 7.23.

7.34 After the completion of all analyses, the original "left over" sample containers will remain in sample storage until their final disposal. Samples are held during this period for the purposes of retesting if required by a laboratory corrective action or by a client. Refer to the current revision of Katahdin SOP, SD-903, Sample Disposal, for details on final disposal of samples.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Each thermometer used to monitor sample storage or cooler temperatures must be calibrated annually against a NIST traceable thermometer. The QAO is responsible for ensuring that the thermometer(s) are scheduled for annual calibration and for maintaining the calibration records. All other procedures and documentation listed in this SOP must be followed at all times.

9.0 METHOD PERFORMANCE

Not applicable.

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

10.0 APPLICABLE DOCUMENTS/REFERENCES

"Handbook for Analytical Quality Control in Water and Wastewater Laboratories," U.S. EPA EMSL Office of Research and Development, March 1979.

Code of Federal Regulations 40, Parts 136 and 141.

"Test Methods for Evaluating Solid Waste: Physical/Chemical Methods," SW-846 Chapters 1 & 2, USEPA, Third Edition, including Updates I, II, IIA, and IIB, III June, 1997.

Katahdin Analytical Services, Environmental Health & Safety Manual, current revision.

Katahdin QA Manual, current revision

Department of Defense Quality Systems Manual for Environmental Laboratories (DoD QSM), Current Version.

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

LIST OF TABLES & FIGURES

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

TABLE 1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GENERAL CHEMICAL ANALYSES - AQUEOUS					
Acidity	SM 2310B, 305.1	100 mL	P,G	1,2	14 days
Alkalinity- Titrimetric	SM2320B, 310.1	100 mL	P,G	1,2	14 days
Ammonia-Nitrogen with distill-Auto. Phenate	350.1/350.2 SM4500NH3 B&H	100 L	P,G	1,3	28 days
Ammonia-Nitrogen-Automated Phenate	350.1, SM4500NH3 H	100 mL	P,G	1,3	28 days
Anions (F, Cl, Br, SO4, NO2, NO3)	300.0	250 mL	P, G	1	48hr/28days
Bicarbonate, Carbonate (calculation from alkalinity)	SM4500-CO2 D				
Biochemical Oxygen Demand-Carbonaceous	SM 5210B, 405.1	1 L	P,G	1	48 hours
Biochemical Oxygen Demand-Total	SM 5210B, 405.1	1 L	P,G	1	48 hours
Chemical Oxygen Demand-Manual Colorimetric	410.4	100 mL	P,G	1,3	28 days
Chloride-Automated Ferricyanide	SM4500-Cl E, 325.2	100 mL	P,G	1	28 days
Chlorine, Total Residual	SM4500-Cl G, HACH 8167	100 mL	P,G	1,9	ASAP
Chromium, Hexavalent	SM3500Cr D / SW7196	200 mL	P,G	1,9	24 hours
Color, Apparent	SM2120B, 110.2	100 mL	P,G	1,2	48 hours
Cyanide, Amenable-Spectrophotometric	SM4500CN G, 335.1	100 mL	P,G	1,5	14 days
Cyanide, Total-Spectrophotometric	SM4500CN C 335.4	100 mL	P,G	1,5	14 days
Dissolved Oxygen(Lab)-Membrane Electrode	SM4500-O G, 360.1	500 mL	G	1	ASAP
Ferrous Iron - Colorimetric	SM3500-Fe D	250mL	P	1,12	24 hrs
Fluoride with distillation, Potentiometric ISE	SM4500F B/C, 340.2	500 mL	P only	1	28 days
Fluoride, Potentiometric ISE	SM4500F C, 340.2	200 mL	P only	1	28 days
Free CO2	SM4500-CO2 C	250mL	P	1	24 hrs.
Hardness, Total-Manual Titrimetric	130.2, SM2340C	250 mL	P,G	4	6 months
MBAS, Extraction-Colorimetric	SM5540C	1 L	P,G	1	48 hours
Nitrate+Nitrite-Automated Cadmium Reduction	SM4500-NO3 F, 353.2	100 mL	P,G	1,3	28 days
Nitrate-Automated Cadmium Red./Diazotization	SM4500-NO3 F, 353.2	100 mL	P,G	1	48 hours
Nitrite-Automated Diazotization	SM4500-NO3 F, 353.2	100 mL	P,G	1	48 hours
Oil & Grease-Total Recoverable, Gravimetric N-Hexane extractable material N-Hexane extractable material w/ silica gel cleanup	1664	(2) 1 L	glass only	1,11	28 days
pH (Laboratory)	SM 4500H B 150.1	100 mL	P,G	1,2	24 hours
Phenolics, Total Recoverable-Manual 4AAP	420.1	1000 mL	glass only	1,3	28 days
Phosphate, Ortho- Ascorbic Acid	SM4500-P E, 365.2	100 mL	P,G	1	48 hours

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PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
Phosphate,Total	365.4	100 mL	P,G	1,3	28 days
Solids-Filterable Residue (TDS),Gravimetric180	SM 2540C, 160.1	250 mL	P,G	1	7 days
Solids-Nonfilterable Residue (TSS)	SM 2540D, 160.2	1 L	P,G	1	7 days
Solids-Settleable Solids (SS)	SM2540F, 160.5	1 L	P,G	1	48 hours
Solids-Total Solids	SM 2540B, 160.3	250 mL	P,G	1	7 days
Solids-Total Volatile (TVS)	SM 2540E, 160.4	250mL	P,G	1	7 days
Solids-Volatile Filterable Residue (VDS)	SM2540C/E, 160.1/160.4	250 mL	P,G	1	7 days
Solids-Volatile Nonfilterable Residue (VSS)	SM 2540 F	500 mL	P,G	1	7 days
Specific Conductance	SM2510B, 120.1	100 mL	P,G	1,2	28 days
Sulfate-Turbidimetric	ASTM D516-02, 375.4	100 mL	P,G	1	28 days
Sulfide-Iodometric	SM4500-S2 F, 376.1	500 mL	P,G	1,7	7 days
Sulfite-Titrimetric	SM4500-SO3 B, 377.1	500 mL	P,G	1,9	ASAP
Tannin/Lignin-Colorimetric	SM 5550 B	100 mL	P,G	1	7 days
TKN-Auto Block Digest, Spect.	351.2	100 mL	P,G	1,3	28 days
Total Inorganic Carbon	SM 5310B, 415.1	(2) 40 mL	VOA vial	1	28 days
Total Inorganic Carbon	SM 5310B, 415.1	(2) 40 mL	VOA vial	1	28 days
Total Organic Carbon	SM 5310B, 415.1	(2) 40 mL	VOA vial	1,3	28 days
Total Organic Halogen	9020	500 mL	Amber Glass	1,3	28 days
Turbidity	SM2130B, 180.1	100 mL	P,G	1	48 hours
Volatile Fatty Acids	SOP CA-776	(2) 40 mL	VOA vial	17	14 days
ELEMENTAL ANALYSES - AQUEOUS					
Chromium, Hexavalent	7196/6010	500 mL	P,G	1,9	24 hrs
ICP Elements	200.7/6010	500 mL	P,G	4	6 months
ICP MS Elements	200.8/6020	500 mL	P,G	4	6 months
Low Level Mercury	1631	500 mL	G	16	90 days
Mercury	245.1/7470	500 mL	P,G	4	28 days
GC ORGANIC ANALYSES - AQUEOUS					
EDB, DBCP & 1,2,3-TCP	8011 & 504.1	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Extractable Petroleum Hydrocarbons	MADEP EPH	(2) 1000 mL	Amber Glass	1,12	14days/40days
Formaldehyde	556	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Fuel Oil in Water	8015Modified	(2) 1000 mL	Amber Glass	1,8	7days/40days
Fuel Oil in Water	ME HETL 4.1.25	(2) 1000 mL	Amber Glass	1,8	7days/40days
Gasoline in Water	8015Modified	(2) 40 mL	VOA vial	1,8	14 days
Gasoline in Water	ME HETL 4.2.17	(2) 40 mL	VOA vial	1,8	14 days
Petroleum Range Organics	FL-PRO	(2) 1000 mL	Amber Glass	1,12	7days/40days

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SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
Total Petroleum Hydrocarbons	TX1005	(2) 40 mL	VOA vial	12	14days/14days
Extractable Total Petroleum Hydrocarbons	CT-ETPH	(2) 1000 mL	Amber Glass	1	7days/40days
Glycols	8015Modified	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Herbicides	8151	(2) 1000 mL	Amber Glass	1	7days/40days
Methane, Ethane & ethene	RSK 175	(2) 40 mL	VOA vial	1,8,9	14 days(~)
PCB's	608 & 8082	(2) 1000 mL	Amber Glass	1	7days/40days
PCB Congeners	8082	(2) 1000 mL	Amber Glass	1	7days/40days
Pesticides	608 & 8081	(2) 1000 mL	Amber Glass	1	7days/40days
Pesticides and PCB's	608 & 8081/8082	(2) 1000 mL	Amber Glass	1	7days/40days
Solvents (Direct Injection)	8015M	(2) 40 mL	VOA vial	1	14 days
Volatile Petroleum Hydrocarbons	MADEP VPH	(2) 40 mL	VOA vial	1,11	14days
Chloropicrin	8011 Mod.	(2) 40 mL	VOA vial	1,8,9	14 days
HPLC ANALYSES - AQUEOUS					
HPLC-Explosives	8330A/B/ B Mod.	(2) 1000 mL	Amber Glass	1	7days/40days
GC/MS ORGANIC ANALYSES - AQUEOUS					
Acid Extractables	625	(2) 1000 mL	Amber Glass	1	7days/40days
Acid Extractables	8270	(2) 1000 mL	Amber Glass	1	7days/40days
Base Neutral Extractables	625	(2) 1000 mL	Amber Glass	1	7days/40days
Base Neutral Extractables	8270	(2) 1000 mL	Amber Glass	1	7days/40days
Drinking Water Volatiles - Low Level	524.2	(3) 40 mL	VOA vial	1,8,9,10	14 days(~)
Polyaromatic Hydrocarbons	8270/8270 SIM	(2) 1000 mL	Amber Glass	1	7days/40days
Semivolatile Extractables	625	(2) 1000 mL	Amber Glass	1	7days/40days
Semivolatile Extractables & (SIM)	8270/8270 SIM	(2) 1000 mL	Amber Glass	1	7days/40days
Volatile Organics & (limited SIM)	8260/8260 SIM	(3) 40 mL	VOA vial	1,8,9	14 days(~)
Volatile Organics	624	(3) 40 mL	VOA vial	1,8,9	14 days(~)
MICROBIOLOGICAL ANALYSES - AQUEOUS					
Coliform, Fecal (wastewater)	SM 9222D	100 mL	P,G	1,6	6 hours
Coliform, Fecal (wastewater)	Colilert-18 w/ Quantitray	100 mL	P,G	1,6	6 hours
Coliform, Total (wastewater)	SM 9222B	100 mL	P,G	1,6	6 hours
Coliform, Total (drinking water)	SM 9222B	100 mL	P,G	1,6	30 hours
Coliform and E-coli, Total (drinking water)	SM9223B, Colitag	100 mL	P,G	1,6	30 hours
E-coli (wastewater)	SM9213D	100 mL	P,G	1,6	6 hours
E-coli (wastewater)	SM9223B Colilert w/ Quantitray	100 mL	P,G	1,6	6 hours
Heterotrophic Plate Count	SM9215B, SIMPlate	100 mL	P,G	1,6	30 hours
GENERAL CHEMICAL ANALYSES – SOLID					
% Carbon	9060 mod.	4 oz	Soil Jar	1	28 days

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

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SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
Ammonia-Nitrogen-Automated Phenate	350.1/350.2 SM4500NH3 B&H mod.	4 oz	Soil Jar	1	28 days (^)
Anions (F, Cl, Br, NO3, NO2, SO4)	9056	4 oz	Soil Jar	1	48hrs to 28 days (^)
Cation Exchange Capacity	9081	4 oz	Soil Jar	1	14days/7days (^)
Chloride-Automated Ferricyanide	9251/9056	4 oz	Soil Jar	1	28days (^)
Cyanide, Amenable-Spectrophotometric	9012	4 oz	Soil Jar	1	14 days
Cyanide, Total-Spectrophotometric	9012	4 oz	Soil Jar	1	14 days
Fluoride, Potentiometric ISE	SM4500F B/C, 340.2 mod.	4 oz	Soil Jar	1	28 days (^)
Lime Equivalency	310.1 mod.	4 oz	Soil Jar	1	28 days (^)
Nitrate+Nitrite-Automated Cadmium Reduction	9056 mod./353.2	4 oz	Soil Jar	1	28 days (^)
Nitrate-Automated Cadmium Red./Diazotization	9056 mod./353.2	4 oz	Soil Jar	1	48 hrs (^)
Nitrite-Automated Diazotization	9056 mod./353.2	4 oz	Soil Jar	1	48 hrs (^)
Oil & Grease-Total Recoverable, Gravimetric N-Hexane extractable material N-Hexane extractable material w/ silica gel cleanup	9071	4 oz	Soil Jar	1	28 days (^)
Organic Nitrogen-Auto. Block Digest.,Spectro.	350.1/351.2 mod.	4 oz	Soil Jar	1	28 days (^)
pH (Laboratory)	9045	4 oz	Soil Jar	1	28 days (^)
Phenolics, Total Recoverable-Manual 4AAP	Mod. 9065	4 oz	Soil Jar	1	28 days (^)
Phosphate, Ortho- Ascorbic Acid	9056 mod./365.2	4 oz	Soil Jar	1	48 hrs (^)
Phosphate,Tot.-Auto Ascorbic Acid/Block Dig.	Mod. 365.4	4 oz	Soil Jar	1	28 days (^)
Solids-Ash	SM 2540 G	4 oz	Soil Jar	1	28 days (^)
Solids-Total Solids	SM2540 G, current CLP SOW	4 oz	Soil Jar	1	28 days (^)
Solids-Volatile Solids	SM 2540 G	4 oz	Soil Jar	1	28 days (^)
Sulfate-Turbidimetric	9038	4 oz	Soil Jar	1	28 days (^)
Sulfide-Iodometric	9030	4 oz	Soil Jar	1	7days (^)
TKN-Auto Block Digest,Spectro.	351.2 mod.	4 oz	Soil Jar	1	28 days (^)
Total Organic Carbon	9060	4 oz	Soil Jar	1	28 days
Total Organic Carbon	Llyod Kahn	4 oz	Soil Jar	1	14 days
Total Organic Carbon	Walkley Black	4 oz	Soil Jar	1	14 days
ELEMENTAL ANALYSES – SOLID					
ICP Elements	6010	4 oz	Soil Jar	1	6 months
ICP MS ELements	6020	4 oz	Soil Jar	1	6 months
Mercury	7471	4 oz	Soil Jar	1	28 days
Chromium, Hexavalent	3060/7196	4 oz	Soil Jar	1	30dys/24hrs
GC ORGANIC ANALYSES – SOLID					
Extractable Petroleum Hydrocarbons	MADEP EPH	4 oz	Soil Jar	1	14days/40days

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SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
Fuel Oil	ME HETL 4.1.25 & 8015 mod.	4 oz	Soil Jar	1	14days/40days
Petroleum Range Hydrocarbons	FL-PRO	4 oz	Soil Jar	1	14days/40days
Total Petroleum Hydrocarbons	TX1005	4 oz	Soil Jar	1	14days/14days
Extracted Total Petroleum Hydrocarbons	CT-ETPH	4 oz	Soil Jar	1	14days/40days
Gasoline	ME HETL 4.2.17 & 8015 mod.	(2) 40 mL	VOA Vial	1	14 days
Herbicides	8151	4 oz	Soil Jar	1	14days/40days
PCB's	8082	4 oz	Soil Jar	1	14days/40days
PCB's in Oil	8082	4 oz	VOA Vial	1	40 days
Pesticides	8081	4 oz	Soil Jar	1	14days/40days
Pesticides and PCB's	8081/8082	4 oz	Soil Jar	1	14days/40days
Solvents (Direct Injection)	8015M	(2) 40 mL	VOA Vial	1	14 days
Volatile Petroleum Hydrocarbons	MADEP VPH	(2)40 mL	VOA vial	1,13	28days
HPLC ANALYSES – SOLID					
HPLC-Explosives	8330B/B Mod.	4 oz or ISM sample	Soil Jar	1	14days/40days
GC/MS ANALYSES – SOLID					
Acid Extractables	8270	4 oz	Soil Jar	1	14 days/40 days
Base Neutral Extractables	8270	4 oz	Soil Jar	1	14 days/40 days
Polyaromatic Hydrocarbons	8270/8270SIM	4 oz	Soil Jar	1	14 days/40 days
Semivolatile Extractables & (SIM)	8270/8270 SIM	4 oz	Soil Jar	1	14 days/40 days
Volatile Organics – High Soil (>200 ug/kg) (Please refer to Figure 6-2 for details on collection and preservation)	5035/8260	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2
Volatile Organics – Low Soil (<200 ug/kg) (Please refer to Figure 6-2 for details on collection and preservation)	5035/8260	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2
Volatile Organics & (limited SIM)	8260/8260 SIM	(2) 40 mL	VOA Vial	1	14 days
Miscellaneous – SOLID					
Grain Size (sieve and hydrometer)	ASTM D422	8 oz	Soil jar or bag	1	none
RCRA - HAZARDOUS WASTE CHARACACTERIZATION					
Corrosivity-pH	9045	4 oz	Soil Jar	1	24 hours (^)
Ignitability-Flash Point (closed cup)	1010	4 oz	Soil Jar	1	14 days (^)
Reactivity-Reactive Cyanide	7.3.3.2	4 oz	Soil Jar	1	14 days
Reactivity-Reactive Sulfide	7.3.4.1	4 oz	Soil Jar	1	7 days
TCLP					
TCLP Extraction-Volatile Organics	1311/8260	100 g	Soil Jar	1	14 days/14 days
TCLP Extraction-Semivolatiles	1311/8270	200 g	Soil Jar	1	14 days/7 days/40 days

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

TABLE 1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
TCLP Extraction-Pesticides & Herbicides	1311/8081 & 8151	400 g	Soil Jar	1	14 days/7 days/40 days
TCLP Extraction-Metals	1311/6010/6020	200 g	Soil Jar	1	28 days/180 days
TCLP Extraction-Mercury	1311/7470	200 g	Soil Jar	1	28 days/28 days
GC/MS ANALYSES - AIR					
Volatile Organics	TO-15	(1) 1.4 or 6 L	Canister	16	30 days
Volatile Organics	MA-DEP APH	(1) 1.4 or 6 L	Canister	16	30 days

METHODS OF PRESERVATION
1 = Cool at 4 Degrees Celsius
2 = Settled
3 = H2SO4 to pH<2
4 = HNO3 to pH<2
5 = NaOH to pH>12
6 = 1 mL 0.1M Na2S2O3 or 1 10 mg pellet
7 = 1 m/L 2NZnAc/L & NaOH
8 = 2 drops 1:1 HCl
9 = No headspace
10 = Na2S2O3, if chlorinated
11 = HCl to pH < 2
12 = 5 mL of HCL
13 = 15 mL of methanol
14 = methanol
15 = sodium bisulfate
16 = None
17 = benzalkonium chloride

~ Hold time for unpreserved samples is 7 days.

^ Because there are no published holding times for Wet Chemistry soil methods, these are only recommended holding times. They are not regulatory.

Project-specific (i.e. CLP, NYSDEC) hold times take precedence over these hold times as appropriate.

For solid samples, please place parameters of the same analytical group (ie. wet chemistry) in the same container whenever possible. Also, organic and inorganic parameters should be placed in separate containers. Volatile organics should always be placed in organic-free jars. Several 4 oz. soil jars may be needed when numerous parameters are required.

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 1

EXAMPLE OF STANDARD KATAHDIN CHAIN-OF-CUSTODY FORM

Katahdin ANALYTICAL SERVICES
600 Technology Way
Scarborough, ME 04074
Tel: (207) 874-2400
Fax: (207) 775-4029

CHAIN of CUSTODY

PLEASE BEAR DOWN AND PRINT LEGIBLY IN PEN

Page ____ of ____

Client	Contact	Phone # ( )	Fax # ( )
Address	City	State	Zip Code
Purchase Order #	Proj. Name / No.		Katahdin Quote #
Bill (if different than above)	Address		
Sampler (Print / Sign)			Copies To:

LAB USE ONLY | WORK ORDER #:
KATAHDIN PROJECT NUMBER _____
REMARKS: _____
SHIPPING INFO: ❒ FED EX ❒ UPS ❒ CLIENT
AIRBILL NO: _____
TEMP°C _____ ❒ TEMP BLANK ❒ INTACT ❒ NOT INTACT

ANALYSIS AND CONTAINER TYPE / PRESERVATIVES

*	Sample Description	Date / Time coll'd	Matrix	No. of Cntrs.	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N
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COMMENTS

Relinquished By: (Signature)	Date / Time	Received By: (Signature)	Relinquished By: (Signature)	Date / Time	Received By: (Signature)
Relinquished By: (Signature)	Date / Time	Received By: (Signature)	Relinquished By: (Signature)	Date / Time	Received By: (Signature)

THE TERMS AND CONDITIONS ON THE REVERSE SIDE HEREOF SHALL GOVERN SERVICES, EXCEPT WHEN A SIGNED CONTRACTUAL AGREEMENT EXISTS.

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 2

EXAMPLE OF KATAHDIN HOMEOWNER CHAIN-OF-CUSTODY FORM

Katahdin
ANALYTICAL SERVICES

600 Technology Way
P.O. Box 540
Scarborough, ME 04070
Tel: (207) 874-2400 Fax: (207) 775-4029

Drinking Water Chain of Custody

Client:	Contact:	Phone:	Fax:
Address:	City:	State:	Zip:
Purchase Order #:	Project Name/No.:	E-mail:	
Billing Address (if different):			
Sampler (Print/Sign):		Copies To:	

***Test results are for compliance and will be reported to the state (see statement below) yes no — Compliance samples may need to be received on ice.

Lab Use Only | Work Order #: | KAS Project Manager:

Shipping: UPS Fed-Ex Mail Drop-Off

Sample(s) Received on Ice? Yes No Temperature if Iced:

Requested Services

Sample Description (Sample Identification and/or Lot #)	Date Collected	Time Collected	No. of Cntrs.	Standard Homeowner	Arsenic	Total Coliforms, e-coli	Lead (1st draw)	Safety Test – coliform,N+N	FHA/MSH	Fluoride	Uranium		What's Included in the Standard Test and the FHA/MSH Test.
													Standard Homeowner: Total Coliform/e-coli, Nitrate, Nitrite, Chloride, pH, Hardness, Uranium, Copper, Iron, Lead, Manganese, Sodium, Arsenic
													FHA/MSH: Standard plus Lead(1st draw), Turbidity, Color, Odor

Relinquished By:	Date/Time:	Received By:	Relinquished By:	Date/Time:	Received By:

Per the National Environmental Laboratory Accreditation Program (NELAP) Standards, Katahdin is required to accept samples that have been properly preserved. All sample containers provided to you have been properly preserved, but the proper preservation also requires samples to be received at temperatures specified in the regulations. The Safe Drinking Water Act regulations only require this for compliance samples (i.e., results that are submitted to the state). By circling no for compliance (above), you acknowledge that the samples described above are not for compliance purposes, and thus may not meet the temperature receipt requirements. All services shall be governed by Katahdin's standard terms and conditions.

QA-059 – Revision 2 – 03/31/2016

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 3

EXAMPLE OF KATAHDIN FOOD/MICROBIOLOGY CHAIN-OF-CUSTODY FORM

Katahdin
ANALYTICAL SERVICES

600Technology Way
P.O. Box 540
Scarborough, ME 04070
Tel: (207) 874-2400 Fax: (207) 775-4029

Chain of Custody

Client:	Contact:	Phone:	Fax:
Address:	City:	State:	Zip:
Purchase Order #:	Project Name/No.:	E-mail:	
Billing Address (if different):			
Sampler (Print/Sign):		Copies To:	

Lab Use Only	Work Order #:	KAS Project Manager:	Food & Microbiological Services
Shipping: UPS Fed-Ex	Airbill No.:		
Temperature:			

Sample Description (Sample Identification and/or Lot #)	Date/Time Collected	Matrix	No. of Cntrs.	Plate Count (AHS)	Listeria	Yeast and Mold	Salmonella	E-Coli	E-Coli 0157:H7	Staph	Vibrio	Total Coliforms	Campylobacter	Shelf Life	Challenge Study		

Relinquished By:	Date/Time:	Received By:	Relinquished By:	Date/Time:	Received By:

The terms and conditions on the following page hereof shall govern services, except when a signed contractual agreement exists.

QA-058 – Revision 1 – 09/22/2010

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 4

EXAMPLE OF KATAHDIN AIR CHAIN-OF-CUSTODY FORM

Katahdin
ANALYTICAL SERVICES

600 Technology Way
P.O. Box 540
Scarborough, ME 04070
Tel: (207) 874-2400 Fax: (207) 775-4029

Air Analysis Chain of Custody

Client:	Contact:	Phone:	Fax:
Address:	City:	State:	Zip:
Purchase Order #:	Project Name/No.:	E-mail:	
Billing Address (if different):			
Sampler (Print/Sign):		Copies To:	

Lab Use Only	Work Order #:	KAS Project Manager:	Requested Services
Shipping:	UPS	Fed-Ex	Mail	Drop-Off	

Sample Description (Sample Identification and/or Lot #)	Collection					Matrix	Sampler	Can Size	Can ID	Flow Controller ID				Comments
	Date	Start Time	End Time	Initial Vac	Final Vac									

Relinquished By:	Date/Time:	Received By:	Relinquished By:	Date/Time:	Received By:

Katahdin inspects and verifies all equipment including, but not limited to, canisters and flow controllers before being sent to the client. As the client you have agreed to pay a rental fee for use of this equipment, which is the sole property of Katahdin. All equipment will be inspected for damage and completeness upon return to Katahdin. In the event that rental equipment is missing and/or damaged, by signing this COC, you (the client) agrees to pay Katahdin for replacement of any unuseuable, damaged or missing equipment.

QA-132 – Revision 1 – 02/06/2014

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 5

EXAMPLE OF KATAHDIN SAMPLE RECEIPT LOGBOOK

KATAHDIN ANALYTICAL SERVICES, LLC.
SAMPLE LOG IN

pH Paper Lot #: 7K 564756

Date Received	Time Received	Date Logged In	Time Logged In	Work Order	Client	Initials
5/13/16	1345	5-13-16	1400	SJ 3311	Harmon's	
5/13/16	1350	5-13-16	15:00	SJ 3312	Bristol Seafood	
↓	↓			SJ 3313	Camp Sunshine	↓
5-13-16	14:00			SJ 3314	DEP-B	
				SJ 3315	↓	
				SJ 3316	DEP-A	
				SJ 3317	↓	
			15:30	SJ 3318	FGS	
				SJ 3319	CES	
				SJ 3320	↓	
				SJ 3321		
			↓	SJ 3322	SWCole	
		5-13-16	16:00	SJ 3323	Clearwater	
				SJ 3324		
				SJ 3325		
				SJ 3326		
				SJ 3327		
				SJ 3328		
				SJ 3329		
				SJ 3330		
				SJ 3331		
				SJ 3332		
				SJ 3333		
		↓	↓	SJ 3334	PWD	↓ open
↓	↓	5-13-16	16:40	SJ 3335	Cape Elizabeth Tax	
5-13-16	15:00			SJ 3336	MEL	
↓	↓			SJ 3337	↓	↓
5-13-16	15:35			SJ 3338	PWD	
5/13/16	1540			SJ 3339	Maine Medical	
				SJ 3340	COLM	
↓	↓	↓	↓	SJ 3341	↓	↓

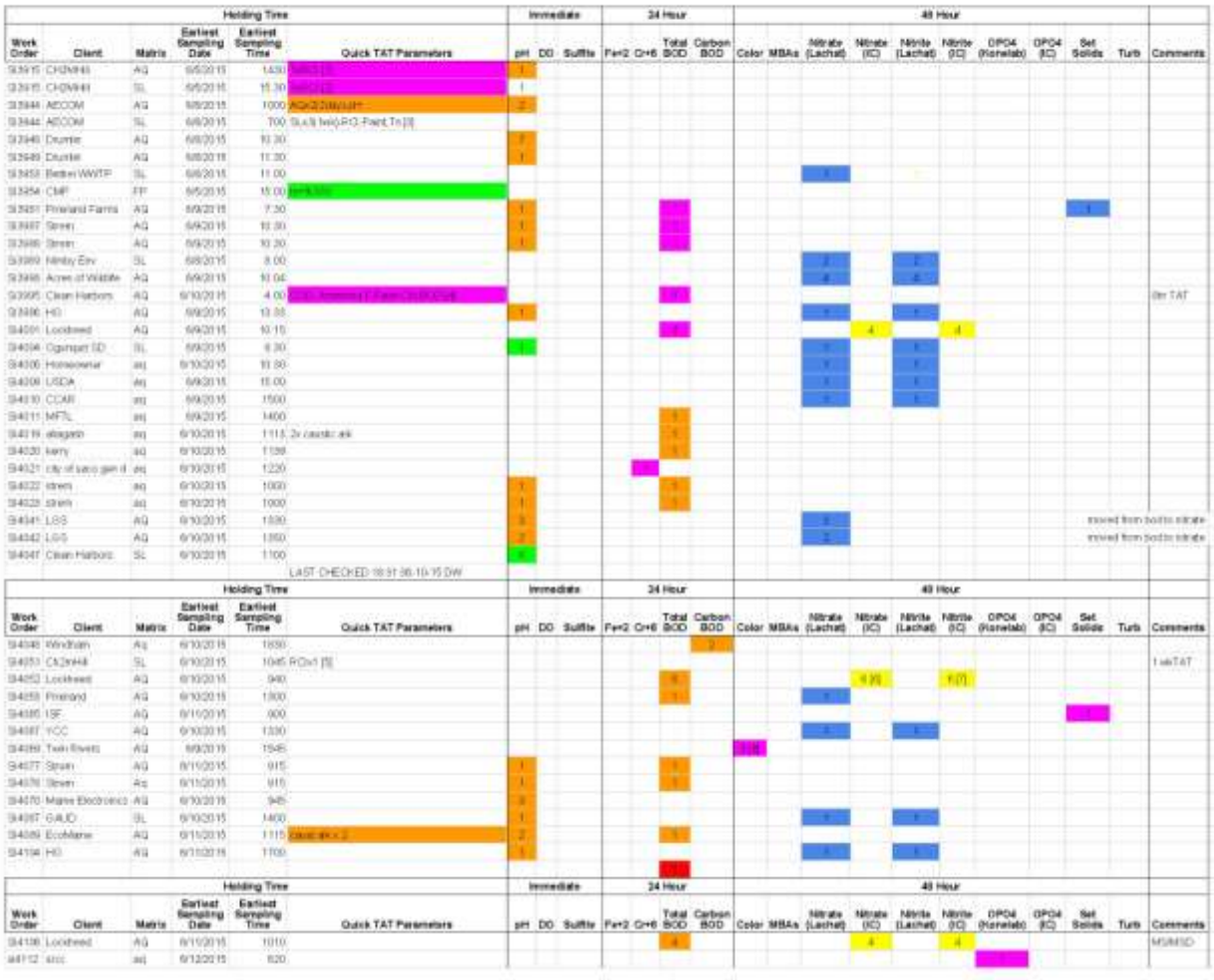
QA-032 - Revision 1 - 12/30/2009 Updated: 04/26/2016

QAQC793 0000011

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 6

EXAMPLE OF WET CHEMISTRY SHORTS AND RUSHES SCREEN SHOT



TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 7

EXAMPLE OF SAMPLE RECEIPT CONDITION REPORT FORM

Katahdin Analytical Services, LLC. **Sample Receipt Condition Report**

Client:	KAS PM:	Sampled By:
Project:	KIMS Entry By:	Delivered By:
KAS Work Order#:	KIMS Review By:	Received By:
SDG #:	Cooler: _____ of _____	Date/Time Rec:

Receipt Criteria	Y	N	EX*	NA	Comments and/or Resolution
1. Custody seals present / intact?					
2. Chain of Custody present in cooler?					
3. Chain of Custody signed by client?					
4. Chain of Custody matches samples?					
5. Temperature Blanks present? If not, take temperature of any sample w/ IR gun.					Temp (°C):
Samples received at <6 °C w/o freezing?					Note: Not required for metals (except Hg soil) analysis
Ice packs or ice present?					The lack of ice or ice packs (i.e. no attempt to begin cooling process) or insufficient ice may not meet certain regulatory requirements and may invalidate certain data.
If yes, was there sufficient ice to meet temperature requirements?					
If temp. out, has the cooling process begun (i.e. ice or packs present) and sample collection times <6hrs., but samples are not yet cool?					Note: No cooling process required for metals (except Hg soil) analysis.
6. Volatiles: **Aqueous:** No bubble larger than a pea? **Soil/Sediment:** Received in airtight container? Received in methanol? Methanol covering soil? D.I. Water - Received within 48 hour HT?					
Air: Refer to KAS COC for canister/flow controller requirements.	√ if air included				
7. Trip Blank present in cooler?					
8. Proper sample containers and volume?					
9. Samples within hold time upon receipt?					
10. Aqueous samples properly preserved? Metals, COD, NH3, TKN, O/G, phenol, TPO4, N+N, TOC, DRO, TPH – pH <2 Sulfide - >9 Cyanide – pH >12					

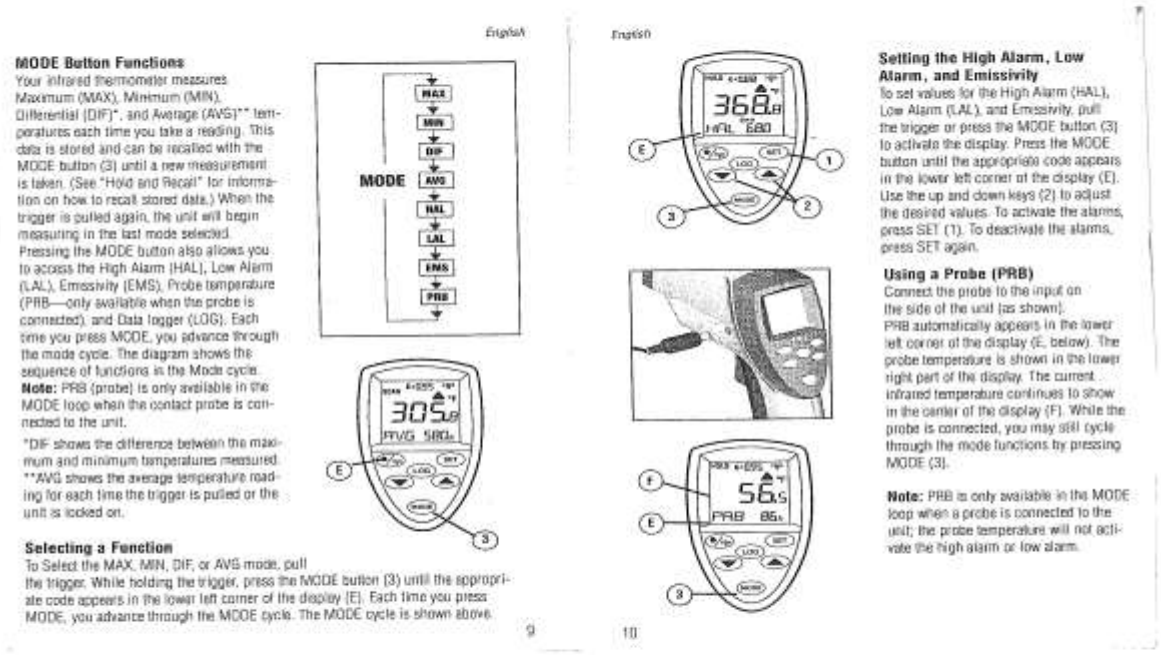
* Log-In Notes to Exceptions: document any problems with samples or discrepancies or pH adjustments.

QA-048 – Revision 6 – 07/20/2015

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 8

IR THERMOMETER MANUFACTURER'S INSTRUCTIONS FOR CHANGING EMISSIVITY



English

MODE Button Functions

Your infrared thermometer measures Maximum (MAX), Minimum (MIN), Differential (DIF)*, and Average (AVG)** temperatures each time you take a reading. This data is stored and can be recalled with the MODE button (3) until a new measurement is taken. (See "Hold and Recall" for information on how to recall stored data.) When the trigger is pulled again, the unit will begin measuring in the last mode selected. Pressing the MODE button also allows you to access the High Alarm (HAL), Low Alarm (LAL), Emissivity (EMS), Probe temperature (PRB—only available when the probe is connected), and Data logger (LOG). Each time you press MODE, you advance through the mode cycle. The diagram shows the sequence of functions in the Mode cycle.

Note: PRB (probe) is only available in the MODE loop when the contact probe is connected to the unit.

*DIF shows the difference between the maximum and minimum temperatures measured.
**AVG shows the average temperature reading for each time the trigger is pulled or the unit is locked on.

Selecting a Function

To Select the MAX, MIN, DIF, or AVG mode, pull the trigger. While holding the trigger, press the MODE button (3) until the appropriate code appears in the lower left corner of the display (E). Each time you press MODE, you advance through the MODE cycle. The MODE cycle is shown above.

9

English

Setting the High Alarm, Low Alarm, and Emissivity

To set values for the High Alarm (HAL), Low Alarm (LAL), and Emissivity, pull the trigger or press the MODE button (3) to activate the display. Press the MODE button until the appropriate code appears in the lower left corner of the display (E). Use the up and down keys (2) to adjust the desired values. To activate the alarms, press SET (1). To deactivate the alarms, press SET again.

Using a Probe (PRB)

Connect the probe to the input on the side of the unit (as shown). PRB automatically appears in the lower left corner of the display (E, below). The probe temperature is shown in the lower right part of the display. The current infrared temperature continues to show in the center of the display (F). While the probe is connected, you may still cycle through the mode functions by pressing MODE (3).

Note: PRB is only available in the MODE loop when a probe is connected to the unit; the probe temperature will not activate the high alarm or low alarm.

10

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 9

EXAMPLE OF KATAHDIN SAMPLE FILTRATION LOGBOOK

KATAHDIN ANALYTICAL SERVICES, INC.
Sample Filtration Logbook

Katahdin Sample No. List Individually	Site ID (Optional)	Filtration Requested By:		Filtered and Preserved By:		
		Initials	Date	Initials	Date	Time

Reviewed and Approved by: _____ **Date:** _____

ME-005 - Revision 1 - 09/23/2010

FIGURE 10

MEASURED TURBIDITY AND PRESERVATION OF INCOMING SAMPLES LOGBOOK

KATAHDIN ANALYTICAL SERVICES

Measured Turbidity and Preservation of Incoming Samples

KAS Lab Sample ID	Measured Turbidity (NTU)	Turbidity Date	Turbidity Analyst	Preservation Date	Preservation Time	Preservation Analyst
REVIEWED BY:			DATE:			

QA-068 – Revision 1 – 09/23/2010

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 11

EXAMPLE OF KIMS LABORATORY INCOMING SAMPLE REPORT

Katahdin ANALYTICAL SERVICES

INCOMING SAMPLE REPORT

Quote: ELM001 Account: ELM001 Project:
Company: [redacted] Quote Date: 29-MAR-10 Expires:
Name: [redacted] Date Expected: 28-SEP-40
Address: [redacted] Email: [redacted]

Notes: 8-aqueous VOA, 4-MEE,22-TOC, 44-metals (Total & Dissolved), 22-alkalinity, 12-Chloride,Nitrate, Nitrite, Sulfate

Analysis Notes: Merge Results for EDD

Report Notes: Email pdf and EDD to maltmayer@elmllc.com and tsnarr@elmllc.com, Mail rpt and EDD on CD, no HC, metals need to be rpt mg/l. Down load rpt to FTP site for ELM. Hold Rpt Till Payment See Daphne

Description:
Project Name: Pilot Test [redacted] Client PO:
QCLevel: II Tat: 13 Terms: Reg List: Edd: KAS064-XLS

Product	Matrix	Quant	STD or Special Lists	Short	Unit Price	Total Price
E325.2-CHLORIDE	AQ	1	STD		40	40
E353.2-NITRATE	AQ	1	STD	SHORT	0	0
E353.2-NITRITE	AQ	1	STD	SHORT	0	0
E375.4-SULFATE	AQ	1	STD		0	0
RSKSOP175-MEE	AQ	1	STD		85	85
SM5310B-TOC	AQ	1	STD		25	25
SW3010-PREP	AQ	1	STD		0	0
SW6010-ARSENIC	AQ	1	STD		60	60
SW6010-ARSENIC-DIS	AQ	1	STD		60	60
SW6010-CALCIUM	AQ	1	STD		0	0
SW6010-CALCIUM-DIS	AQ	1	STD		0	0
SW6010-IRON	AQ	1	STD		0	0
SW6010-IRON-DIS	AQ	1	STD		0	0
SW6010-MAGNESIUM	AQ	1	STD		0	0
SW6010-MAGNESIUM-DIS	AQ	1	STD		0	0
SW6010-MANGANESE	AQ	1	STD		0	0
SW6010-MANGANESE-DIS	AQ	1	STD		0	0
SW6010-POTASSIUM	AQ	1	STD		0	0
SW6010-POTASSIUM-DIS	AQ	1	STD		0	0
SW6010-SODIUM	AQ	1	STD		0	0
SW6010-SODIUM-DIS	AQ	1	STD		0	0
SW8260FULL_LD	AQ	1	STD		115	115
						$ 385.00

History: _____
Other: _____
_____

Printed: 21-SEP-10 1 of 1

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 12

EXAMPLE OF KATAHDIN WORK ORDER/LOGIN COC REPORT

Katahdin
ANALYTICAL SERVICES

Katahdin Analytical Services

Login Chain of Custody Report (lno1)

Jan. 26, 2007
03:51 PM

Page: 1 of 1

Login Number: SA0395
Account:KATAHD001
Katahdin Analytical Services
Project:

Web

Login Information

ANALYSIS INSTRUCTIONS	:
CHECK NO.	:
CLIENT PO#	:
COOLER TEMPERATURE	: n/a
DELIVERY SERVICES	: In House
EDD FORMAT	:
MAIL DATE	:
PM	: LAD
PROJECT NAME	: QC Holding Blanks
QC LEVEL	: I
REGULATORY LIST	:
REPORT INSTRUCTIONS	:
SDG ID	:
SDG STATUS	:

Primary Report Address:
Leslie Dimond
Katahdin Analytical Services
600 Technology Way
P.O. Box 540
Scarborough,ME 04070

Primary Invoice Address:
Accounts Payable
Katahdin Analytical Services
600 Technology Way
P.O. Box 540
Scarborough,ME 04070

Report CC Addresses:
Invoice CC Addresses:

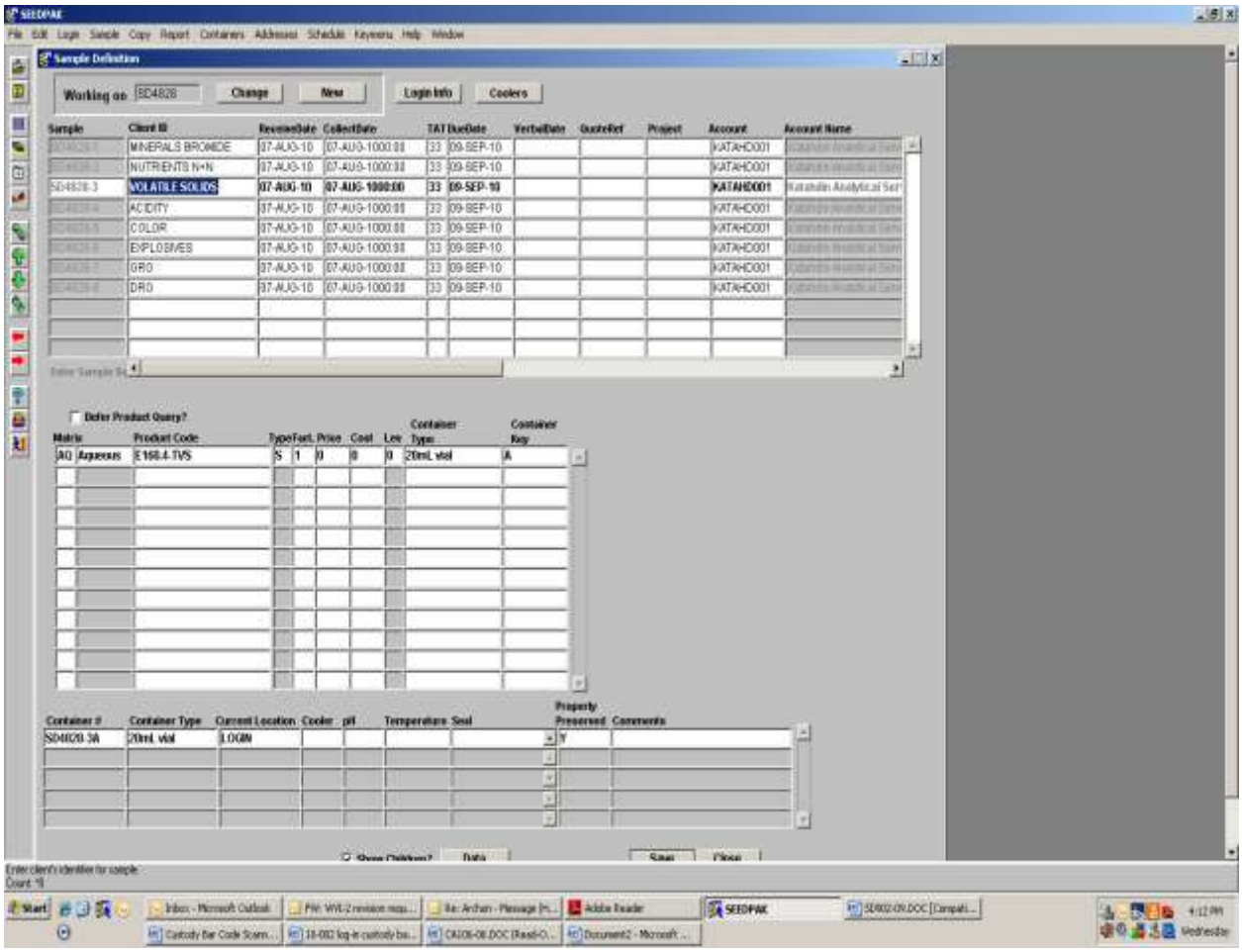
Laboratory Sample ID	Client Sample Number	Collect Date/Time	Receive Date	PR	Verbal Date	Due Date	Comments
SA0395-1	WHITE FRIDGE	26-JAN-07 15:50	26-JAN-07			08-FEB-07	
Matrix	*Product*	*Hold Date (shortest)*	*Bottle Type*		*Bottle Count*		
Aqueous	S SW8260FULLMS	09-FEB-07			3		
SA0395-2	BLUE FRIDGE	26-JAN-07 15:50	26-JAN-07			08-FEB-07	
Matrix	*Product*	*Hold Date (shortest)*	*Bottle Type*		*Bottle Count*		
Aqueous	S SW8260FULLMS	09-FEB-07			3		

Total Samples: 2 ***Total Analyses:*** 2

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 13

EXAMPLE OF LOGIN SCREEN IN KIMS



TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 14

EXAMPLE OF REFRIGERATOR TEMPERATURE LOGBOOK

KATAHDIN ANALYTICAL SERVICES, INC.

Sample Receipt Refrigerator and Freezer Temperature Logbook

Corrective Action: If acceptance criteria are not met, notify the QAO or your supervisor immediately to determine corrective action to be taken. Document the corrective action in the Comments section.

Thermometer Location		Sample Receipt Refrigerator 1	Sample Receipt Freezer 1	Comments
Acceptance Criteria		Above 0 to 6 °C	< -10 °C	
Date	Initials	Temp (°C)	Temp (°C)	

QA-069 – Revision 1 – 06/12/2013

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 15

EXAMPLE OF IMMEDIATE INTERNAL COC LOGBOOK

QA-046 – Revision 1 – 04/15/2010

KATAHDIN ANALYTICAL SERVICES, INC.
INTERNAL CUSTODY RECORD FOR IMMEDIATES

CLIENT	PROJECT	CLIENT ID &/or WORK ORDER #	ANALYSIS	OUT date/time	IN date/time	INIT	Consumed?
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no

0000001

FIGURE 16

SAMPLE ACCEPTANCE POLICY

Katahdin Analytical Services Sample Acceptance Policy

Katahdin Analytical Services reserves the right to refuse any samples due to any anomalies, discrepancies or non-compliances concerning the receipt and/or analysis of samples. These may include but are not limited to:

- Insufficient sample volume
- Insufficient remaining holding time
- Health or safety risks the samples may pose, including radioactivity
- Insufficient experience to handle sample or analysis
- Improper or illegible labeling of samples
- Improper sample containers
- Insufficient documentation including sample identification, location, date and time of collection, collector's name, preservation type, sample type and any special remarks concerning the sample
- Damaged, contaminated or inadequately preserved samples

Any decisions to reject samples are made with the client's input.

TITLE: **SAMPLE DISPOSAL**

Prepared By: _____ Date: 2/01

Approved By:

Group Supervisor: _____ Date: _____

Operations Manager: _____ Date: 2/01

QA Officer: _____ Date: 2.01

General Manager: _____ Date: 2/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Format changes, ~~added pollution prevention~~, added updated log book and greater detail on disposal.	DH	2.01	2/01
02	Major rewrite to include more detail on hazardous waste regulations & to reflect current practices.	DH	02/05	02/05
03	Rewrite of section 7 to comply with current practices in new facility. Updated Figures 1 to 3.	DH	02.08	02.08
04	Added elementary neutralization to section 7.0. Other minor edits.	DH	05.09	0509
05	Sect. 7 - Added non-hazardous samples are recycled, added PCB information, changed elementary neutralization target pH to 5-~~8~~9. Added wording for clarification. Updated Figures 1, 3 and 5.	LAM	06/13	06/13

TITLE: SAMPLE DISPOSAL

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SD-903-05**, titled **SAMPLE DISPOSAL**.

Recipient: _____ Date: _____

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SD-903-05**, titled **SAMPLE DISPOSAL**.

Recipient: _____ Date: _____

TITLE: SAMPLE DISPOSAL

1.0 SCOPE AND APPLICATION

Katahdin Analytical Services, Inc. requires strict adherence to specific procedures for the disposal of samples. The procedures are designed to categorize waste materials, provide for their safe and timely disposal and to ensure compliance with local and federal regulations pertaining to disposal of chemicals and environmental samples. Any other means of disposal not described in this SOP is prohibited without consent from the Katahdin Environmental Health & Safety Officer and/or the Katahdin Environmental Compliance Officer.

The purpose of this SOP is to describe the procedures utilized by Katahdin Analytical personnel for the disposal of samples. These procedures apply to the disposal of all samples received or processed by Katahdin. Refer to the current revision of Katahdin SOP CA-107 regarding the disposal of spent preparation and analysis reagents, standards, sample extracts, distillates, or digestates.

1.1 Definitions

Hazardous Waste – A “Solid Waste” which displays a hazardous characteristic or is specifically listed as hazardous waste.

Solid Waste – Any discarded material that is not excluded from the definition of hazardous waste.

Discarded Material – Material that is abandoned, recycled or inherently waste-like.

Waste (State of Maine) –

- Any useless, unwanted, or discarded substance or material, whether or not such substance or material has any other future use.
- Any substance or material that is spilled, leaked, pumped, poured, emptied or dumped onto the land or into the water or ambient air.
- Materials which are used in a matter constituting disposal, burned for energy recovery, reclaimed, or accumulated speculatively.

Ignitable Hazardous Waste – EPA Waste Code D001

- Liquids with a flash point less than 140°F or 60°C.
- Solids capable of spontaneous combustion under normal temperature and pressure.
- Ignitable compressed gas.
- Oxidizers.

Corrosive Hazardous Waste - Liquids with a pH less than or equal to 2.0 or greater than or equal to 12.5. EPA waste code D002.

Reactive Hazardous Waste – EPA waste code D003.

- A material that reacts violently with water.
- A material that generates toxic gases or fumes.
- Explosives.

Toxic Hazardous Waste – A material that exceeds certain concentration levels based on the toxicity characteristic leaching procedure (TCLP). See Figure 3 for the chemicals and concentration levels covered under this definition.

Listed Wastes – Lists of chemicals that are considered hazardous based on the following criteria

- Virgin chemical or unused product.
- Sole active ingredient.
- Single substance spill debris.

Listed wastes are divided into 5 subcategories

- F-wastes – Describe hazardous waste from non-specific sources usually containing halogenated and non-halogenated solvents.
- K-wastes – Describe hazardous wastes created by specific processes.
- U-wastes – Describe toxic or non-acute hazardous wastes.
- P-wastes – Describe acute hazardous wastes. (Note: Maine considers a material to be a P-listed waste if it contains 10% or more of any P-listed chemical.
- State listed wastes – Maine lists any material with a concentration of greater than 50 ppm Polychlorinated Biphenyls (PCB) as a hazardous waste.

Organics hit – A liquid sample containing greater than 1 mg/L of organic contaminants or a soil sample containing greater than 20 mg/kg of organic contaminants.

1.2 Responsibilities

Only designated analysts/technicians trained in these procedures may dispose of samples or analytical by-products. Each analyst or technician must be familiar with Katahdin Analytical safety procedures. Gloves, safety glasses, lab coats and/or other protective clothing must be worn at all times.

It is the responsibility of the designated Katahdin personnel involved in the disposal of samples to read and understand this SOP, to adhere to the procedures outlined, to properly document their activities in the appropriate lab notebook and file the necessary manifests and reports to outside agencies in the required manner. Refer to

Katahdin SOP QA-805, "Personnel Training & Documentation of Capability," current revision.

It is the responsibility of the Department Managers to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

It is the responsibility of the Katahdin Environmental Health & Safety Officer (EHSO) to manage the proper classification and disposal of samples. Katahdin is responsible for regulatory compliance of Katahdin's waste storage areas (less than 90 day storage). The EHSO ensures compliance of the waste storage areas with applicable state and federal regulations. The EHSO is responsible for providing the appropriate training to all individuals involved in the proper classification and/or disposal of samples. The EHSO is responsible for working with the Laboratory Operations Manager/Environmental Compliance Officer to help identify problems and assure resolution, to facilitate corrective action where needed, and to communicate unresolved problems and concerns to the Laboratory Vice President.

It is the responsibility of the Operations Manager/Environmental Compliance Officer to oversee adherence to Katahdin sample disposal and hazardous waste practices by all laboratory groups under his/her authority, to help identify problems and assure resolution, to facilitate corrective action where needed, and to communicate problems and concerns to the EHSO and/or the Laboratory Vice President.

It is the responsibility of the Laboratory Vice President to provide the necessary resources to meet the regulatory requirements of proper classification and disposal of samples.

2.0 SUMMARY OF METHOD

Not applicable.

3.0 INTERFERENCES

Not applicable.

4.0 APPARATUS AND MATERIALS

Not applicable.

TITLE: SAMPLE DISPOSAL

5.0 REAGENTS

Not applicable.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Not applicable.

7.0 PROCEDURES

7.1 Sample purging is the removal of samples from laboratory refrigerated storage. Sample storage areas where samples are removed (purged) from include wet chemistry, organic extractables, metals, volatiles, total organic carbon and soils. Wet chemistry, aqueous metals, organic extractables, total organic carbon, and soils can all be found in the walk-in refrigerator. Aqueous and soil volatiles can be found in the volatiles laboratory refrigerators/freezer.

7.2 Samples are purged from storage, after analysis and reporting, on a routine basis to make room for incoming samples. Samples are to be kept in storage for a duration of 30 days past the report mailed date. Some samples must be kept for 60 or 90 days beyond the report mailed date, depending on specific client requests and contracts.

7.3 The first step in disposing of samples is to generate a disposal list. The disposal list contains sample analysis information stored in the Katahdin Information Management System (KIMS). The analytical data for the samples is compared to the hazardous waste criteria specified in 40CFR Part 261 and to local wastewater discharge criteria. Refer to Figure 4 for 40 CFR Part 261 Characteristic Hazardous Waste Criteria. Based on this comparison, the report displays information on the classification/category for disposal of each sample. The disposal report should be reviewed against the data reports for accuracy. Refer to Figure 2 for an example of a KIMS generated disposal list. The primary disposal categories listed in the report are: non-hazardous, high organics, high metals, flashpoint, high mercury, high PCBs, and high cyanide. Katahdin has established 14 waste stream profiles with a 3rd party waste transporter/waste disposal firm for sample disposal based on these categories. As required, new or special temporary waste profiles are established based on the characteristics of samples.

7.4 Sorting through samples and preparing them for disposal is a crucial quality checkpoint. Samples put into the incorrect waste stream could not only produce adverse environmental effects, but, could also interrupt the 3rd party's waste treatment efficiency, or endanger an individual handling the waste stream. Therefore, when sorting through samples pay close attention to which waste stream each sample falls into.

7.5 Once you are ready to dispose of the samples of interest (the oldest samples that have been purged), these samples must be sorted, logged, and the classification/category (sample knowledge) information recorded.

Sample storage times (as listed in section 7.2) and space should be taken into consideration when purging samples. It is important to make room for future samples, but to make sure that samples are not purged too early. Samples should be pulled from the walk-in or the volatiles refrigerators to make room for new samples. When purging, chose a section that needs extra space the most and remove the oldest samples.

Safety glasses, nitrile gloves, lab coat, and a splash apron must be worn when handing samples during disposal

7.6 Remove the designated purge samples from the shelf one by one and line them up on the countertop in the log-in area. Generally, removing two cartloads at a time is a good amount to purge at one time. For volatile samples in 40mL vials, 5 or 6 vial trays should be purged at a time. Samples should be lined up across the counter with the earliest sample to the left and building up to the right, organizing the samples according to work order and sample number. After the samples are lined up, they should be recorded in the Sample Disposal Logbook (SDL). Refer to Figure 1 for an example SDL page. The location the samples were removed from should also be recorded. Sample storage areas are recorded with the following designations:

VOA (Aq)	Aqueous Volatiles (VOA)
VOA (SL)	Solid Volatiles (VOA)
M	Metals
EXT	Extractables (Organic)
TOC	Total Organic Carbon
WC	Wet Chemistry
S	Soils

7.7 The next step is to use the sample disposal list to determine the earliest release date of the reports and to determine each samples appropriate waste classification/characterization. As stated in section 7.3, the primary disposal categories listed in the report are: non-hazardous, high organics, high metals, flashpoint, high mercury, high PCBs, and high cyanide.

Using the information from the KIMS disposal list, record the appropriate classification for each sample in the SDL. If multiple categories are identified as being present then a single category is selected as controlling. The order of precedence is PCB's, metals and then organics. If another scenario is found, the individual should bring it to the EHSO for a determination of the acceptable waste stream designation or a determination that it should be lab packed separately.

If samples have been sorted that have not been in storage for the 30 days beyond the release date (60 or 90 for certain clients), then these samples need to be placed back in storage and it should be noted in the SDL.

7.8 As stated above, a sample may be categorized into a waste stream based upon the analytes it contains as determined by laboratory testing. In addition, many samples are also categorized as hazardous waste based upon the preservative that they contain. Since many samples contain preservatives, caution must be used when dumping samples. It is also important to ensure that the sample container is empty. This can be accomplished by holding the container upside down and shaking gently until liquid is no longer observed coming out of the container.

7.9 Once waste categories have been determined and entered into the SDL, The following waste categories are disposed of as follows:

7.9.1 Dumping non-hazardous samples (as determined by laboratory testing)

Non-hazardous liquid samples (non-preserved) are poured directly into the sink in the warehouse.

Non-hazardous solid samples and their containers are disposed of with the recycling trash, which is picked up by commercial trash collectors and ultimately turned into construction material.

7.9.2 Dumping Samples with high Organics (as determined by laboratory testing)

Aqueous samples get dumped into waste stream “K”. Containers are disposed of with general trash. Solid samples are placed into waste stream “I” with their containers. The disposal date is recorded in the SDL.

7.9.3 Dumping samples high in metals, including mercury (as determined by the by laboratory testing)

Aqueous samples get disposed of in waste stream “A”. Containers are disposed of with general trash. Solid samples are placed in waste stream “L” with their containers. The disposal date is recorded in the SDL.

7.9.4 Dumping Acidic Samples that do not contain any other hazardous waste constituents (as determined by the acidic preservative or by laboratory testing)
Refer to section 7.10 below.

7.9.5 Dumping samples with high PCBs (as determined by laboratory testing)

Aqueous samples are disposed of in waste stream “Q”. Containers are disposed of with general trash. Solid samples get disposed of in waste stream “F” with their containers. The disposal date is recorded in the SDL. Any PCB samples with PCB content 50 ppm or greater, solid or aqueous, are set aside for TCSA regulated disposal.

7.9.6 Dumping samples with low flashpoints (as determined by laboratory testing)

Aqueous samples are disposed of in waste stream “O”. Containers are disposed of with general trash. Solid samples get disposed of in waste stream “I” with their containers. The disposal date is recorded in the SDL.

7.9.7 Dumping samples with high cyanide (as determined by laboratory testing)

Aqueous samples are disposed of in waste stream “NHi”. Containers are disposed of with general trash. Solid samples should be set aside for labpack. The disposal date is recorded in the SDL.

7.9.8 Miscellaneous Disposal (as determined by the preservative)

7.9.8.1 Sodium Bisulfate: Sodium Bisulfate often comes in vials, but may also come in the 2-4oz glass jars. Dump the Sodium Bisulfate out of the container into waste stream “A”. There may be remaining soil left in the sample container. The soil’s waste stream and dump date will be dictated by the SDL. The disposal date is recorded in the SDL.

7.9.8.2 Methanol / Free Products: This often comes in vials, but may also come in the 2-4oz glass jars. Dump the methanol out of the container into the mix-flammables accumulation. When this satellite accumulation container gets full it can be dumped into the “O” waste stream. There may be remaining soil left in the sample container. The soil’s waste stream and dump date will be dictated by the SDL. Lastly, samples marked “free product” on the Katahdin sample ID label can be dumped into the mixed flammables stream. The disposal date is recorded in the SDL.

7.10 Pursuant to Maine DEP regulations, Katahdin has the necessary agreements, processes and documentation in place to neutralize samples without a license. Refer to the current revision of the Katahdin Environmental Health & Safety Manual for additional information. Generally, the following procedures are followed.

7.10.1 Samples that have been determined to be hazardous due **solely** to the corrosivity characteristic are neutralized using sodium hydroxide pellets. In the warehouse, samples are emptied into a five gallon heavy duty carboy to about 60% capacity. The carboy is kept in a secondary container. Sodium

hydroxide pellets are added slowly to the carboy (about 5 grams at a time) and stirred with a long glass stirring rod. The pH is checked with pH paper.

7.10.2 This process is continued until the pH is between 5 and 9. This normally takes about 30-40 grams of sodium hydroxide pellets, but may vary depending on the buffering capacity of the individual samples.

7.10.3 The carboy is emptied into the sink in the warehouse. The tap water is run at the same time as the neutralized material is disposed of. An eyewash station and spill material is located at this sink.

7.10.4 All neutralization activities are documented, including the date and time of neutralization, the name of the person doing the neutralizing, the amount of neutralized liquid discharged, details on the inspection of the drain area and the date and nature of any significant repairs or corrective actions. This documentation is maintained by the EHSO. Refer to Figure 5 for an example logbook page of neutralization documentation.

7.11 Dumping Basic samples (as determined by the basic preservative or by laboratory testing). If the samples have been to be hazardous due solely to the corrosivity characteristic, they are included in the neutralization process above.

7.12 Every 3 to 5 weeks a pickup of hazardous waste is scheduled with the 3rd party waste transporter/waste disposal firm. An inventory is faxed to the transporter summarizing the number of drums and waste streams/profiles. As required, a “lab pack” of expired chemicals or orphan samples is organized as necessary. A designated individual, with applicable Hazardous Waste (RCRA) and Department of Transportation (DOT) training, oversees the waste pickup and signs the hazardous manifests and land ban documentation. Within 7 days a copy is forwarded to the Maine Department of Environmental Protection (MEDEP) and the environmental agency in the designation state (if required by that state). Once the report is received at the disposal facility a copy is returned to KATAHDIN and the MEDEP.

7.13 Prior to March 31 of each year, the laboratory prepares the Annual Hazardous Waste Report (i.e., MEDEP modified EPA Form 8700-13A) as required by MEDEP Hazardous Waste Management Rules. The complete report is reviewed by the Katahdin Environmental Compliance Officer and then forwarded to the following address:

Maine Department of Environmental Protection
Bureau of Remediation & Waste Management
State House Station #17
Augusta, ME. 04333
Attn: Annual Hazardous Waste Report

TITLE: SAMPLE DISPOSAL

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

On a daily basis, a designated individual performs quality checks in all hazardous waste storage areas. The daily check documentation is located in login. Any discrepancy is copied to the Operations Manager and the Katahdin Vice President for corrective action. Refer to the current revision of Katahdin SOP CA-107, *The Management of Hazardous Waste as it Relates to the Disposal of Laboratory Process Waste, Reagents, Solvents & Standards*, for more information. Refer to Figure 3 for a copy of the daily check documentation.

9.0 METHOD PERFORMANCE

Not applicable.

10.0 APPLICABLE DOCUMENTS/REFERENCES

USEPA Code of Federal Regulations, 40 CFR Part 261.

Maine Department of Environmental Protection (ME DEP) Hazardous Waste Management Rules

ME DEP modified EPA Form 8700-13A

LIST OF TABLES AND FIGURES

TITLE: SAMPLE DISPOSAL

FIGURE 1

EXAMPLE OF SAMPLE DISPOSAL LOGBOOK (SDL)

QA-022 - Revision 1 - 11/09/2009

QAQC645

0000012

KATAHDIN ANALYTICAL SERVICES, INC. –SAMPLE STORAGE/DISPOSAL LOGBOOK

WORK ORDER/ SAMPLE NUMBERS	DEPARTMENT	EARLIEST RELEASE DATE	< CRITERIA	SAMPLE KNOWLEDGE									DATE DISPOSED	INITIALS
			CLEAN	WL	ORG	METS	CN	FP	HG	PCBS				
SG-1969-1	M	4-10-13		✓					✓				5-20-13	5-20-13
SG-1970-1		4-9-13		✓										
SG-1977-1		4-4-13	✓											
SG-1978-1-22		4-18-13	1-10, 12-H 16-22		11, 15									
SG-1979-2-10		4-10-13	✓											
SG-1990-1		4-4-13				✓								
SG-1991-1	↓	4-4-13				✓							↓	↓
SG-1002-1	WC	2-27-13	✓										5-21-13	5-21-13
SG-1010-1		2-26-13	✓											
SG-1017-1		2-21-13	✓											
SG-1021-1		2-26-13	✓											
SG-1022-1,2	↓	2-28-13	2	1									↓	↓

TITLE: SAMPLE DISPOSAL

FIGURE 2

EXAMPLE OF KIMS GENERATED WASTE DISPOSAL REPORT

SAMPLE DISPOSAL REPORT

Query by: Login SA6501 to SA7000
Date : 15-JAN-08

Sample	SDG	Status	Mail Date	Parameter	Value		
SA6605-1		NEED	12/02/07				
SA6606-1		NEED	12/02/07				
SA6607-1		NEED	11/15/07				
SA6608-1		NEED	12/06/07				
				ORG	1.17	MG/L	(HIGH)
SA6608-1		NEED	12/06/07				
SA6608-2		NEED	12/06/07				
				AA	13	MG/KG	(HIGH)
SA6609-1		NEED	11/26/07				
SA6609-1		NEED	11/26/07				
SA6610-1		NEED	11/30/07				
SA6611-1	FCS-020	NEED	12/07/07				
SA6611-2	FCS-020	NEED	12/07/07				
SA6611-3	FCS-020	NEED	12/07/07				
SA6611-4	FCS-020	NEED	12/07/07				
SA6611-5	FCS-020	NEED	12/07/07				
SA6611-6	FCS-020	NEED	12/07/07				
SA6611-7	FCS-020	NEED	12/07/07				
SA6611-8	FCS-020	NEED	12/07/07				
SA6612-1	NSA-030	NEED	12/07/07				
SA6612-2	NSA-030	NEED	12/07/07				
SA6612-3	NSA-030	NEED	12/07/07				
SA6612-4	NSA-030	NEED	12/07/07				
				ORG	1.70735	MG/L	(HIGH)
SA6612-5	NSA-030	NEED	12/07/07				
				ORG	1.0481	MG/L	(HIGH)

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TITLE: SAMPLE DISPOSAL

FIGURE 3

EXAMPLE OF HAZARDOUS WASTE STORAGE AREA DAILY CHECK

HZ-007 – Revision 1 – 09/30/2010

Daily Checklist for
HAZARDOUS WASTE STORAGE AREA

Week of: 6-10, 2013

Item/Day:	Monday	Tuesday	Wednesday	Thursday	Friday
1. Are containers closed? (Except when waste is being added)	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No
2. Are containers properly labeled with a hazardous waste label?	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No
3. Do you have access to each container and can you read the label? (36" aisle?)	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No
4. Is each container marked with the date storage began?	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No
5. Are the dates on the containers less than 90 days old?	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No
6. Is container free of dents, bulges, rust, spills or leaks?	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No
7. Are all containers on a firm working surface?	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No	(Yes) / No
8. Inspection by: Name (No Initials)					
9. Time of Inspection	14:45	15:10	16:30	12:00	16:00
10. Verification of Inspection (Name/Date)	Dave Medler 6/10/13	Dave Medler 6/11/13	Dave Medler 6/12/13	Dave Medler 6/13/13	Dave Medler 6/14/13

Deficiency noted:					
Corrective action:					
By (Name/Date):					

0000040

TITLE: SAMPLE DISPOSAL

FIGURE 4

CHARACTERISTIC TOXIC HAZARDOUS WASTE AND TCLP CONCENTRATIONS

Chemical Name	CAS Number	Waste Code	TCLP conc. liquid	Equivalent conc. In Soil
Arsenic	7440-38-2	D004	5.0 mg/L	100 mg/kg
Barium	7440-39-3	D005	100 mg/L	2000 mg/kg
Cadmium	7440-43-9	D006	1.0 mg/L	20 mg/kg
Chromium	7440-47-3	D007	5.0 mg/L	100 mg/kg
Lead	7439-92-1	D008	5.0 mg/L	100 mg/kg
Mercury	7439-97-6	D009	0.2 mg/L	4 mg/kg
Selenium	7782-49-2	D010	1.0 mg/L	100 mg/kg
Silver	7440-22-4	D011	5.0 mg/L	20 mg/kg
Endrin	72-20-8	D012	0.02 mg/L	0.4 mg/kg
Lindane	58-89-9	D013	0.4 mg/L	8 mg/kg
Methoxychlor	72-43-5	D014	10 mg/L	200 mg/kg
Toxaphene	8001-35-2	D015	0.5 mg/L	10 mg/kg
2,4-D	94-75-7	D016	10 mg/L	200 mg/kg
2,4,5-TP (Silvex)	93-72-1	D017	1.0 mg/L	20 mg/kg
Benzene	71-43-2	D018	0.5 mg/L	10 mg/kg
Carbon Tetrachloride	56-23-5	D019	0.5 mg/L	10 mg/kg
Chlordane	57-74-9	D020	0.03 mg/L	0.6 mg/kg
Chlorobenzene	108-90-7	D021	100 mg/L	2000 mg/kg
Chloroform	67-66-3	D022	6.0 mg/L	120 mg/kg
o-Cresol	95-48-7	D023	200 mg/L	4000 mg/kg
m-Cresol	108-39-4	D024	200 mg/L	4000 mg/kg
p-Cresol	106-44-5	D025	200 mg/L	4000 mg/kg
Cresol	1319-77-3	D026	200 mg/L	4000 mg/kg
1,4-Dichlorobenzene	106-46-7	D027	7.5 mg/L	150 mg/kg
1,2-Dichloroethane	107-06-2	D028	0.5 mg/L	10 mg/kg
1,1-Dichloroethylene	75-35-4	D029	0.7 mg/L	14 mg/kg
2,4-Dinitrotoluene	121-14-2	D030	0.13 mg/L	2.6 mg/kg
Heptachlor	76-44-8	D031	0.008 mg/L	0.16 mg/kg
Hexachlorobenzene	118-74-1	D032	0.13 mg/L	2.6 mg/kg
Hexachlorobutadiene	87-68-3	D033	0.5 mg/L	10 mg/kg
Hexachloroethane	67-72-1	D034	3.0 mg/L	60 mg/kg
Methyl Ethyl Ketone	78-93-3	D035	200 mg/L	4000 mg/kg
Nitrobenzene	98-95-3	D036	2.0 mg/L	40 mg/kg
Pentachlorophenol	87-86-5	D037	100 mg/L	2000 mg/kg
Pyridine	110-86-1	D038	5.0 mg/L	100 mg/kg
Tetrachloroethylene	127-18-4	D039	0.7 mg/L	14 mg/kg
Trichloroethylene	79-01-6	D040	0.5 mg/L	10 mg/kg
2,4,5-Trichlorophenol	95-95-4	D041	400 mg/L	8000 mg/kg
2,4,6-Trichlorophenol	88-06-2	D042	2.0 mg/L	40 mg/kg
Vinyl Chloride	75-01-4	D043	0.2 mg/L	4.0 mg/kg

TITLE: SAMPLE DISPOSAL

FIGURE 5

EXAMPLE OF ELEMENTARY NEUTRALIZATION LOGBOOK

Katahdin Analytical Services, Inc. – Elementary Neutralization Logbook

Date: 5-9-13		Time: 16:30	Analyst: GN
# of gallons neutralized	Final pH	Condition of drain and sink area before and after neutralization.	Significant Repairs or Corrective Actions
6	7	good	
6	7		
5	6		
5	5		
5	7		

Date: 5-16-13		Time: 12:00	Analyst: GN/WS
# of gallons neutralized	Final pH	Condition of drain and sink area before and after neutralization.	Significant Repairs or Corrective Actions
5	7	good	
5	5		
5	7		
5	7		
6	5		
6	8		
5	7		
5	7		
4	6		

ADDENDUM

SOP NO CHANGE FORM

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Galen Nickerson

Review Date: 12-8-14

SOP Number: SD-903

SOP Title: Sample Disposal

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: Deborah J. Nadeau **Date:** 12.8.14

QAO Signature: Jessie Dimond **Date:** 12.08.14

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP:

Review Date: 02/02/16

SOP Number: SD-903-05

SOP Title: Sample Disposal

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: _____ **Date:** 2-2-16

QAO Signature: Jessie Dimond **Date:** 02.03.16

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP:

Review Date: 02/02/16

SOP Number: SD-903-05

SOP Title: Sample Disposal

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: _____ **Date:** 2-2-16

QAO Signature: Leslie Dimond **Date:** 02.03.16

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Gale Nickerson

Review Date: 5-13-16

SOP Number: SD-903-05

SOP Title: Sample Disposal

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: Gale Nickerson **Date:** 05-13-16

QAO Signature: Lucio Dimond **Date:** 05.13.16

change waste check list figure: Daily → weekly

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

SOP Number: CA-510
Revision History
Cover Page
Page 1

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

Prepared By: George Brewer Date: 12/97

Approved By:

Group Supervisor: George Brewer Date: 02/01/01

Operations Manager: John C Buxton Date: 2/2/01

QA Officer: Deborah J. Nadeau Date: 2.1.01

General Manager: Donald F. Kenfield Date: 2/08/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01 1311	Changed figures, inserted database references. Format changes, added pollution prevention.	DN	2.1.01	2/1/01
02 1311	Modified to reflect change from TCLP database to handwritten logbooks. Changed metals spiking instructions	LAD	030805	030805
03	Added expiration dates for TCLP fluids (1YR) Added DOC requirement Revised TCLP logbook to include SPLP and spaces for pH and exp. dates.	LAD	01/07	01/07
04	Sect. 4: Added use of fluorinated extraction vessels for organics. Updated TCLP/SPLP Logbook example.	LAD	03/08	03/08
05	Updated Figure 8 - TCLP Extraction logbook page.	LAD	03/09	03/09

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
06	Updated and/or added references to sections 7, 9 and 10. Updated Figure 8- Logbook page.	LAD	06/10	06/10
07	Revised Logbook and updated Figures 8 and 9. Updated text references to logbook in SOP. Revised section 7.4.2 to require pH measurement by meter rather than pH strips. Added and updated references in section 10	LAD	04/12	04/12
08	Sect. 4.5 - Changed reagent and preparation from 1N HNO_3 to 5% HNO_3. Table 2 - Added HNO_3 concentration. Sect. 10 - Added and updated references. Updated Figures 6 → 9	LAD	06/14	06/14
09	Sect. 7 - Added room temperature criteria. Fixed typographical errors. ~~KAS → K~~ KAS INC → KAS throughout LAD 08/15/15	LAD	08/15	08/15

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-510-09,** titled **Toxicity Characteristic Leaching Procedure (TCLP) for Inorganic and Non-Volatile Organic Analytes**.

Recipient: _____ Date: _____

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-510-09,** titled **Toxicity Characteristic Leaching Procedure (TCLP) for Inorganic and Non-Volatile Organic Analytes**.

Recipient: _____ Date: _____

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to define the procedures used by Katahdin Analytical Services personnel for TCLP extraction of samples for inorganic and non-volatile organic components using USEPA Method 1311 (Test Methods for Evaluating Solid Waste, Physical / Chemical Methods, US EPA SW846), with the modifications discussed in Table 2.

The TCLP (Toxicity Characteristic Leaching Procedure) is designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes.

If a total analysis of the waste demonstrates that individual analytes are not present in the waste, or that they are present but at such low concentrations that the appropriate regulatory levels could not possibly be exceeded, the TCLP need not be run.

If an analysis of the liquid fractions of the TCLP extract indicates that a regulated compound is present at a concentration that, after accounting for dilution from the other fractions of the extract, would be equal to or above the regulatory level for that compound, then the waste is hazardous and it is not necessary to analyze the remaining fractions of the extract. The regulated toxicity characteristic analytes are listed in Table 3.

1.1 Definitions - None.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of, analysts experienced in TCLP extractions. Each analyst must demonstrate the ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, Personnel Training and Demonstration of Capability.

It is the responsibility of all Katahdin technical personnel involved in TCLP extractions to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to ensure that members of their group follow this SOP, to ensure that their work is properly documented, and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be aware of inherent laboratory hazards, proper disposal procedures for contaminated materials, and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this

method may not be precisely known; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets (MSDS) is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with the Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Plan for further details on pollution prevention techniques.

Wastes from TCLP extraction may contain acids, heavy metals, toxic organics, and other toxic components and should be disposed of in a manner appropriate to the hazards they present. Further information regarding waste classification and disposal may be obtained by consulting the Katahdin Hazardous Waste Management Plan and the Department Manager.

2.0 SUMMARY OF METHOD

2.1 For liquid wastes (i.e., those containing less than 0.5% dry solid material), the waste, after filtration through a 0.6 to 0.8 µm glass fiber filter, is defined as the TCLP extract.

2.2 For wastes containing greater than or equal to 0.5% solids, the liquid phase is first separated from the solid phase and stored for later analysis. The particle size of the solid phase is reduced, if necessary, and the solid phase is extracted with an amount of extraction fluid equal to 20 times its weight. The composition of the extraction fluid employed depends on the alkalinity of the solid phase of the waste. After extraction, the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8 µm glass fiber filter.

2.3 If they are compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract and these are analyzed

together. If they are incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration.

3.0 INTERFERENCES

Because the dissolved solids contents of TCLP extracts are typically high, analyses of these extracts are often troubled by matrix interferences. Methods to detect and overcome matrix interferences are integral to the TCLP procedure and are discussed in detail in Section 8.0, Quality Control.

Potential interferences that may be encountered during analysis are discussed in the individual analytical methods.

4.0 APPARATUS AND MATERIALS

4.1 Agitation apparatus (rotary extractor) - The agitation apparatus must be capable of rotating the extraction vessel in an end-over-end fashion at 30±2 revolutions per minute (rpm) – see Figure 1. Each of the laboratory's rotary extractors is equipped with a device that displays the actual rotation rate in rpm. The rotation rate of each extractor is monitored before each use, and the measured rotation rates are recorded in a logbook maintained for that purpose (see Figure 7). If the measured rotation rate of an extractor is outside the range 30±2 rpm, it must be taken out of service until it can be repaired.

4.2 Extraction vessels - must fit the rotary extractor and have sufficient capacity to hold the sample and the extraction fluid (jars with capacities of 2.2 L are normally used). The vessel must be made of borosilicate glass or fluorinated polyethylene if the extract is to be analyzed for organics. If the extract is to be analyzed only for inorganics, polyethylene or polypropylene containers may be used.

4.3 Filter Holder - Filter holders for pressure filtration are used. They are constructed of type 316 stainless steel (with or without PTFE linings) and are capable of sustaining internal pressures exceeding 50 psi. These devices have an internal capacity of 1.5 L and accommodate glass fiber filters 142 mm in diameter.

4.4 Filters - Borosilicate glass fiber filters containing no binder materials and having an effective pore size of 0.6 to 0.8 µm, 142 mm diameter or equivalent. Prefilters must not be used. Glass fiber filters are fragile and should be handled with care. Filters should be acid-washed with 5% HNO_3 and triple rinsed with laboratory reagent grade water (minimum 500 mL/ rinse) prior to use.

4.5 pH meter accurate to ±0.05 units at 25°C. The pH meter must be calibrated on each day of use.

4.6 pH indicator strips covering the pH range 0 - 14 in increments of 1 pH unit.

4.7 Laboratory balance accurate to within ±0.01 grams (all weight measurements are to be within ±0.1 grams).

4.8 Beakers flasks, glass, 500 mL..

4.9 Watch glasses, appropriate diameter to cover beakers.

4.10 Magnetic stirrer.

5.0 REAGENTS

Reagent grade chemicals shall be used in all tests. Other grades may be used only if it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

5.1 Laboratory reagent grade water – Water free of any analyte of interest. Laboratory reagent grade water should be monitored periodically for impurities.

5.2 Hydrochloric acid, concentrated (HCl) – reagent grade.

5.3 Nitric acid, concentrated (HNO_3) – reagent grade.

5.4 Hydrochloric acid, 1N. Dilute 83 mL reagent grade HCl to 1000 mL with laboratory reagent grade water.

5.5 Nitric acid, 5%, for acid-washing filters. Dilute 500 mL reagent grade HNO_3 to 10 L with laboratory reagent grade water.

5.6 Sodium hydroxide (NaOH) – reagent grade, pellets.

5.7 Glacial acetic acid (CH_3COOH) – reagent grade.

5.8 Extraction Fluid #1 - Add 114 mL glacial acetic acid and 51.4 g sodium hydroxide to approximately 1500 mL of laboratory reagent grade water in a clean borosilicate glass extraction vessel reserved for this purpose. Shake until the sodium hydroxide is completely dissolved. Pour this solution into a clean, graduated 20 L carboy reserved for Extraction Fluid #1 and rinse the extraction vessel three times with approximate liter volumes of laboratory reagent grade water, adding the rinsates to the carboy. Add laboratory reagent grade water to the carboy to bring the volume to the 20 L graduation. Cap the carboy and agitate until the fluid is well mixed. When correctly prepared, the pH of this fluid will be 4.93 ±0.05. The fluid may be used for up to one year from the preparation date.

5.9 Extraction Fluid #2 - Add approximately 10 L of laboratory reagent grade water to a graduated 20 L carboy reserved for Extraction Fluid #2. Add 114 mL glacial acetic acid to the carboy, and then add laboratory reagent grade water to bring the volume to the 20 L graduation. Cap the carboy and agitate until the fluid is well mixed. When correctly prepared, the pH of this fluid will be 2.88 ±0.05. The fluid may be used for up to one year from the preparation date.

NOTE: The pH of each extraction fluid must be checked prior to each use to ensure that it has been prepared accurately, and the measured pH is recorded in the Non-Volatile TCLP Extraction Logbook (Figure 8) for each sample extracted. Details of the preparation of these fluids (reagent lot numbers, volumes, and masses; measured pH; etc.) are recorded in the TCLP Fluid Preparation and Use Logbook (Figure 6). Upon preparation, each new batch of extraction fluid is assigned a 3-digit batch number by the analyst (batches are numbered consecutively), and the Katahdin Sample Number of each client sample extracted with a particular fluid batch is recorded in the TCLP Fluid Preparation and Use Logbook. Extraction fluids are monitored for impurities as described in Section 8.0 of this SOP.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

All samples shall be collected in a soil jar using an appropriate sampling plan.

6.1 Sufficient sample must be collected to support the preliminary determinations and to provide an extract volume adequate for all analytical and quality control purposes. The necessary sample size will depend on the solids content of the waste, but in no instance should less than 250 g of waste be provided to the laboratory.

6.2 Preservatives shall not be added to samples before extraction. Samples should be stored at 4°C and opened immediately prior to TCLP extraction.

6.3 TCLP extracts should be prepared for analyses and analyzed as soon as possible following TCLP extraction. Extracts for metals analysis must be acidified to a pH < 2 with nitric acid. Extracts for other analyses should be preserved according to the guidance given in the individual analytical methods. Extracts for organic analyte determinations shall not be allowed to come into contact with the atmosphere (i.e., no headspace) to prevent losses.

6.4 Sample holding times for non-volatile TCLP extraction and analysis summarized in the following table:

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

TCLP PARAMETER	FROM COLLECTION TO TCLP EXTRACTION	FROM TCLP EXTRACTION TO PREPARATIVE EXT'N	FROM PREP EXT'N TO ANALYSIS
PEST/HERBS	14	7	40
SEMIVOLATILES	14	7	40
MERCURY	28	N/A	28
METALS EXCEPT MERCURY	180	N/A	180

7.0 PROCEDURES

The procedure consists of a series of preliminary evaluations of the waste, followed by the actual extraction. Flow charts summarizing the procedure appear as Figures 2 and 3. Preliminary evaluations are to be performed on a minimum 100 g aliquot of the waste. This aliquot may not actually undergo TCLP extraction. These preliminary evaluations include: (1) determination of the percent solids, Section 7.1; (2) determination of whether the waste contains insignificant solids and is, therefore, its own extract after filtration, Section 7.2; (3) particle size evaluation, Section 7.3; and (4) determination of the appropriate extraction fluid to be used for the TCLP extraction, Section 7.4.

All information and measurements pertaining to TCLP extractions are recorded in the Non-Volatile TCLP Extraction Logbook (Figure 8). In the following procedure, the section or column of the Non-Volatile TCLP Extraction Logbook page in which the pertinent information should be recorded is indicated in bold, e.g. **Section II** or **Column C**.

PRELIMINARY EVALUATIONS

7.1 Determination of Percent Solids (**Section III**) - Percent solids is defined for TCLP as that fraction of a waste sample (as a percentage of the total sample) from which no liquid may be forced out by an applied pressure, as described below.

If the waste will obviously yield no liquid when subjected to pressure filtration (i.e., is 100% solids) the percent solids determination may be omitted. Proceed to Section 7.3, Particle Size Evaluation.

If the sample is liquid or multiphasic, liquid/solid separation by filtration is required to make a preliminary determination of percent solids. This involves the filtration device. The procedure is as follows, Sections 7.1.1 through 7.1.9:

7.1.1 Pre-weigh the filter (**Column A**) and the container that will receive the filtrate (filtrate vessel) (**Column B**).

7.1.2 Assemble the filter holder and filter following the manufacturer's instructions. Place the filter on the support screen and secure.

7.1.3 Weigh out a subsample of the waste (100 gram minimum) and record the combined weight of the weigh boat and waste (**Column C**).

7.1.4 Allow slurries to stand to permit the solid phase to settle. Wastes that settle slowly may be centrifuged, prior to filtration. Centrifugation is to be used only as an aid to filtration. If centrifugation is used, the liquid should be decanted and filtered followed by filtration of the solid portion of the waste through the same filtration system.

7.1.5 Quantitatively transfer the waste sample (liquid and solid phases) to the filter holder, spreading the waste sample evenly over the surface of the filter. If filtration of the waste at 4°C reduces the amount of expressed liquid over what would be expressed at room temperature, then allow the sample to warm up to room temperature in the device before filtering.

7.1.6 Weigh the weigh boat and any residue clinging to it (**Column D**). Determine the total weight of waste to be filtered by subtracting the weight of the weigh boat and residue from the weight of the weigh boat and waste (**Column E**).

7.1.7 Gradually apply vacuum or gentle pressure of 1-10 psi until air or pressurizing gas moves through the filter, collecting any filtrate in the pre-weighed filtrate vessel. If this point is not reached under 10 psi, and if no additional liquid has passed through the filter in any 2-minute interval slowly increase the pressure in 10-psi increments to a maximum of 50 psi. After each incremental increase of 10 psi, if the pressurizing gas has not moved through the filter, and if no additional liquid has passed through the filter in any 2-minute interval, proceed to the next 10-psi increment. When the pressurizing gas begins to move through the filter, or when liquid flow has ceased at 50 psi (i.e., filtration does not result in any additional filtrate within any 2 minute period), stop the filtration.

The material in the filter holder is defined as the solid phase of the waste, and the filtrate is defined as the liquid phase.

7.1.8 Weigh the filtrate vessel and its contents (**Column F**). Determine the weight of the liquid phase by subtracting the weight of the filtrate vessel from the total weight of the filtrate-filled container (**Column G**).

7.1.9 Calculate the percent wet solids as follows (**Column H**):

$$\text{Percent wet solids} = \frac{\text{(Total weight of waste)-(Weight of liquid phase)}}{\text{Total weight of waste}}$$

7.2 If the percent solids determined in Section 7.1.9 above is equal to or greater than 0.5% and the weight of water entrained in the filter is small in comparison with the

weight of the solid phase, then proceed to Section 7.3 to determine whether the solid material requires particle size reduction. Continue with Section 7.2 if it is noticed that the amount of the filtrate entrained in wetting the filter is significant in proportion to the weight of the solid phase. If the percent solids determined in Section 7.1.9 is less than 0.5%, then proceed to Section 7.5.4 using a fresh portion of the waste.

7.2.1 Remove the solid phase and filter from the filtration apparatus.

7.2.2 Dry the filter and solid phase at 100± 20°C until two successive weighings yield the same value within ±1%. Record the weight of the filter and dry solids (**Column I**).

NOTE: Caution should be taken to ensure that the subject solid will not flash upon heating. It is recommended that the drying oven be vented to a hood or other appropriate device.

7.2.3 Calculate the weight of dry solids by subtracting the weight of the filter from the weight of the filter and dry solids (**Column J**).

7.2.4 Calculate the percent dry solids as follows (**Column K**):

$$\text{Percent dry solids} = \frac{\text{Weight of dry solids}}{\text{Total weight of waste}} \times 100$$

Note: Non-aqueous liquid samples (e.g. oils) may be entrained in the filter, and may remain in the filter after drying, contributing weight to the dried filter. If this is the case, the surface of the filter should be examined for apparent solids or particulate material. If none are found, a comment to that effect should be made in the Comments section of the Non-Volatile TCLP Extraction Logbook (e.g. "No apparent solids present – dry solid weight is due to entrained non-volatile liquid"), and the sample should be treated as if it contains less than 0.5% dry solids.

7.2.5 If the percent dry solids is less than 0.5%, then proceed to Section 7.5.4. If the percent dry solids is greater than or equal to 0.5%, proceed to Section 7.3.

7.3 Particle Size Evaluation - Visually evaluate the particle size of the solid phase of the waste. Filamentous material (cloth, paper, etc.) will require particle size reduction if it has a surface area per gram of less than 3.1 cm^3. Other solid materials require particle size reduction if the particles are greater than 1 cm in their narrowest dimension (i.e. if they will not pass through a 9.5 mm standard sieve). Particle size reduction may be accomplished by cutting, crushing, or grinding the waste to a surface area or particle size as described above. Perform particle size reduction on the solid material that will actually undergo extraction, not on that used for the preliminary determinations.

7.4 Determination of Appropriate Extraction Fluid - If the solid content of the waste is greater than or equal to 0.5%, determine the appropriate fluid for the non-volatiles extraction as follows:

7.4.1 Weigh out a small subsample of the solid phase of the waste, reduce the particle size (if necessary) to approximately 1 mm in diameter or less, and transfer 5.0 grams of the solid phase of the waste to a 500 mL beaker or Erlenmeyer flask.

7.4.2 Add 96.5 mL of laboratory reagent grade water to the beaker, cover with a watch glass, and stir vigorously for 5 minutes using a magnetic stirrer. Using the pH meter, measure and record the pH to at least one decimal place(**Section II**). If the pH is <5.0, use Extraction Fluid #1 and proceed with the TCLP extraction, Section 7.5.

7.4.3 If the pH from Section 7.4.2 is >5.0, add 3.5 mL 1N HCl, stir briefly, cover with a watch glass, heat to 50°C, and hold at 50°C for 10 minutes.

7.4.4 Let the solution cool to room temperature and record the pH (**Section II**). If the pH is <5.0, use Extraction Fluid #1. If the pH is still >5.0, use Extraction Fluid #2. Proceed to the TCLP extraction, Section 7.5.

TCLP EXTRACTION FOR NON-VOLATILES

7.5 A minimum sample size of 100 grams (solid and liquid phases) is recommended. In some cases, a larger sample size may be appropriate, depending on the solids content of the waste sample, whether the initial liquid phase of the waste will be miscible with the aqueous extract of the solid, and whether inorganics, semivolatile organics, pesticides, and herbicides are all analytes of concern. Enough solids should be generated for extraction such that the volume of TCLP extract will be sufficient to perform all of the required analyses. If necessary, multiple extractions may be performed and the extracts combined and aliquoted for analysis. Please refer to Katahdin Analytical Services SOP CA-108, “Basic Laboratory Technique”, current revision, for information on subsampling.

7.5.1 If the waste will obviously yield no liquid when subjected to pressure filtration (i.e., is 100% solid), weigh out a subsample of the waste (100 g minimum), record the weight (**Section II**), and proceed to Section 7.5.11. If the sample is liquid or multiphasic, liquid/solid separation is required - proceed to Section 7.5.2.

7.5.2 Pre-weigh the container that will receive the filtrate (filtrate vessel) (**Section IV**, **Column L**).

7.5.3 Assemble the filter holder and filter following the manufacturer's instructions. Place the filter on the support screen and secure. Acid-wash the filter if extracting for metals components. Acid-washed filters may be used for non-volatile extractions even when metals are not of concern.

7.5.4 Weigh out a subsample of the waste (100 gram minimum) and record the combined weight of the waste and weigh boat (**Column M**). If the waste contains <0.5% dry solids, the liquid portion of the waste, after filtration, is defined as the TCLP extract. Therefore, enough of the sample should be filtered so that the amount of filtered liquid will support all of the required analyses. For wastes containing >0.5% dry solids, information is obtained in Section 7.1 to determine the optimum sample size (100 gram minimum) for filtration. Enough solids should be generated by filtration to support the analyses to be performed on the TCLP extract.

7.5.5 Allow slurries to stand to permit the solid phase to settle. Wastes that settle slowly may be centrifuged prior to filtration. Use centrifugation only as an aid to filtration. If centrifugation is used, the liquid should be decanted and filtered followed by filtration of the solid portion of the waste through the sample filtration system.

7.5.6 Quantitatively transfer the waste sample (liquid and solid phases) to the filter holder. Spread the waste sample evenly over the surface of the filter. If filtration of the waste at 4°C reduces the amount of expressed liquid over what would be expressed at room temperature, then allow the sample to warm up to room temperature in the device before filtering.

7.5.7 Weigh the weigh boat and any residue clinging to it (**Column N**). Determine the total weight of waste to be filtered by subtracting the weight of the weigh boat and residue from the weight of the weigh boat and waste (**Column O**).

7.5.8. Gradually apply vacuum or gentle pressure of 1-10 psi until air or pressurizing as moves through the filter, collecting any filtrate in the pre-weighed filtrate vessel. If this point is reached under 10 psi, and if no additional liquid has passed through he filter in any 2-minute interval, slowly increase in pressure in 10-psi increments to a maximum of 50 psi. After each incremental increase of 10 psi, if the pressurizing gas has not moved through the filter, and if no additional liquid has passed through the filter in any 2-minute interval, proceed to the next 10-psi increment. When the pressurizing gas begins to move through the filter, or when the liquid flow has creased at 50 psi (i.e., filtration does not result in any additional filtrate within a 2 minute period), stop the filtration.

The material in the filter holder is defined as the solid phase of the waste, and the filtrate is defined as the liquid phase.

7.5.9 Weigh the filtrate vessel and its contents (**Column P**). Determine the weight of the liquid phase by subtracting the weight of the filtrate vessel from the total weight of the filtrate-filled container (**Column Q**). Decant the liquid phase into a graduated cylinder and measure and record its volume (**Column R**). Pour the liquid phase back into the filtrate vessel for storage. The liquid phase may now either be analyzed or stored at 4°C until time of analysis.

NOTE: Some wastes, such as oily wastes and some paint wastes, will obviously contain some material that appears to be a liquid. Even after applying pressure filtration, as outlined in Section 7.5.8, this material may not filter. If this is the case, the material within the filtration device is defined as a solid and is carried through the extraction as a solid. Do not replace the original filter with a fresh filter under any circumstances. Use only one filter.

7.5.10 Calculate the weight of wet solids by subtracting the weight of the liquid phase from the total weight of waste (**Column S**).

7.5.11 If necessary, prepare the solid portion of the waste for extraction by crushing, cutting, or grinding the waste to a surface area or particle size as described in Section 7.3. Describe the particle size reduction process in the Comments section (**Section V**) of the logbook. When the surface area or particle size has been appropriately altered, quantitatively transfer the solid material into an extractor bottle. Include the filter used to separate the initial liquid from the solid phase.

7.5.12 Determine the amount of extraction fluid to add to the extractor vessel as follows:

$$\text{Weight of extraction fluid} = \frac{(20)\,(\text{Weight of wet solids})}{100}$$

Slowly add this amount of appropriate extraction fluid to the extractor vessel. Record the fluid batch ID, the amount used, and the pH (measured on day of use) in **Sections I and II** of the logbook. Close the extractor bottle tightly (Teflon tape may be used to ensure a tight seal), secure in rotary agitation device, and rotate at 30± 2 RPM during the extraction period of 18 $\pm$ 2 hours at 23 ± 2 ºC. Record the extraction start and end times and the room temperatures in **Section I** of the logbook.

NOTE: As agitation continues, pressure may build within the extractor bottle for some types of wastes (e.g., limed or calcium carbonate containing waste may evolve gases such as carbon dioxide). To relieve excess pressure, the extractor bottle may be periodically opened (e.g., after 15 minutes, 30 minutes, and 1 hour) and vented into a hood.

7.5.13 Following the extraction, separate the contents of the vessel into its component liquid and solid phases by filtering through a new acid-washed glass fiber filter, as outlined in Section 7.5.6. For final filtration of the TCLP extract, the glass fiber filter may be changed, if necessary, to facilitate filtration.

NOTE: If the waste contained no initial liquid phase, it is only necessary to filter enough extract to support the required analyses. However, if the waste contained an initial liquid phase, the entire contents of the extraction vessel must be filtered.

7.5.14 Prepare the TCLP extract as follows:

7.5.14.1 If the waste contained no initial liquid phase, the filtered liquid material obtained from Section 7.5.13 is defined as the TCLP extract. Proceed to Section 7.5.15.

7.5.14.2 If compatible (e.g., multiple phases will not result on combination), combine the filtered liquid resulting from Section 7.5.13 with the initial liquid phase of the waste obtained in Section 7.5.8. This combined liquid is defined as the TCLP extract. Proceed to Section 7.5.15.

7.5.14.3 If the initial liquid phase of the waste, as obtained from Section 7.5.8, is not or may not be compatible with the filtered liquid resulting from Section 7.5.13, do not combine these liquids. Measure the volume of filtrate obtained in Section 7.5.13 and record in the Comments section (**Section V**) of the logbook. Individually analyze these two liquids, collectively defined as the TCLP extract, and combine the results mathematically, as described in Section 7.6.

7.5.15 Following collection of the TCLP extract, the pH of the extract should be measured and recorded (**Section II**). Immediately aliquot and preserve the extract for analysis. Metals aliquots must be acidified with nitric acid to pH <2. All other aliquots must be stored under refrigeration (4°C) until analyzed.

7.6 The TCLP extract shall be prepared and analyzed according to appropriate analytical methods. TCLP extracts to be analyzed for metals shall be acid digested except in those instances where digestion causes loss of metallic analytes. If an analysis of the undigested extract shows that the concentration of any regulated metallic analyte exceeds the regulatory level, then the waste is hazardous and digestion of the extract is not necessary. However, data on undigested extracts alone cannot be used to demonstrate that the waste is not hazardous. If the individual phases are to be analyzed separately, determine the volume of the individual phases (to ± 0.5%),

conduct the appropriate analyses, and combine the results mathematically by using a simple volume-weighted average:

$$\text{Final Analyte Concentration} = \frac{(V_1)(C_1) + (V_2)(C_2)}{V_1 + V_2}$$

where: V_1 = The volume of the first phase (L).
C_1 = The concentration of the analyte of concern in the first phase (mg/L).
V_2 = The volume of the second phase (L).
C_2 = The concentration of the analyte of concern in the second phase (mg/L).

7.7 Compare the analyte concentrations in the TCLP extract with the levels identified in the appropriate regulations. Refer to Section 8.0 for quality control requirements.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

USEPA Method 1311 requires the laboratory to perform specific quality control checks to assess laboratory performance and data quality. Minimum frequencies, acceptance criteria, and corrective actions for these control checks are listed in Table 1 and are described below. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations and client and project specific Data Quality Objectives. The Department Manager, Operations Manager and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases “qualified” data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed

8.1 A minimum of one method blank for every 20 extractions performed using a particular batch of extraction fluid and per 20 extractions performed in a particular extraction vessel must be extracted and analyzed for the same contaminants as all associated

samples. The method blanks are analyzed to check for laboratory contamination. A count of extractions performed in each extraction vessel is maintained in order to monitor the frequency of method blanks (1 per 20 extractions per vessel) required for each extraction vessel. .

8.1.1 After TCLP extraction, TCLP method blanks must undergo preparative extraction and analysis within method holding times (refer to Section 6.4). For this reason it may be necessary to extract more than one method blank using a particular batch of extraction fluid. For example, suppose that a sample requiring analysis for TCLP metals and semivolatiles is extracted using freshly prepared fluid from Batch 300. Because the fluid is new, a method blank is extracted with the sample and analyzed for the same components as the sample. Eight days later, a different sample requiring full TCLP analysis (metals, semivolatiles, pesticides, and herbicides) is extracted using fluid from Batch 300. Because the holding time for the previous TCLP method blank for pesticides and herbicides has expired, a new TCLP method blank must be extracted and analyzed for pesticides and herbicides. The new method blank need not be analyzed for metals and semivolatiles, because the first method blank that was prepared with fluid from Batch 300 has already been analyzed for these constituents.

8.1.2 Each TCLP method blank is identified in the TCLP extraction logbooks by a seven-character code. The first three characters are “PBT”, which stands for “Preparation Blank - TCLP”. Characters 4 through 6 consist of the three-digit preparation number of the extraction fluid. The seventh character is a letter, starting with “A” and proceeding alphabetically, which is unique to the extraction date for a particular batch of fluid. For example, “PBT316A” refers to the first TCLP method blank extracted using fluid from Batch 316; “PBT316B” refers to the second TCLP method blank extracted using the same fluid. The extraction date of each TCLP method blank is recorded in the TCLP Fluid Preparation and Use Logbook.

8.2 The laboratory recommends that a matrix spike be performed for each waste type (e.g., wastewater treatment sludge, contaminated soil, etc.) unless the result exceeds the regulatory level and the data are being used solely to demonstrate that the waste property exceeds the regulatory level. Because the laboratory charges for the preparation and analysis of TCLP matrix spikes, selection of samples for TCLP matrix spiking is left to the discretion of the client. A minimum of one TCLP matrix spike must be analyzed for each batch of 20 TCLP extractions. As a minimum, follow the matrix spike addition guidance provided in each analytical method. Additional matrix spiking directions and guidance are provided in Table 4 and Figures 4 and 5.

8.2.1 Matrix spikes are to be added after filtration of the TCLP extract and before any preservation. Matrix spikes should not be added prior to TCLP extraction of the sample.

8.2.2 Instructions for preparing TCLP matrix spikes for metals analysis are contained in Table 4. Instructions for preparing TCLP matrix spikes for organics analyses are contained in Figures 4 and 5. In order to avoid differences in matrix effects, the matrix spikes must be added to the same nominal volume of TCLP extract as that which was analyzed for the unspiked sample.

8.2.3 Matrix spike recoveries are calculated by the following formula:

$$\text{Recovery (\%)} = 100\ (X_s - X_u)/K$$

where: X_s = measured value for the spiked sample,
X_u = measured value for the unspiked sample, and
K = known value of the spike in the sample

8.2.4 The purpose of the matrix spike is to monitor the performance of the sample preparation and analytical methods used and to determine whether matrix interferences exist. Use of internal calibration methods (e.g. the method of standard additions [MSA]), modification of the analytical methods, or use of alternate analytical methods may be needed to accurately measure the analyte concentration of the TCLP extract when the recovery of the matrix spike is below the expected analytical method performance. Metallic analytes must be quantitated by the method of standard additions if the TCLP matrix spike recovery for the analyte is less than 50% and the measured concentration of the analyte in the unspiked aliquot is within 20% of the regulatory level.

8.3 Each new analyst must demonstrate her/his ability to perform the method acceptably by while being witnessed by an analyst who is experience in performing the method. To successfully demonstrate the method, the analyst must perform the method in conformance with all the requirements of the SOP, referring to the SOP for guidance as necessary. In addition, each analyst must demonstrate the ability to produce TCLP Extraction Blanks that are free of contamination. This demonstration will require the analyst to collect and file the analytical results from four Extraction Blanks that he/she has generated.

8.4 All quality control measures described in the appropriate analytical methods shall be followed.

9.0 METHOD PERFORMANCE

Refer to the applicable analytical SOP.

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, US EPA SW846, Third Edition, Final Update I (7/92), Method 1311

Federal Register, Volume 55, Number 126, Friday, June 29, 1990, PP 26986-26998

Federal Register, Volume 57, Number 227, Tuesday, November 24, 1992, PP 55114-55117

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 4.2, 10/25/2010.

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.0, March, 2013

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP QA-803, Laboratory QA: Self Inspection System, current revision.

List of Tables and Figures

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

TABLE 1

QC REQUIREMENTS

Parameter/ Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Toxicity Characteristic Leaching Procedure (TCLP)/ EPA 1311	Method Blanks	One per 20 samples extracted using a particular batch of extraction fluid.	Refer to individual analytical methods.	Prepare fresh extraction fluid and repeat TCLP extraction of all associated samples.
		One per 20 samples extracted in a particular extraction vessel.	Refer to individual analytical methods.	Remove extraction vessel from service.
	Matrix Spike	One per 20 TCLP extractions performed (required). One per waste type (suggested, left to discretion of client).	For metallic analytes, >50% if native analyte concentration is within ± 20% of regulatory level. For other analytes, refer to appropriate analytical methods.	For metallic analytes, quantitate by method of standard additions. For other analytes, refer to appropriate analytical methods.
	Demonstration of analyst proficiency; accuracy and precision	One time demonstration by each analyst performing the method	New analyst's performance of the method is witnessed by an experienced analyst. New analyst must produce method blanks that meet all method and laboratory acceptance criteria.	Repeat analysis until able to demonstrate acceptable performance of the method to witnessing analyst and by producing acceptable method blanks; document successful performance in personal training file.

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

TABLE 2

SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-510-08	EPA METHOD 1311
Reagents	Extraction Fluid **#**1 prepared using sodium hydroxide pellets. 5% HNO3	Extraction Fluid **#**1 prepared using 1N sodium hydroxide solution. 1N HNO3
QC - Method Blanks	Frequency of one method blank per 20 extractions performed using a particular batch of extraction fluid and per 20 extractions performed in a particular extraction vessel.	Frequency of one method blank per 20 extractions performed in a particular extraction vessel.
QC - Spikes	Matrix spike **recommended** for each waste type.	Matrix spike **required** for each waste type.

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

TABLE 3

TOXICITY CHARACTERISTIC CONSTITUENTS AND REGULATORY LEVELS

Constituent	Regulatory Level (mg/L)
Arsenic	5.0
Barium	100.0
Benzene	0.5
Cadmium	1.0
Carbon tetrachloride	0.5
Chlordane	0.03
Chlorobenzene	100.0
Chloroform	6.0
Chromium	5.0
o-Cresol	200.0
m-Cresol	200.0
p-Cresol	200.0
Cresol	200.0
2,4-D	10.0
1,4-Dichlorobenzene	7.5
1,2-Dichloroethane	0.5
1,1-Dichloroethylene	0.7
2,4-Dinitrotoluene	0.13
Endrin	0.02
Heptachlor (and its hydroxide)	0.008
Hexachlorobenzene	0.13
Hexachloro-1,3-butadiene	0.5
Hexachloroethane	3.0
Lead	5.0
Lindane	0.4
Mercury	0.2
Methoxychlor	10.0
Methyl ethyl ketone	200.0
Nitrobenzene	2.0
Pentachlorophenol	100.0
Pyridine	5.0
Selenium	1.0
Silver	5.0
Tetrachloroethene	0.7
Toxaphene	0.5
Trichloroethylene	0.5
2,4,5-Trichlorophenol	400.0
2,4,6- Trichlorophenol	2.0
2,4,5-TP (Silvex)	1.0
Vinyl Chloride	0.2

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

TABLE 4

TCLP MATRIX SPIKING FOR METALLIC ANALYTES

SPIKING INSTRUCTIONS			
Sample or Solution Name	**Component Solution Name**	**Source of Component**	**Amount of Component Added per 50 mL Final Volume (mL)**
TCLP Matrix Spike (ICP)	CLPP-SPK-1	Inorganic Ventures	0.050
	CLPP-SPK-INT1	Lab Prepared (see below)	0.50
TCLP Matrix Spike (Mercury)	1000 ug/L Hg Standard	Prepared from 1000 mg/L stock standard	0.10

Note: Spiking must be performed after TCLP extraction and before preservation.

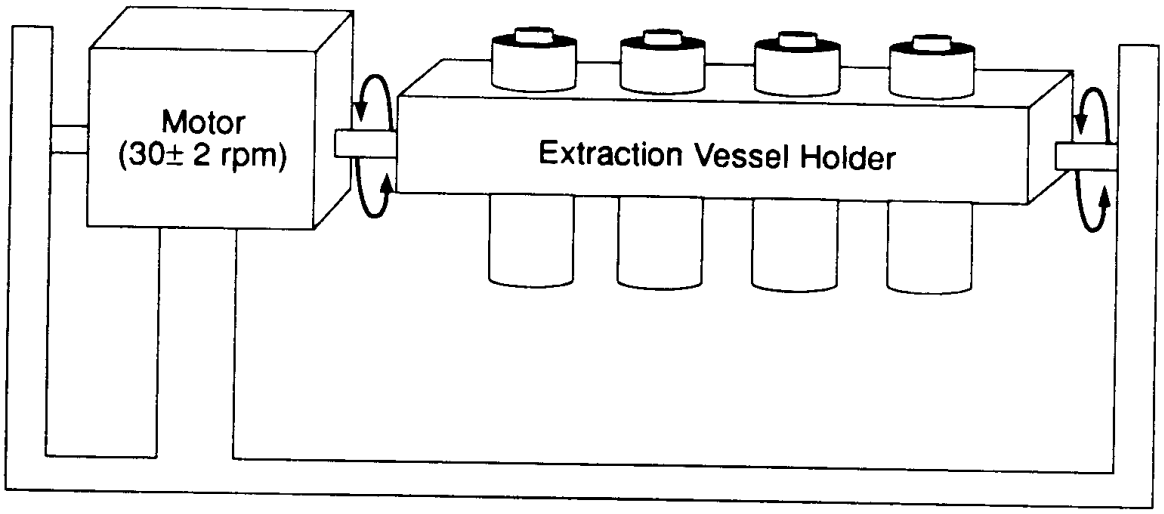
PREPARATION OF INTERMEDIATE SPIKING SOLUTIONS			
Solution Name	**Component Solution Name**	**Source of Component**	**Amount of Component Added per 100 mL Final Volume (mL)**
CLPP-SPK-INT1	QCP-CICV-3	Inorganic Ventures	10.0
	1000 mg/L Sb	High Purity Standards	5.0
	10000 mg/L K	High Purity Standards	10.0
	10000 mg/L Na	High Purity Standards	7.5
	10000 mg/L Mg	High Purity Standards	5.0
	10000 mg/L Ca	High Purity Standards	2.5
1000 ug/L Hg Standard	1000 mg/L Hg	Inorganic Ventures	0.10

ELEMENT CONCENTRATIONS IN MATRIX SPIKES AND SPIKING SOLUTIONS				
Element	**CONCENTRATION IN SOLUTION, mg/L**			
	TCLP Matrix Spike	**CLPP-SPK-1**	**CLPP-SPK-INT1**	**1000 ug/L Hg Std.**
Arsenic	2.000		200	
Barium	2.000	2000		
Cadmium	0.050		5	
Chromium	0.200	200		
Lead	0.500		50	
Selenium	2.000		200	
Silver	0.050	50		
Mercury	0.0020			1000

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

FIGURE 1

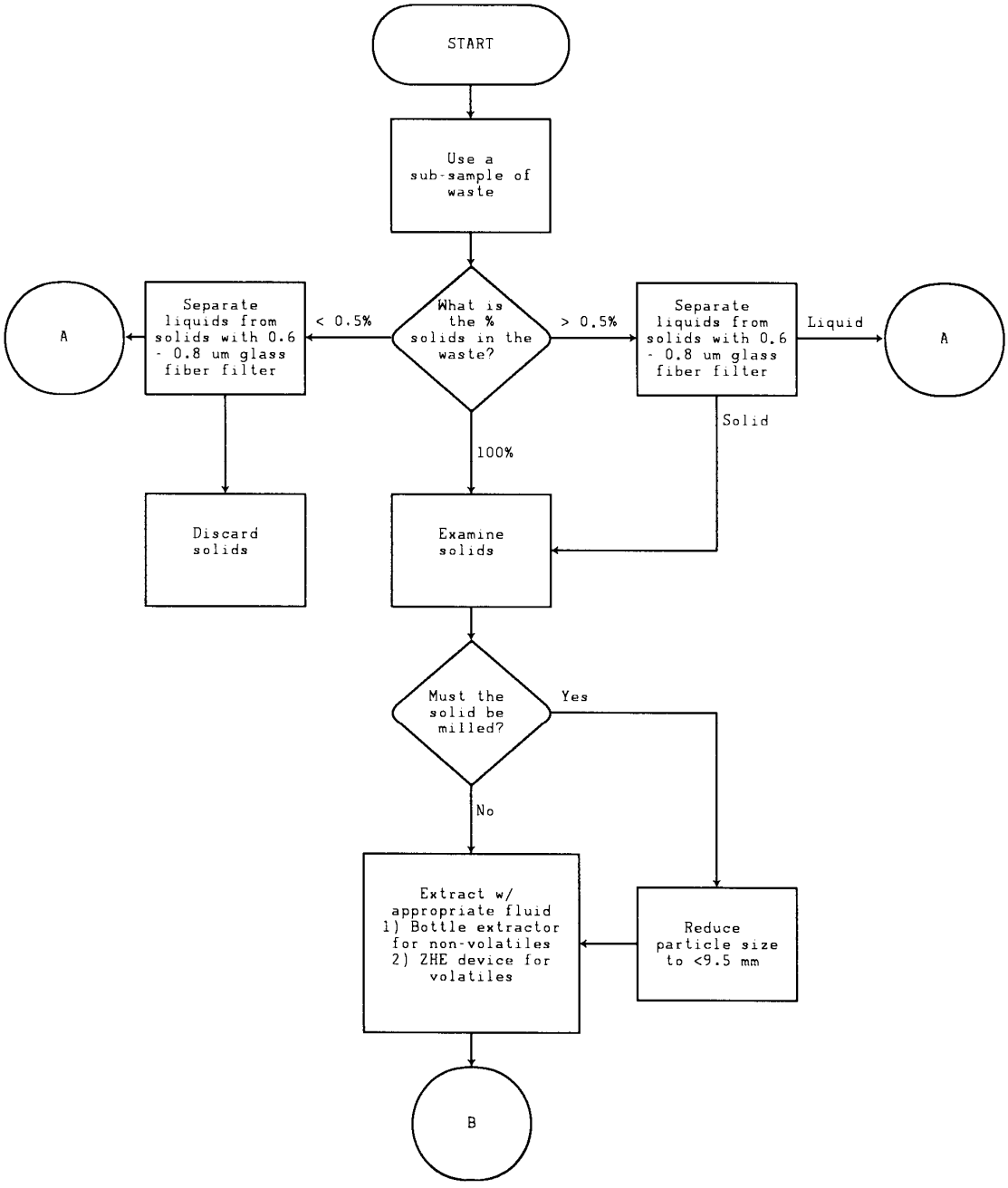
ROTARY AGITATION APPARATUS



TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

FIGURE 2

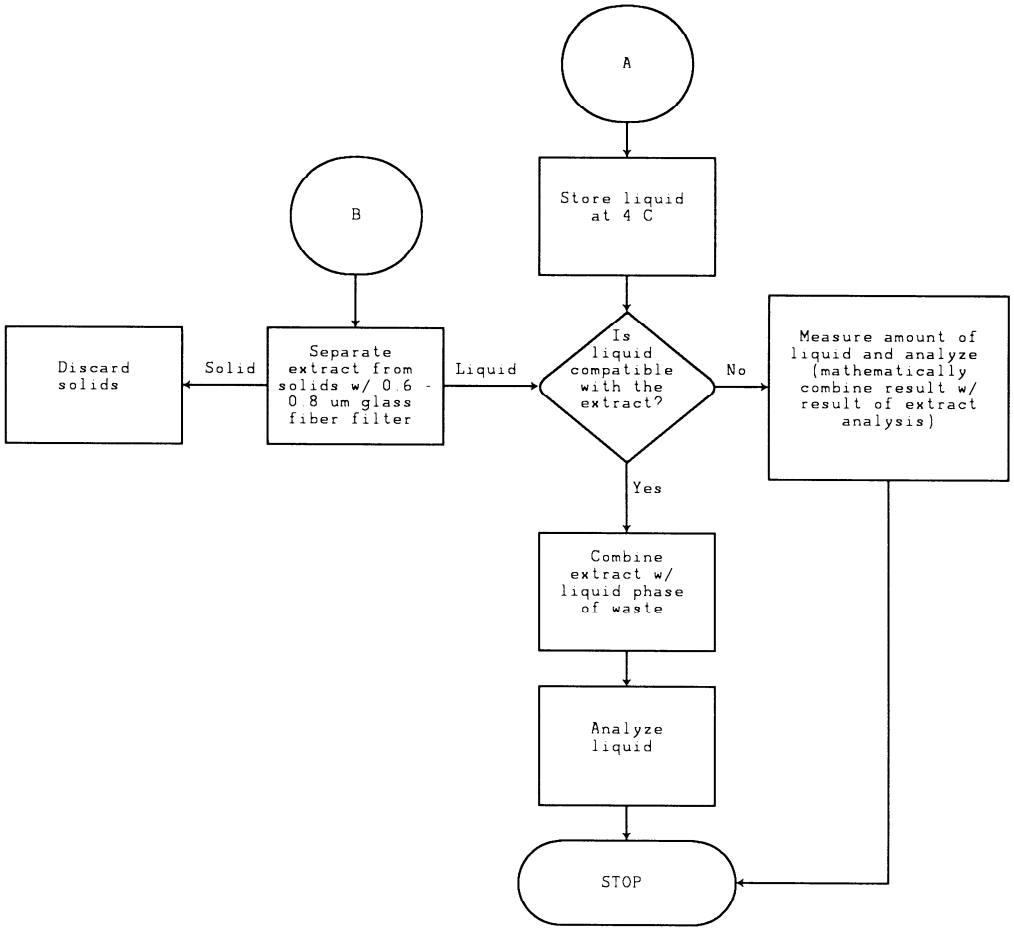
TCLP FLOW CHARTS



TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

FIGURE 3

TCLP FLOW CHARTS



TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

FIGURE 4

SVOA TCLP MATRIX SPIKE AND SURROGATE GUIDELINES

MATRIX SPIKE

The following compounds are reported for TCLP matrix spikes, although a full list spike solution is utilized (refer to SOP CA-502, current revision). Acid extractable compounds are at 100 ug/mL and base/neutral extractable compounds are at 50 ug/mL. 1.0 mL of this mix is added to the sample designated for the TCLP matrix spike.

Pyridine
1,4-Dichlorobenzene
2-Methylphenol
3-,4-Methylphenol*
Hexachloroethane
Nitrobenzene
Hexachlorobutadiene
2,4,6-Trichlorophenol
2,4,5-Trichlorphenol
2,4-Dinitrotoluene
Hexachlorobenzene
Pentachlorophenol

* Due to coelution on the GC/MS, 3-methylphenol and 4-methylphenol are reported as the combined concentration for the two isomers; the matrix spike solution contains 4-methylphenol at 100 ug/mL.

SURROGATE

The following surrogate compounds are reported for TCLP samples, although the surrogate mix also includes one additional surrogate (refer to SOP CA-502, current revision). Acid extractable surrogates are at 100 ug/mL and base/neutral extractable surrogates are at 50 ug/mL. 1.0 mL of this mix is added to all samples.

2-Fluorophenol	100 ug/mL
Phenol-d5	100 ug/mL
Nitrobenzene-d5	50 ug/mL
2-Fluorobiphenyl	50 ug/mL
2,4,6-Tribromophenol	100 ug/mL
Terphenyl-d14	50 ug/mL

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

FIGURE 5

PESTICIDE TCLP MATRIX SPIKE AND SURROGATE GUIDELINES

MATRIX SPIKE

The following compounds are reported for TCLP matrix spikes, although a full list spike solution is utilized (refer to SOP CA-515, current revision). All compounds are at 0.5 ug/mL. 1.0 mL of this mix is added to the sample designated for the TCLP matrix spike.

Endrin
Heptachlor
Methoxychlor
Lindane
Heptachlor Epoxide

SURROGATE

Surrogates are at 1.0 ug/mL. 1.0 mL of this mix is added to all samples.

Decachlorobiphenyl (DCB)
Tetrachloro-m-xylene (TCMX)

TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

FIGURE 6

EXAMPLE PAGE FROM TCLP FLUID USE LOGBOOK

Katahdin Analytical Services, Inc.

Non-Volatile TCLP/SPLP Extraction Fluid Preparation and Use Logbook

FLUID PREPARATION					
TCLP ☑ SPLP ☐	TCLP Fluid #:	Fluid Batch #:	Prep Date:	Prepared by:	Measured pH:
	1	1164	6/3/14	GEJ	4.98

Reagent	Manufacturer's Lot Number	Reagent Volume (mL)	Reagent Mass (g)	Fluid Final Volume (L)
Glacial Acetic Acid	51466	114	N.A.	20L
Sodium Hydroxide	26131	N.A.	54.34	↓
0.6% Sulfuric Acid / 0.4% nitric acid				
	GEJ 6/5/14			

FLUID USE LOG					
Katahdin Sample Number	TCLP Extraction Start Date	Extract to be Analyzed for:			
		Metals	SVOA	Pest	Herb
PBT 1164A	6/5/14	✓	✓	✓	✓
SH 3844-1A	↓	✓	✓	✓	✓

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TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

FIGURE 7

EXAMPLE PAGE FROM ROTARY EXTRACTOR RPM VERIFICATION LOGBOOK

KATAHDIN ANALYTICAL SERVICES, INC.

ROTARY EXTRACTOR RPM VERIFICATION LOGBOOK

EXTRACTOR #1: TOP SHELF SERIAL NUMBER: NONE
EXTRACTOR #2: MIDDLE SHELF SERIAL NUMBER: 1173
EXTRACTOR #3: BOTTOM SHELF SERIAL NUMBER: 1169

Please record the number of RPMs for each extractor each time they are used.

Date	Initials	Extractor #1	Extractor #2	Extractor #3	Comments
614114	GJ	N/A	N/A	32	Pass
615114	GJ	N/A	N/A	30	Pass

Acceptance Range is 28-32 RPMS.
Meters Should Be Verified Against A Wrist Watch Annually And Recorded In The Comments Section.

QAQC276

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TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

FIGURE 8

EXAMPLE PAGE FROM NON-VOLATILE TCLP EXTRACTION LOGBOOK (Page 1)

KATAHDIN ANALYTICAL SERVICES, INC. **Non-Volatile TCLP/SPLP Extraction Log**

I. EXTRACTION CONDITIONS

Extraction Method:	SW846 1311 (TCLP) ☑	Extractor ID: 3	Room Thermometer ID: DIG-23	(Room Temp Criteria. 23(±2)°C)
	SW846 1312 (SPLP) ☐	Balance ID: BAL-08	pH Meter ID: Orion 520A s/n 7422	pH Probe ID: 319005249
Solid pH Determination:	Date: 5-6-14		Analyst: KF	
Rotary Extraction Started:	Date: 5-6-14	Time: 1655	Analyst: KF	Room Temp. (degrees °C): 18.4
Rotary Extraction Completed:	Date: 5-7-14	Time: 0915	Analyst: KF	Room Temp. (degrees °C): 20.4
Extraction Filtered:	Date: 5-7-14	Time: 1000	Analyst: KF	Filter Lot #: R3NA30396
Elapsed Extraction Time (HH:MM): 16:20		5% HNO_3 ID (used to wash filters): MR1333		HNO_3 Lot # (used to preserve extracts): 67379
Fluid 1 pH (Day of use): PBT1157=4.89 PBT1158=4.90		Fluid 1 Expiration Date: PBT1157=4-21-15 PBT1158=4-28-15		
Fluid 2 pH (Day of use): –		Fluid 2 Expiration Date: –		

II. EXTRACTION SETUP TCLP Fluid pH: #1 - 4.93 ± 0.05 #2 - 2.88 ± 0.05 SPLP Fluid pH: #1 - 4.20 ± 0.05 #2 - 5.00 ± 0.05

Katahdin Sample No. (include bottle ID)	Matrix	Check One: 100% Wet Solids- waste will yield no liquid upon filtration	Check One: < 100% Wet Solids (Perform Solids Determination below)	SPLP FLUID # (1 for east and 2 for west of Mississippi River)	TCLP pH Determination and Fluid Selection (date & init. above): Initial pH of solid phase: (if <5, use Fluid #1; if >5 add 3.5 mL of 1 N HCl)	TCLP pH Determination and Fluid Selection (date & init. above): pH after 1 N HCL addition (if <5, use Fluid #1; if >5, use Fluid #2	Extraction Setup: Volume of Extraction Fluid (mL)	Extraction Setup: Fluid # used	Extraction Setup: Associated Extraction Blank ID:	Extraction Setup: Weight of Waste (g)	pH of extract after extraction:	Extract to be analyzed for: Metals (M), SVOA (S), PEST (P), HERB (H), Cyanide (C)	Extraction Bottle ID (if applicable)
SH2865-1F	Aq		✓	N/A								MHS	
-2F	↓		✓	N/A								MHS	
SH2866-4E	↓		✓	N/A								MHS	
-5E	↓		✓	N/A								MHS	
SH2862-1E	SI	✓			10.80	1.88	2000	1	PBT1157A	100.03	6.38	MHP	8
SH2865-3D	↓	✓			5.45	1.49	↓	1	↓	100.18	4.94	MHPS	15
-4D	↓	✓			4.88	1.35	↓	1	PBT1158A	100.08	4.88	MNPS	16
-5D	↓	✓			6.03	1.46	↓	1	↓	100.16	4.88	MNPS	25
					mm	5-29-14							

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TITLE: TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) FOR INORGANIC AND NON-VOLATILE ORGANIC ANALYTES

FIGURE 9

EXAMPLE PAGE FROM NON-VOLATILE TCLP EXTRACTION LOGBOOK (Page 2)

III. SOLIDS DETERMINATION		A	B	C	D	E	F	G	H	I	J	K
Katahdin Sample No. (include bottle ID)	Matrix	Weight of filter (g)	Weight of filtrate vessel (g)	Weight of weigh boat + waste (g)	Weight of weigh boat + residue (g)	Weight of waste (C-D) (g)	Weight of filtrate vessel + filtrate (g)	Weight of liquid phase (F-B) (g)	Percent wet solids [(E-G)/E x 100%] %	Weight of filter + dry solids (g)	Weight of dry solids (I-A) (g)	Percent dry solids (J/E x 100%)
SH2865-1F	Aq	1.17	14.11	229.85	14.08	215.77	226.53	212.42	1.55 ~~0.015%~~	1.30	0.03	0.014%
↓ -2F	↓	1.17	14.01	228.83	14.50	214.33	221.79	207.78	3.06%	1.61	0.44	0.205%
SH3866-4E		1.17	14.12	221.41	14.40	207.01	214.88	200.76	3.02%	1.18	0.01	0%
↓ -5E	↓	1.19	14.09	223.70	14.10	209.60	219.18	205.09	2.15%	1.19	0.00	0%

IV. PHASE SEPARATION				L	M	N	O	P	Q	R	S
Katahdin Sample No. (include bottle ID)	Matrix	Percent dry solids [1]		Weight of filtrate vessel (g)	Weight of weigh boat + waste (g)	Weight of weigh boat + residue (g)	Weight of waste (M-N) (g)	Weight of filtrate vessel + filtrate (g)	Weight of liquid phase (P-L) (g)	Volume of liquid phase (mL) [2]	Weight of wet solids (O - Q) (g)
		<0.5%	>0.5%								

1) If dry solids is <0.5%, filter sufficient volume of waste to support all required analyses. If dry solids >0.5% and wet solids <100%, perform phase separation (steps L – S above).
2) If miscible, proportionately combine pre-extraction filtrate with rotary extract. If not miscible, analyze aliquots separately and mathematically combine results.

V. COMMENTS:

Reviewed By_____ Date_____

ME-001 – Revision 4 – 07/05/2011

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

Prepared By: George Brewer Date: 3/98

Approved By:

Group Supervisor: George Brewer Date: 01/24/01

Operations Manager: Joel C. Burton Date: 1/24/01

QA Officer: Deborah J. Nadeau Date: 1.24.01

General Manager: Duncan F. Hayes Date: 1/25/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01 3050B	Format changes, added pollution prevention, added MSD, added spiking instruction tables.	DH	1.24.01	1/24/01
02 3050B	Removed all references/procedures devoted to GFAA. Added use of digestates for ICP-MS analysis. Revised standard solution names & concs. in Tables 3 & 4 to reflect current practice.	DH	8.29.02	8.29.02
03 3050B	New Title to include ILMO5.3. Use of digestion block and polyethylene digestion tubes added to sections 4.0, 7.0 and Table 1. PBS changed from 1.0g water to 1.0g boiling chips. H_2O_2 addition from 3.0ml then 7.0mls to 2.0ml, 2.0ml then 7.0ml. Figures and Tables updated to reflect current practices.	LAD	03/08	03/08
04	Updated Tables 3 and 4 with current spike concentrations and volumes added. Updated logbook page. Added CA-108 reference for subsampling information.	LAD	08/09	08/09
05	Updated Tables 3 and 4 to reflect current spiking procedures.	LAD	09/10	09/10

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

Revision History (cont.):

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
06	Sect. 7 – Added wording concerning subsampling. Table 3 and 4 – Corrected standard concentrations. Attachment A - Modifications For 8330B Preparation & Digestion. Changed KAS INC. to KAS throughout	UAD	08/15	08/15

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-605-06**, titled **ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS.**

Recipient: _____ Date: _____

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-605-06**, titled **ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS.**

Recipient: _____ Date: _____

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the Katahdin Analytical Services procedure utilized to dissolve solid matrices and solubilize metals from solid samples prior to analysis for metals by ICP-AES and ICP-MS. This SOP applies to samples prepared by EPA Method 3050, with method modifications as summarized in Table 2.

This procedure applies to all solid sample (e.g. sediments, sludges, soils, and ashes) preparations for ICP-AES and ICP-MS analyses. This method is not a total digestion technique for most samples. It is a very strong acid digestion that will dissolve almost all elements that could become "environmentally available". By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

1.1 Definitions

ICP-AES – Inductively Coupled Plasma Atomic Emission Spectroscopy.

ICP-MS – Inductively Coupled Plasma Mass Spectrometry.

LCSO – Laboratory Control Sample for Solids – An aqueous standard that had been brought through the sample preparation process.

LCSS – Laboratory Control Sample for Solids – A solid reference material that has been brought through the sample preparation process.

Matrix Spike – An aliquot of a sample to which a known amount of analyte has been added before digestion.

PBS – Preparation Blank for Solids – An aliquot of reagent water that has been brought through the sample preparation process.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the acid digestion of solid samples by USEPA Method 3050 for metals analysis. Each analyst must demonstrate the ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, "Personnel Training & Documentation of Training".

It is the responsibility of all Katahdin technical personnel involved in the acid digestion of solid samples by USEPA Method 3050 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the procedure or irregularities with

the samples should also be recorded in the lab notebook and reported to the responsible Department Manager or designated qualified data reviewer.

It is the responsibility of the Department Manager to ensure that technical personnel perform acid digestions in accordance with this SOP and to confirm that their work is properly documented through periodic review of the associated logbooks.

1.3 Safety

The acids used in this procedure are highly corrosive and reactive, and spiking standards contain toxic metals. The toxicity and reactivity of client samples are usually unknown, so samples should always be assumed to present a contact hazard. To reduce or eliminate exposure to potentially harmful chemicals, lab coats, gloves, and safety glasses or goggles must be worn whenever handling samples or reagents. Additional safety apparel, including face shields, aprons, dust masks, and shoe protectors, is available in the Metals prep lab and should be worn whenever circumstances warrant.

Acids should be added to samples slowly and carefully, while watching for reactions. This should be done under a hood, in case harmful fumes are evolved.

Hood sashes should be lowered as far as possible whenever beakers are being heated on a hot plate. Use caution when handling hot beakers.

Each qualified analyst or technician must be familiar with Katahdin Analytical Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from the Environmental Health and Safety Officer, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Excess spiking solutions must be emptied into the corrosive waste carboy located in the Metals prep lab for subsequent appropriate disposal in accordance with the Katahdin Hazardous Waste Management Plan and Safety Manual.

Sample digestates should be stored for a minimum of 60 days after digestion to allow for analysis, and reanalysis if necessary. Digestates older than 60 days may be emptied into the corrosive waste carboy in the Metals prep lab for subsequent appropriate disposal in accordance with the Katahdin Hazardous Waste Mnagement Plan and Safety Manual.

2.0 SUMMARY OF METHOD

A representative 1 to 2 g (wet weight) sample is digested with repeated additions of nitric acid and hydrogen peroxide. Hydrochloric acid is added to the initial digestate and the sample is refluxed. The digestate is then filtered and diluted to a final volume of 100 mL.

3.0 INTERFERENCES

Interferences are discussed in the applicable analytical SOPs.

4.0 APPARATUS AND MATERIALS

4.1 Digestion vessels. If digestion is performed using a hot plate, the appropriate digestion vessels are 100 mL pre-cleaned Griffin beakers (cleaned according to the current revision of SOP CA-100, "Labware Cleaning" and CA-602, “Glassware Preparation and Sample Preservation for Trace Element Analyses”). If digestion is performed using a block digester, the appropriate digestion vessels are new 70 mL disposable graduated polyethylene digestion tubes with attached snap lids.

4.2 Ribbed watch glasses. If digestion is performed using a hot plate, 75 mm diameter glass watch glasses (pre-cleaned as above) are used. If digestion is performed using a block digester, 40 mm diameter disposable polyethylene watch glasses are used.

4.3 Adjustable volume automatic pipets covering the range from 10 uL to 1000 uL and disposable pipet tips; calibrated Finn pipets or Eppendorf pipets are acceptable.

4.4 Disposable graduated polystyrene specimen containers with pouring lips, 200 mL capacity.

4.5 Hot plate or block digester, griddle, or other heating source - adjustable and capable of maintaining a temperature of $95^{o}C \pm 5^{o}C$. Heating sources must be numbered for easy identification.

4.6 Device for measuring hot plate temperature, consisting of a flask or digestion vessel in which the bulb of a thermometer is immersed in sand or water. The temperature

of each hot plate used is measured and recorded each day. The hot plate identification number and the measured temperature are recorded on the sample preparation logbook sheet.

4.7 Plastic funnels, pre-cleaned as in Section 4.1.

4.8 Filter funnel holders, capable of suspending plastic funnels above disposable specimen containers.

4.9 Polyethylene wash bottles for dispensing reagent water and 5% HNO_3.

4.10 Filter paper, Whatman No. 41 or equivalent. Filters are acid-washed immediately prior to use as follows. Place a pre-cleaned funnel in the funnel holder and put a disposable plastic specimen container under the funnel to collect the rinsates. Place a folded filter in the funnel and rinse three times with approximate 10 mL volumes of 5% HNO_3, making sure the entire surface of the filter is wetted each time and allowing each rinse to drain completely before continuing. Then rinse three times with approximate 25 mL volumes of reagent water, again allowing each rinse to drain completely. Discard the rinsates into the appropriate waste container. The acid-washed filter is now ready for use.

4.11 Polyethylene sample containers with screw caps or graduated polyethylene sample containers with attached snap lids, 125 mL capacity.

4.12 Repipetters (adjustable repeating pipetters with reservoirs) for dispensing concentrated nitric acid, 1:1 HNO_3, and concentrated HCl.

4.13 Analytical balance capable of reading to 0.01 gram.

4.14 Spatulas, scoops, or spoons; plastic or stainless steel, rinsed with 5% HNO_3 and reagent water. Disposable tongue depressors may be used and do not requrire to be rinsed.

5.0 REAGENTS

5.1 Concentrated nitric acid, HNO_3 – trace metals grade.

5.2 Concentrated hydrochloric acid, HCl – trace metals grade.

5.3 Reagent water - water that meets the performance specifications of ASTM Type II water (ASTM D1193).

5.4 Nitric acid, 1:1. Add a volume of concentrated HNO_3 to an equivalent volume of reagent water and swirl gently to mix.

5.5 Nitric acid, 5% v/v. Add 25 mL concentrated HNO_3 to 475 mL reagent water in a 500 mL wash bottle. Cap, point the dispensing tip into a sink, and shake gently to mix.

5.6 30% hydrogen peroxide (H_2O_2) - spectrometric grade.

5.7 Multielement spiking solutions (see Table 3 for a list of required spiking solutions).

5.8 Solid reference material – a soil containing all the elements of interest, with empirically established method-specific recoveries and acceptance limits for all analytes. Solid reference materials are purchased with documentation of analysis provided by the vendor. See Figure 4 for an example certificate of analysis for a solid reference material.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Samples should be collected in clean plastic or glass containers. Samples must be refrigerated ($4^oC \pm 2^oC$) upon receipt by the laboratory. The holding time for solid samples is 6 months from the date of sample collection.

7.0 PROCEDURE

The procedure described below is condensed for quick reference in Table 3.

SAMPLE PREPARATION

7.1 Prior to performing the digestion, make a list of the samples that are to be digested. Enter digestion information (Katahdin Sample Numbers, QC Batch ID, preparation date, analyst initials, etc.) into the ACCESS computer spreadsheet. Print out a copy of the spreadsheet (see Figure 2 for an example). Hand label the digestate vessels

7.2 If using glass beakers as the digestion vessels, submerge previously cleaned beakers and watch glasses three times into a 10% nitric acid bath, then rinse three times with reagent water. The polyethylene digestion tubes used in conjunction with the block digeter do not require acid rinsing or precleaning. Label the digestion vessels with sample numbers.

7.3 Weigh 1 to 2 g of well-mixed sample into a properly cleaned, labeled, and tared Griffin beaker or polyethylene digestion tube. Avoid rocks, roots, leaves and other organic or inorganic foreign material. Record (hand write) the weight of each sample on the printout of the digestion spreadsheet.

Refer to Katahdin Analytical Services SOP CA-108, current revision "Basic Laboratory Technique" for more information on subsampling.

7.4 Weigh an appropriate amount of solid reference material to a clean, labeled, and tared Griffin beaker or polyethylene digestion tube to serve as a laboratory control sample.

7.5 Add spike solutions to matrix spike samples (refer to Tables 3 and 4 for spiking instructions).

7.6 Using repipetters, add 10 mL of 1:1 HNO_3, mix the slurry. Cover with a ribbed watch glass and place on heat source. Gently heat the sample to 95^{o}C ± 5 ^{o}C and reflux for 10 to 15 minutes without boiling. Remove the digestion vessel from the heat source and cool the sample.

7.7 Add 5 mL of concentrated HNO_3 to the sample, replace the watch glass, and reflux for 30 minutes. If brown fumes are generated, indicating oxidation of the sample by HNO_3, repeat this step (addition of 5 mL of concentrated HNO_3) until no brown fumes are given off by the sample, indicating complete reaction by HNO_3.

7.8 Continue heating the sample at 95^{o}C ± 5^{o}C without boiling until the digestate has evaporated to approximately 5 to 10 mL or until two hours have elapsed, whichever occurs first. Do not allow the sample to go to dryness. Remove the digestion vessel from the heat source and cool the sample.

7.9 Add 2 mL of reagent water and 2 mL of 30% H_2O_2 to the sample, replace the watch glass, and heat gently on the heat source to start the peroxide reaction. Continue heating until effervescence subsides.

7.10 Add an additional 2 mL of 30% H_2O_2 to the sample, replace the watch glass, and heat gently on the heat source to start the peroxide reaction. Continue heating until effervescence subsides.

7.11 Add an additional 6 mL of 30% H_2O_2 in 1-mL aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged.

7.12 Continue heating the sample at 95^{o}C ± 5^{o}C without boiling until the digestate has evaporated to approximately 5 to 10 mL or until two hours have elapsed, whichever occurs first. Do not allow the sample to go to dryness. Remove the sample from the heat source and cool.

7.13 Add 10 mL of concentrated HCl to the digest from 7.12, replace the watch glass, and reflux at 95^{o}C ± 5^{o}C for 15 minutes. Remove the sample from the heat source and cool.

7.14 Use a pre-cleaned funnel and acid-rinsed filter paper to filter the digestate into a clean graduated polystyrene specimen container or graduated polyethylene sample container with attached snap lid. Using a wash bottle, rinse the digestion vessel with reagent water and add the rinsates to the filter apparatus. After all of the liquid in the filter has drained into the specimen container, thoroughly rinse the filter three times with small (5-10 mL) volumes of reagent water, allowing the liquid to drain completely after each rinse. Using the graduations on the specimen container or snap-lid container, dilute to 100 mL with reagent water. If a specimen container has been used, transfer the contents to the corresponding labeled polyethylene sample bottle, cap the bottle, and discard the empty specimen container. If a snap-lid container has been used, close and secure the snap-lid. Shake the container gently to mix. The digestate is now ready for ICP-AES or ICP-MS analysis.

7.15 Review the ACCESS computer spreadsheet for accuracy. If any information is incorrect, make the necessary changes to the computer spreadsheet and print out a corrected copy. Do not discard the original copy of the spreadsheet. Record (hand write) reagent lot numbers, spiking information, and heat source temperature in the appropriate spaces on the spreadsheet. Record any method deviations, irregularities with the samples, or other pertinent observations at the bottom of the page, and sign and date the spreadsheet. Bind all copies of the spreadsheet in the sample preparation log. An example sample preparation logbook page (ACCESS spreadsheet) is included as Figure 2.

7.15 Reopen the electronic ACCESS spreadsheet for the digestion and transcribe the sample weights from the handwritten, bound copy into the electronic copy. The information in this electronic spreadsheet will later be imported into the ACCESS metals database and used to calculate sample concentrations on a weight basis.

7.16 Place each batch of digestates in a box labeled with the QC Batch ID, and put the box of digestates in the metals digestates storage area.

CALCULATIONS

7.17 Analytical results for solid samples are reported on a dry weight basis. Total solids are determined by the Wet Chemistry Group, and are recorded in spreadsheets that are electronically imported into the Access metals database. Final dry weight concentrations are calculated by the Access database as follows:

$$\text{Concentration (mg/kg dry weight)} = (C \times V) / (W \times S)$$

where: C = Measured concentration (mg/L)
V = Digestate final volume (L)
W = Sample wet weight (kg)
S = % Solids/100

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

USEPA Method 3050 requires the laboratory to perform specific quality control checks to assess laboratory performance and data quality. Minimum frequencies, acceptance criteria, and corrective actions for these control checks are tabulated in Table 1 and are described below. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgements. These decisions are based on holding time considerations and client and project specific Data Quality Objectives. The Depatment Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases “qualified” data with narration may be advisable after consultation with the client.

8.1 At least one preparation blank for soils (PBS) is processed concurrently with each digestion batch of 20 or fewer samples, and is used to assess contamination resulting from the digestion procedure. The PBS consists of a 1.0 g of boiling stones that is digested using the same reagents as those used to digest associated samples. Refer to the appropriate analytical SOP for PBS acceptance criteria and corrective actions.

8.2 At least one laboratory control sample for soils (LCSS) is processed concurrently with each digestion batch of 20 or fewer samples. The LCSS consists of an aliquot of a solid reference material for which the concentrations of the analytes of interest have been empirically established (solid-matrix LCSS), or an aliquot of reagent water that is spiked to contain all analytes of interest at known concentrations (aqueous-matrix LCSS). The solid reference material should normally be used as the LCSS, unless a particular client or analytical program requires that spiked reagent water be used. The LCSS is digested using the same reagents as those used to digest associated samples. Directions for spiking the aqueous-matrix LCSS are contained in Table 3. The measured analyte recoveries for the LCSS are used to assess digestion method performance. Refer to the appropriate analytical SOP for LCSS recovery acceptance criteria and corrective actions.

8.3 Matrix spike samples are processed along with each digestion batch at a minimum frequency of one per digestion batch. A matrix spike sample consists of an aliquot of a sample that is fortified with known amounts of all analytes of interest prior to digestion. Matrix spike recoveries are used to assess the biasing effects of sample matrix on digestion and analysis performance. Directions for spiking matrix spike samples are contained in Figure 2. Refer to the appropriate analytical SOP for matrix spike recovery acceptance criteria and corrective actions.

8.4 Matrix spiked duplicate samples are processed concurrently with each digestion batch at a minimum frequency of one per digestion batch. Matrix spiked duplicate samples are used to assess the precision of the digestion and analysis methods. Refer to the appropriate analytical SOP for matrix spike duplicate precision acceptance criteria and corrective actions.

NOTE: Clients may choose specific samples for matrix spike and duplicate analysis; otherwise, the choice is left to the person performing the digestion.

8.5 The quality control measures and frequencies described above are minimum requirements. Individual clients and analytical programs may impose additional QC requirements.

9.0 METHOD PERFORMANCE

Refer to the applicable instrumental analysis SOP for method performance information.

10.0 APPLICABLE DOCUMENTS/REFERENCES

"Test Methods for the Evaluation of Solid Waste," United States Environmental Protection Agency, SW-846, Third Edition, Final Update III, 12/96, Method 3050B.

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 4.1, 04/22/09.

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003.

LIST OF TABLES AND FIGURES

TABLE 1

QC REQUIREMENTS – METHOD 3050

Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
3050	Preparation Blank for Solids (PBS)	One per prep batch of 20 or fewer samples.	Refer to analytical method.	Refer to analytical method.
	Laboratory Control Sample for Solids (LCSS)	One per prep batch of 20 or fewer samples.	Refer to analytical method.	Refer to analytical method.
	Matrix Spike Sample	One per prep batch.	Refer to analytical method.	Refer to analytical method.
	Matrix Spike Duplicate Sample	One per prep batch.	Refer to analytical method.	Refer to analytical method.
	Demonstration of analyst proficiency	One-time demonstration by each analyst performing the method.	Must pass all applicable QC for method.	Repeat analysis until able to perform passing QC; document successful performance in personal training file.

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

TABLE 2

SUMMARY OF METHOD MODIFICATIONS – METHOD 3050

Topic	Katahdin SOP CA-605-06	Method 3050, current revision
Apparatus /Materials	1) Digestion performed in 100 mL Griffin beaker or 70 mL polyethylene tube. 2) Graduated disposable plastic cup or 120 mL polyethylene tube used to bring digestate to final volume.	1) Digestion performed in 250 mL Griffin beaker. 2) Volumetric flask used to bring digestate to final volume.
Procedure	1) Digestate volume reduced to 5 to 10 mL prior to filtering. 2) After filtration, the filters are rinsed three times with reagent water. 3) 30% H_2O_2 is added in two 2 mL aliquots and then six 1 mL aliquots.	1) Digestate volume reduced to 5 mL prior to filtering. 2) After filtration, the filters are rinsed twice with reagent water. 3) 30% H_2O_2 is added in one 3 mL aliquot and then seven 1 mL aliquots.

TABLE 3

PREPARATION OF MATRIX SPIKES AND SPIKING SOLUTIONS FOR DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
Matrix Spike for ICP-AES	CLPP-SPK-1	Inorganic Ventures(IV)	0.10
	CLPP-SPK-INT1	Lab Prepared (see below)	1.00
	CLPP-SPK-INT2	Lab Prepared (see below)	1.00

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
CLPP-SPK-INT1	1000 mg/L As,Pb,Sb,Se,Tl	High Purity Standards	1.0 each
	1000 mg/L Cd	High Purity Standards	2.5
	10000 mg/L K	High Purity Standards	10.0
	10000 mg/L Na	High Purity Standards	7.5
	10000 mg/L Mg	High Purity Standards	5.0
	10000 mg/L Ca	High Purity Standards	2.5
CLPP-SPK-INT2	1000 mg/L Mo	IV or High Purity Standards	1.0
	1000 mg/L B,Li,Sn,Sr,Ti	IV or High Purity Standards	5.0 each
	10000 mg/L Si	High Purity Standards	1.0
	10000 mg/L U	High Purity Standards	1.0
	10000 mg/L W	High Purity Standards	1.0

TABLE 4

ELEMENT CONCENTRATIONS IN ICP-AES MATRIX SPIKES AND THEIR COMPONENT SPIKING SOLUTIONS FOR DIGESTION OF SOLID SAMPLES BY METHOD 3050

	CONCENTRATION IN SOLUTION, mg/L			
Element	Matrix Spike	CLPP-SPK-1	CLPP-SPK-INT1	CLPP-SPK-INT2
Aluminum	2.000	2000		
Antimony	0.100		10	
Arsenic	0.100		10	
Barium	2.000	2000		
Beryllium	0.050	50		
Boron	0.500			50
Cadmium	0.250		25	
Calcium	2.500		250	
Chromium	0.200	200		
Cobalt	0.500	500		
Copper	0.250	250		
Iron	1.000	1000		
Lead	0.100		10	
Lithium	0.500			50
Magnesium	5.000		500	
Manganese	0.500	500		
Molybdenum	0.300			10
Nickel	0.500	500		
Potassium	10.000		1000	
Selenium	0.100		10	
Silicon	5.000			100
Silver	0.050	50		
Sodium	7.500		750	
Strontium	0.500			50
Thallium	0.100		10	
Tin	0.500			50
Titanium	0.500			50
Tungsten	0.100			10
Uranium	0.100			10
Vanadium	0.500	500		
Zinc	0.500	500		

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

FIGURE 1

PROCEDURE CONDENSATION – METHOD 3050

1. Prepare and print out ACCESS spreadsheet.
2. If performing digestion on a hot plate, rinse 250 mL Griffin beakers and ribbed watch glasses 3 times in acid bath. Then rinse beakers and watch glasses 3 times with laboratory reagent grade water. If perfoming digestion with block digester, polyethylene digestion tubes do not require precleaning.
3. Label digestion vessels (beakers or polyethylene sample tubes) with sample numbers.
4. Weigh 1 to 2 g of well-mixed sample into tared digestion vessels. Record sample weights.
5. Add spike solutions to matrix spike samples.
6. Add 10 mL 1:1 HNO_3 to samples and cover with watch glasses.
7. Reflux for 10 to 15 minutes at $95^{o} \pm 5^{o}$ C. without boiling. Cool samples.
8. Add 5 mL conc. HNO_3, cover beakers, and reflux for 30 minutes.
9. Repeat Step 8 as necessary until digestion is complete.
10. Reduce sample volumes to 5 to 10 mL or heat for 2 hours, whichever occurs first.
11. Cool sample and add 2 mL reagent water and 2 mL 30% H_2O_2. Heat gently until effervescence subsides.
12. Cool sample and add 2 mL 30% H_2O_2. Heat gently until effervescence subsides.
13. Cool samples and add 6 mL of 30% H_2O_2 in 1 mL aliquots. Heat gently until effervescence subsides.
14. Reduce sample volumes to 5 to 10 mL or heat for 2 hours, whichever occurs first.
15. Add 10 mL conc. HCl and reflux for 10 to 15 minutes at $95^{o} \pm 5^{o}$ C.
16. Cool sample and filter into graduated specimen container. Bring to volume with reagent water and transfer to labeled polyethylene bottle.
17. Enter sample weights into ACCESS spreadsheet.

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

FIGURE 2

EXAMPLE PAGE FROM METALS SAMPLE PREPARATION LOGBOOK

Katahdin Analytical Services, Inc. — Metals Preparation Benchsheet

Reagent Information:
JT Baker HNO3: M12022 JT Baker HCL: H64040 KMG H2O2: 6/6022 Method: 3050H

LCS / Spike — LCS/Spiking Information:

☐ ☑	I.V. CLPP-SPK-1 (ID/Vol): MS1564	0.1	mL	Hot Plate/Block ID : B	Fisher Filter Paper: K11672323B
☐ ☑	CLPP-SPK-INT1 (ID/Vol): MW11464	1.0	mL	Start Temp.: 95 °C	
☐ ☑	CLPP-SPK-INT2 (ID/Vol): MW11864	1.0	mL	End Temp. : 95 °C	
☐ ☑	Uranium Spike (ID/Vol): MS1594	0.001	mL	Thermometer ID/Pos.: ALC 8 / 1.4	
☐ ☐	CLPP-SPK-4 (ID/Vol): N/A		mL		

LCSS : MS1578 Balance ID: Ohaus Galaxy 400 7/31/09 AJD

REVIEWED
7/31/09
KATAHDIN ANALYTICAL METALS SECTION

Sample ID	Batch ID	Initial Wt/Vol	Initial Units	Final Vol	Final Units	MX	Meth	Anal.	Date	Initial Color	Initial Texture	Final Color	Final Clarity	Artifacts	Bottle
LC2SZG311CS0	ZG311CS0	0.5074	g	0.10	L	SL	IC	AJB	07/31/2009	N/A	N/A	N/A	N/A	N/A	N/A
LCSSZG311CS0	ZG311CS0	0.5034	g		L	SL	IC	AJB	07/31/2009	N/A	N/A	N/A	N/A		
PBSZG311CS0	ZG311CS0	1.00	g		L	SL	IC	AJB	07/31/2009	N/A	N/A	N/A	N/A		
SC4328-001	ZG311CS0	1.79	g		L	SL	IC	AJB	07/31/2009						A
SC4328-001P	ZG311CS0	1.05	g		L	SL	IC	AJB	07/31/2009						
SC4328-001S	ZG311CS0	1.04	g		L	SL	IC	AJB	07/31/2009						
SC4348-001	ZG311CS0	1.35	g		L	SL	IC	AJB	07/31/2009						
SC4348-002	ZG311CS0	1.24	g		L	SL	IC	AJB	07/31/2009						
SC4348-003 7/31/09	ZG311CS0	1.11	g		L	SL	IC	AJB	07/31/2009						
SC4357-001 AJD	ZG311CS0	1.40	g		L	SL	IC	AJB	07/31/2009						
SC4357-~~001~~002	ZG311CS0	1.17	g		L	SL	IC	AJB	07/31/2009						
SC4357-~~001~~003	ZG311CS0	1.52	g	0.10	L	SL	IC	AJB	07/31/2009						A

AJD 7/31/09

Digestion performed by: AJD Date: 7/31/09 Page: ZG104 Revision: 00

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

FIGURE 3

EXAMPLE CERTIFICATE OF ANALYSIS FOR SOLID REFERENCE MATERIAL

ENVIRONMENTAL RESOURCE ASSOCIATES®
The Industry Standard™

MS1475

DataPacK™
Lot No. D051-540

Trace Metals in Soil
Catalog No. 540

Certification

Method 3050 HNO3, H2O2, HCl Parameter	Total Concentration [1] (mg/Kg)	Certified Value [2] (mg/Kg)	Performance Acceptance Limits™ [3] (mg/Kg)
aluminum	55600*	7870	4630 - 11100
antimony	160	70.5	D.L. - 149
arsenic	316	289	234 - 344
barium	869	211	174 - 247
beryllium	60.9	54.4	45.2 - 63.6
boron	129	91.3	58.8 - 124
cadmium	114	101	82.9 - 119
calcium	9750*	3680	2970 - 4390
chromium	249	224	180 - 268
cobalt	113	101	82.7 - 119
copper	94.9	88.0	73.3 - 103
iron	24400*	15700	6610 - 24900
lead	184	158	129 - 187
magnesium	3780*	2260	1760 - 2750
manganese	703	420	343 - 497
mercury	5.32	5.18	3.42 - 6.87
molybdenum	80.2	69.6	55.5 - 83.7
nickel	137	120	99.1 - 141
potassium	33000*	3000	2200 - 3800
selenium	146	130	101 - 159
silver	127	104	68.9 - 139
sodium	15600*	1080	692 - 1470
strontium	326	113	90.5 - 135
thallium	106	94.0	72.8 - 115
tin	175	149	104 - 194
titanium	3100*	284	116 - 453
vanadium	151	111	85.1 - 137
zinc	311	272	215 - 329

Method 3050 HNO3, H2O2 Parameter	Total Concentration [1] mg/Kg	Certified Value [2] mg/Kg	Performance Acceptance Limits™ [3] mg/Kg
aluminum	55600*	7380	4440 - 10300
antimony	160	75.2	D.L. - 198
arsenic	316	284	225 - 343
barium	869	217	177 - 257
beryllium	60.9	53.6	42.7 - 64.5
boron	129	89.5	58.9 - 120
cadmium	114	103	83.6 - 122
calcium	9750*	3540	2800 - 4270
chromium	249	224	172 - 275
cobalt	113	101	82.0 - 120
copper	94.9	85.5	70.4 - 100
iron	24400*	12500	5480 - 19500
lead	184	162	132 - 192
magnesium	3780*	2160	1650 - 2670
manganese	703	415	330 - 500
mercury	5.32	5.18	3.42 - 6.87
molybdenum	80.2	68.8	52.7 - 84.9
nickel	137	119	98.5 - 140
potassium	33000*	2840	2160 - 3520
selenium	146	135	104 - 166
silver	127	107	49.8 - 164
sodium	15600*	1010	709 - 1310
strontium	326	111	89.0 - 133
thallium	106	99.3	76.8 - 122
tin	175	148	70.6 - 225
titanium	3100*	283	104 - 463
vanadium	151	104	70.5 - 138
zinc	311	275	222 - 328

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

ATTACHMENT 1

MODIFICATIONS FOR 8330B PREPARATION & DIGESTION

4.0 APPARATUS AND MATERIALS – additional materials

4.1 Sieves - #10 mesh (2 mm) – 8" diameter with covers and collection trays.

4.2 Aluminum drying trays with drying rack

4.3 Heavy duty aluminum foil

4.4 Stainless steel scoopulas

4.5 Dust mask

7.0 PROCEDURES – additional procedures

Prior to the digestion of samples (section 7.1 in SOP):

Spread the entire aliquot of soil onto a drying tray lined with heavy duty aluminum foil and dry in air at room temperature or colder to a constant weight (last two successive dry weights within 3% RPD). Trays should be placed in rack for drying. Record all weights in the Sample Drying Logbook.

Note: Hydric soils and sediments with high moisture content may take several days to dry to constant weight.

Remove the oversize fraction by passing it through a 10-mesh (2 mm) sieve. Be sure to break up caked up soil with a gloved hand. Weigh both fractions – oversize and <2mm. Record all weights in the Sieving & Grinding Logbook.

To obtain a subsample, the entire sample must be mixed with a stainless steel scoopula and spread out on a clean surface (aluminum tray lined with foil) so that it is only 1 or 2 cm thick - preferably in a fume hood designed to prevent the spread of dust and possible inhalation or residue losses. Using the scoopula, obtain at least 30 different increments, i.e., portions (~0.3 g) from randomly chosen locations throughout the entire sample profile for a total of ~10 g. Mix this subsample one more time with the scapula and then obtain an aliquot for metals digestion (beginning with section 7.3).

TITLE: TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010

Prepared By: George Brewer Date: 7/98

Approved By:

Group Supervisor: George Brewer Date: 01/23/01

Operations Manager: Joel C. Burton Date: 1/23/01

QA Officer: Deborah J. Nadeau Date: 1·23·01

General Manager: Duncan F. Hufnagle Date: 1/25/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01 6010B	Format changes, added pollution prevention, expanded procedure and QC sections. Added tables.	DH	1·23·01	1/23/01
02 6010B	Calibration begins with analysis of S0 (Cal. blank) followed by S1 (Mixed Cal. Std.) Changes to section 7.5 and Table 8 to reflect this. Made changes to element conc's. in Tables 3, 4, 5, 6 to reflect current practices	DH	10·21·02	10·21·02
03 6010B	Added MN_IEC to standards run. Changed frequency of LRS. Changed concentration % HNO_3 in calibration blank. CRI changed from three separate solutions to one. Changed CRI vendor.	MRC	04.15.04	04.15.04
04	Updated ICV, CCV, ICB, PQL Chk Std. PBW, PBS, MS & MSD acceptance criteria updated Table 1	LAD	05/06	05/06
05	Updated Tables 3, 4, 5, 6 and 7 with current Standard concentrations and prep. Updated Table 1 with current practices including NAVY audit findings. Updated Sections 2, 7.2, 7.6 and Table 1 with new ICP information. Updated Table 8 with current sequence requirements.	LAD	07/07	07/07

TITLE: TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
06	Added hardness definition and calculation (APP. I)	LAD	09/07	09/07
07	Updated Summary to reflect new ICP functions. Removed ICP set-up Updated tables to reflect changes in Standard Concentrations and preparation	LAD	11/08	11/08
08	Updates to Sections 8 and 10, Tables 1 and 2 to reflect changes from 6010B to 6010C. Added LLQC information and criteria to Sect. 8 and Table 1. Added criteria to analyze PQL standard at the beginning and END of each run.	LAD	02/09	02/09
09	Updated Sections 8, 9, 10 and Table 1 for compliance with DoD QSM version 4.1.	LAD	08/09	08/09
10	Added Table 2 - DoD QSM Ver. 4.1 QC Requirements. Minor correction to Table 1.	LAD	04/10	04/10
11	Added yttrium criteria to section 7 and Table 1.	LAD	06/10	06/10
12	Revised Tables 4 → 8 with the following information: -Add palladium and gold; removed tungsten and uranium; removed Stock Standard ~~QCP-CICV~~ 200.7ICS-1; changed stock standard QCP-CICV-3 to CL-CAL-3. Added references to section 10. LAD 09/22/11	LAD	09/11	09/11
13	The changes above had not been finalized in SOP-12. Sect. 9 - Added MDL, LOD and LOQ information. Added Attachment 2 - Analysis of Palladium by SW846 6010	LAD	04/12	04/12

TITLE: TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010

Revision History (cont.):

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
14	Sect. 9 & Table 1 - Fixed typos.	LAD	05/13	05/13
15	Sect. 10- Updated references. Added Table 3- DoDQSM 5.0 QC Requirements- Renumbered rest of Tables. Updated Tables(6→8). Changed KAS INC to KAS LLC.	LAD	12/14	12/14
16	Sect. 5 & 7 - Corrected Table references. Tables 5, 6, 7 & 8 - Updated Standard, Concentrations & Sources. Changed KAS LLC to KAS	LAD	05/16	05/16
17	Sect. 1 and 6 - Added Tissue matrix	LAD	07/16	07/16
18	Sect. 8.1 - changed reagent spiked water to calibration blank solution. Sect. 10 - update method references.	LAD	09/17	09/17

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

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KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

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TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

1.0 SCOPE AND APPLICATION

Inductively coupled plasma atomic-emission spectroscopy (ICP-AES) determines trace elements, including metals, in solution. The purpose of this SOP is to describe the procedures used by Katahdin Analytical Services, LLC personnel to analyze aqueous and solid samples for trace metals by USEPA Method 6010 (Test Methods for Evaluating Solid Waste, Physical/ Chemical Methods, USEPA SW846).

Sample types that may be analyzed using these methods include drinking waters, ground waters, aqueous samples, TCLP, SPLP and EP Toxicity extracts, industrial and organic wastes, soils, sludges, sediments, biological tissue and other solid wastes. The following elements may be analyzed under this SOP: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si, Ag, Na, Sn, Sr, Tl, Ti, V, and Zn.

All samples, except filtered ground water samples, analyzed under USEPA Method 6010 require digestion prior to analysis. USEPA Methods 3005, 3010, and 3050 describe appropriate digestion procedures for samples to be analyzed by ICP-AES under EPA Method 6010. Refer to current revisions of Katahdin SOPs CA-604 and CA-605, current revisions, for sample digestion procedures.

1.1 Definitions

Analytical Spike - An aliquot of a sample to which a known amount of analyte has been added before analysis and after digestion, if digestion is required.

CCB - Continuing Calibration Blank - An analyte-free solution consisting of acidified reagent water used to verify calibration accuracy periodically during analysis.

CCV - Continuing Calibration Verification - A midrange standard used to verify calibration accuracy periodically during analysis.

CRI - Contract Required detection limit sample for ICP - A low concentration standard used to verify calibration accuracy near the low end of the calibration range.

Duplicate - A second aliquot of a sample that is prepared and analyzed in the same way as the original sample in order to determine the precision of the method.

ICB - Initial Calibration Blank - An analyte-free solution consisting of acidified reagent water used to verify calibration accuracy.

ICP-AES - Inductively Coupled Plasma Atomic Emission Spectroscopy.

ICS - Interference Check Sample - Two standards (ICSA and ICSAB) used to verify the effectiveness of interelement correction and background correction. Solution

ICSA contains only interferents (Al, Ca, Fe, and Mg) at high concentrations (200 to 500 mg/L); solution ICSAB contains interferents at the same concentrations as well as analytes at low (20 mg/L or less) concentrations.

ICV - Initial Calibration Verification - A standard made from a source independent from the calibration standards and with analyte concentrations different from those in the CCV; used to verify the accuracy of the instrument calibration.

IDL - Instrument Detection Limit - The lowest concentration of an analyte that can be determined with 99% confidence.

LOD – Limit of Detection – An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix-specific and is used for DoD QSM acceptance criteria.

LOQ – Limit of Quantitation.- The minimum concentration of a target analyte that produces a quantitative result within specified limits of precision and bias.

LCS - Laboratory Control Sample - A standard or solid reference material that has been brought through the sample preparation process.

LRS - Linear Range Standard - A high-concentration standard used to determine the upper reporting limit of the ICP calibration.

PB - Preparation Blank - Reagent water that has been brought through the sample preparation process.

PQL - Practical Quantitation Limit - The lowest concentration of an analyte that is routinely reported by the laboratory; nominally three to five times the IDL.

Matrix Spike - An aliquot of a sample to which a known amount of analyte has been added before digestion.

Serial Dilution - The dilution of a sample by a factor of five. When corrected by the dilution factor, the measured analyte concentrations of the diluted sample should agree with those of the original undiluted sample within specified limits. Serial dilution may reflect the influence of interferents.

Hardness – The sum of the calcium and magnesium concentrations, both expressed as calcium carbonate, in mg/L.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of, analysts experienced in ICP analysis by EPA Method 6010. Each analyst must demonstrate and document

their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, "Personnel Training & Documentation of Capability".

It is the responsibility of all Katahdin technical personnel involved in ICP analysis by Method 6010 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

Samples, sample digestates, standards, and other reagents used in ICP analysis may contain high concentrations of acids and toxic metals. Safety glasses should be worn when changing or adjusting argon tanks.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Wastes from ICP analysis should be disposed of in a manner appropriate to the hazards they present. Wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Analytical Environmental Health and Safety Manual l and SOP SD-903, “Sample Disposal,” current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP.

2.0 SUMMARY OF METHOD

This method describes multielemental determinations by ICP-AES using simultaneous optical systems and radial and axial viewing of the plasma. The basis of the method is the measurement of atomic emission from sample atoms entrained in an argon plasma by optical spectroscopy. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where thermal excitation of entrained atoms and ions occurs. Characteristic atomic-line and ionic-line emission spectra are produced by a radio-frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating and the intensities of the emitted lines are monitored by a solid state charge injection device (CID) camera system. Photocurrents from the CID camera system are measured by a computer system. Element concentrations of unknown samples are quantitated by comparison of sample emission intensities to emission intensities of standards of known concentration. A background correction technique is used to compensate for variable background contribution to the determination of trace elements. Background is measured adjacent to the analyte lines on samples during analysis. The position selected for the background intensity measurement, on either or both sides of the analytical line, has been determined by the complexity of the spectrum adjacent to the analytical line. The position used must be relatively free of spectral interference and must reflect the same change in background intensity as occurs at the analyte wavelength. Physical interferences are corrected through the use of an internal standard (yttrium) that is automatically added to all samples and standards prior to nebulization. The possibility of additional interferences (noted in section 3) must be recognized and appropriate corrections applied.

3.0 INTERFERENCES

Several types of interference effects may contribute to inaccuracies in the determination of trace elements. They can be summarized as spectral interferences, physical interferences, and chemical interferences.

Spectral interferences can be categorized as 1) overlap of a spectral line from another element; 2) unresolved overlap of molecular band spectra; 3) background contribution from continuous or recombination phenomena; and 4) background from stray light from the line emission of high concentration elements. The first of these effects is compensated by utilizing the computer correction of raw data, requiring the monitoring and measurement of

the interfering element (interelement correction). The second effect is controlled by choosing analytical wavelengths that are free from overlapping molecular emission spectra. The third and fourth effects are usually compensated by a background correction adjacent to the analyte line. Uncorrected spectral interferences may be detected through examination of serial dilution and matrix spike data.

Physical interferences are generally considered to be effects associated with sample nebulization and transport processes. Such properties as changes in viscosity and surface tension can cause significant inaccuracies, especially in samples that may contain high dissolved solids and/or acid concentrations. Matrix matching of standards and samples and the use of a peristaltic pump may lessen these interferences. If these types of interferences are operative, they must be reduced by dilution of the sample and/or utilization of standard addition techniques. Another problem that can occur from high dissolved solids is salt buildup at the tip of the nebulizer. This affects aerosol flow rate causing instrumental drift. Regular cleaning of nebulizer tips and dilution of samples with high dissolved solids contents are used to control this problem. Physical interferences are also corrected by this laboratory through the use of an internal standard. Uncorrected physical interferences may be detected through examination of serial dilution and matrix spike data. Instrument drift caused by the salting up of nebulizer tips may also be detected by looking for oriented drift in calibration verification standards analyzed regularly throughout the run.

Chemical interferences are characterized by molecular compound formation, ionization effects, and solute vaporization effects. Normally these effects are not pronounced with the ICP technique; however, if observed they can be minimized by careful selection of operating conditions (i.e., incident power, observation position, etc.), by matrix matching, and by standard addition procedures. These types of interferences can be highly dependent on matrix type and the specific analyte element. Uncorrected chemical interferences may be detected through examination of serial dilution data.

4.0 APPARATUS AND MATERIALS

4.1 Computer-controlled inductively-coupled plasma atomic emission spectrometer (plasma viewed radially or axially) equipped for internal standardization, and capable of performing automatic background correction and interelement correction. For more information refer to the current revision of Katahdin SOP CA-632, “Operation and Maintenance of the Thermo ICAP 6500 ICP Spectrophotometer”.

4.2 Computer-controlled autosampler.

4.3 Argon gas supply – high purity.

4.4 Volumetric glassware of suitable precision and accuracy.

4.5 Automatic pipets of suitable precision and accuracy. Calibrated Eppendorf Reference pipets and Finn digital pipets are appropriate.

Refer to the appropriate instrument-specific SOP for additional required equipment.

5.0 REAGENTS AND STANDARDS

5.1 Hydrochloric acid, concentrated (HCl) – spectroscopic grade.

5.2 Nitric acid, concentrated (HNO_3) – spectroscopic grade.

5.3 Reagent water, trace metals free.

5.4 Calibration blank – reagent water containing HCl (5% v/v) and HNO_3 (5% v/v). Calibration blank solution is prepared in large volumes (up to 20 liters) and stored in a carboy. Calibration blank solution is used in establishing the analytical curve, and in all initial and continuing calibration blank determinations. This solution is also used to flush the system between standards and samples. Intermediate and working standards are prepared by diluting stock standards and intermediate standards with calibration blank solution so that all standards and blanks are acid matrix-matched to sample digestates.

5.5 Single element and multielement stock standard solutions – purchased standards prepared from high purity salts or metals, and supplied by the vendors with certificates of purity and analysis. Refer to Tables 5 and 6 for a listing of stock standards required, and to Table 9 for element concentrations in stock standards.

5.6 Intermediate standard solutions – laboratory-prepared multielement standards that are used in the subsequent preparation of working standards. Refer to Table 6 for a listing of intermediate standards required and for preparation instructions. Refer to Table 8 for element concentrations in intermediate standards.

5.7 Working standard solutions – laboratory-prepared multielement standards that are used to calibrate the instrument and to perform all necessary QC checks. Refer to Table 5 for a listing of working standards and for preparation instructions. Refer to Table 7 for element concentrations in working standards.

5.8 5 mg/L yttrium internal standard solution – add 0.5 mL 10000 mg/L yttrium stock standard to a 1000 mL volumetric flask half filled with calibration blank solution. Bring to volume with calibration blank solution.

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Samples to be analyzed for trace metals by ICP should be collected and preserved as described in the following table.

Matrix	Container[1]	Volume / Weight	Preservation / Treatment	Holding Time
Aqueous (total)	P, G	250 mL	HNO_3 to pH < 2	6 months
Aqueous (dissolved)	P, G	250 mL	Filter, HNO_3 to pH < 2	6 months
Solid	P, G	10 g	Cool, 4°C	6 months
Tissue	P, G	25 g	Cool, 4°C	6 months

[1] P = polyethylene or, G = glass

7.0 PROCEDURES

7.1 Begin by following the startup and calibration instructions provided in the current revision of Katahdin SOP CA-632, "Operation and Maintenance of the Thermo ICAP 6500 ICP Spectrophotometer"

7.2 Analysis must proceed in the sequence described in Table 10 to ensure that all necessary quality control samples are analyzed at the appropriate frequencies. A minimum of two replicate integrations is required for all standards and samples. Analysis always begins with the analysis of a calibration blank solution (S0) followed by analysis of a multi-element calibration standard (S1 in Table 5) to calibrate the instrument. The system is flushed with calibration blank for two minutes between each sample and standard, and each sample and standard is aspirated for one minute prior to the beginning of emission measurements.

7.3 Analysis continues with analysis of the initial calibration verification standard (ICV) and the initial calibration blank (ICB) to verify the accuracy of the calibration. Refer to Section 8 and Tables 1 through 3 for additional information.

7.4 A continuing calibration verification standard (CCV) and a continuing calibration blank (CCB) must be analyzed at the beginning of the run, after every ten samples, and at the end of the run to verify the continued accuracy of the calibration. Refer to Section 8 and Tables 1 through 3 for additional information.

7.5 Interference check standard solutions (ICSA and ICSAB) must be analyzed at the beginning, end, and at periodic intervals (4-6 hours, 30-40 analytical samples) throughout the sample run to verify the accuracy of the IEC factors. Refer to Section 8 and Tables 1 through 3 for additional information.

7.6 A practical quantitation limit standard (PQL) must be analyzed at the beginning of each run to determine the accuracy of the calibration at the reporting limit. Refer to Section 8 and Tables 1 through 3 for additional information.

7.7 All sample analytical results for a particular element that are bracketed (preceded or followed) by failing results in a QC sample (ICV, ICB, CCV, CCB, ICSA, or ICSAB) for that element must not be reported. The sample must be reanalyzed for the element in question.

7.8 All samples that exceed the linear dynamic range must be diluted and reanalyzed. This includes samples with interfering elements that exceed the calibration ranges, because accurate quantitation of interfering elements is necessary for reliable interelement correction. For example, if a sample has been submitted to the laboratory for lead analysis, and the measured aluminum concentration of that sample exceeds the calibration range for aluminum, it must be diluted sufficiently to bring aluminum within the linear dynamic range and the lead result must be reported from that dilution analysis.

7.9 If dilutions of digested samples are performed, the measured element concentrations must be multiplied by the dilution factor prior to reporting. This is accomplished automatically by entering the dilution factor in the autosampler table prior to initiation of analysis.

7.10 All analyses are performed using yttrium as an internal standard to compensate for enhancement or depression of the analytical signal due to matrix effects. Yttrium solution is pumped at a constant rate through one channel of the peristaltic pump. Samples and standards are pumped through a second channel of the pump. The tubing carrying the internal standard is connected to the tubing carrying samples and standards downstream from the pump, and mixing of the two streams is accomplished in a mixing coil downstream from the connection, prior to nebulization. For each sample or standard, the computer that controls the spectrometer divides the detected emission signal for each element by the detected yttrium emission signal prior to quantitation, thus normalizing all emission signals to that of yttrium. The yttrium recovery must be within ± 20% of the counts of the initial calibration blank. If the recovery is outside of this, the sample must be diluted and reanalyzed.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

USEPA Method 6010 requires the laboratory to perform specific quality control checks to assess laboratory performance and data quality. Minimum frequencies, acceptance criteria, and corrective actions for these control checks are tabulated in Table 1 and are described below. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations and client and

project specific Data Quality Objectives. The supervisor, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed. Tables 2 and 3 list the QC Check, minimum frequencies, acceptance criteria, corrective actions, flagging criteria and additional comments for work analyzed in accordance with DoD QSM versions 4.2 and 5.0.

INITIAL DEMONSTRATION OF PERFORMANCE

8.1 Instrument detection limits (IDL) are determined quarterly for each analyte analyzed on each instrument. This determination requires seven replicate analyses of calibration blank solution, performed on three non-consecutive days. The standard deviation of the 21 analyses is multiplied by three to obtain the IDL. For more information on performing IDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.2 Method detection limits (MDL) are determined annually for each analyte analyzed on each instrument. This determination requires at least seven replicate digestions and analyses of reagent water spiked at 3-5 times the anticipated MDL for each analyte. MDLs differ from IDLs in that the seven replicates are digested prior to analysis, and they may be analyzed on a single day. The standard deviation of the 7 (or more) replicate analyses is multiplied by the Student's t-value to obtain the MDL. For more information on performing MDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.3 Limits of Detection (LOD) are used when evaluating data using DoD QSM. The LOD is established by spiking a quality system matrix at 2-3 times the detection limit for a single analyte standard and 1-4 times the detection limit for a multi-analyte standard. The LOD must be verified quarterly. For more information on performing LOD determinations, refer to the current revision of Katahdin SOP QA-806.

8.4 Limits of Quantitation (LOQ) are used when evaluating data using DoD QSM. The LOQ must be above the LOD.

8.5 A Lower Limit of Quantitation Check (LLQC) sample must be prepared and analyzed annually or on an as-needed basis to confirm the laboratory's Practical Quantitation Limits (PQLs). The LLQC sample is equivalent to the PQL standard (Section 8.10) but is carried through the entire sample preparation and analysis process. Element recoveries for the LLQC sample must fall within 70% to 130% of the expected concentrations to confirm the previously established PQLs.

8.6 The upper limit of the linear dynamic range (LDR) must be established for each wavelength utilized. It must be determined from a linear calibration prepared in the normal manner using the established analytical operating procedure for the instrument. The LDR should be determined by analyzing succeedingly higher standard concentrations of the analyte until the observed analyte concentration differs by no more than 10% from the stated concentration of the standard. Determined LDRs must be documented and kept on file. The LDR which may be used for the analyses of samples should be judged by the analyst from the resulting data. Determined sample analyte concentrations that are greater than the determined upper LDR limit must be diluted and reanalyzed. The LDRs should be verified **every six months** or whenever, in the judgment of the analyst, a change in analytical performance caused by either a change in instrument hardware or operating conditions would dictate they be redetermined.

8.7 The alkali and alkaline earth metals may have non-linear response curves due to ionization and self-absorption effects. These curves may be used for quantitation of samples if the effective range is checked and if the second order curve fit has a correlation coefficient of 0.998 or better. Third order fits are not acceptable. Non-linear response curves must be revalidated and recalculated every six months.

ANALYTICAL RUN QC SAMPLES

8.8 An Initial Calibration Verification (ICV) solution is analyzed after the initial calibration to check calibration accuracy. The ICV solution is prepared by combining compatible elements from a standard source different than that of the calibration standard and at concentrations within the linear working range of the instrument. The results of the ICV must fall within 90% to 110% of the expected values. If the ICV fails, result for the failing elements may not be reported from the run unless the ICV recovery is greater than 110% and the sample result is less than the PQL.

No results may be accepted for failing elements if DoD QSM acceptance criteria are being used.

8.9 Continuing Calibration Verification (CCV) solutions are analyzed after the initial calibration, after every ten samples, and at the end of the analytical run. The CCV solution is prepared using the same standards used for calibration at concentrations near the mid-point of the calibration curve. Results of the CCVs must fall within 90% to 110% of the expected values. If a CCV fails, results for the failing elements

may not be reported from the run unless the CCV recovery is greater than 110% and the sample result is less than the PQL (less than reporting limit for DoD QSM). Also, for failing elements, all samples analyzed after the last passing CCV must be reanalyzed.

8.10 Calibration blank solution is analyzed after each ICV and CCV. A calibration blank that is analyzed after the ICV is called an Initial Calibration Blank (ICB). A calibration blank that is analyzed after a CCV is called a Continuing Calibration Blank (CCB). The absolute values of results of ICBs and CCBs must be less than the Practical Quantitation Level (PQL) for each element. If an ICB or a CCB fails, results for the failing elements may not be reported from the run until the problem is corrected and a passing ICB or CCB has been analyzed, with the following exception. If the result for a CCB or ICB is greater than the PQL, sample results that are less than the PQL or greater than or equal to ten times the measured CCB concentration may be reported. Also, for failing elements, all samples analyzed after the last passing CCB must be reanalyzed, with the exception noted above.

If DoD QSM acceptance criteria are being used, the absolute values of results of ICBs and CCBs must be less than the Limit of Detection (LOD). If an ICB or a CCB fails, results for the failing elements may not be reported from the run until the problem is corrected and a passing ICB or CCB has been analyzed.

8.11 Interference check solutions ICSA and ICSAB (refer to Section 1.1) are analyzed at the beginning of each run to verify interelement correction factors and background correction. ICSA contains interferent elements (Al, Ca, Fe, and Mg) only, at concentrations of 200 mg/L to 500 mg/L. Results for interfering elements in the ICSA must fall within 80% to 120% of the expected values. Results for unspiked elements in ICSA must fall within $\pm$ PQL if the PQL is greater than 0.01 mg/L, within $\pm$ 2xPQL if the PQL is less than or equal to 0.01 mg/L. If DoD QSM acceptance criteria are being used, the absolute value of unspiked elements must be less than the LOD. ICSAB contains interferent elements at concentrations of 200 mg/L to 500 mg/L, and analytes at concentrations of 20 mg/L or less. Results for all elements (interferents and analytes) in ICSAB must fall within 80% to 120% of the expected values. If the ICSA or ICSAB fails, results for the failing elements may not be reported from the run until the problem is corrected and a passing ICSA or ICSAB has been analyzed.

8.12 A Practical Quantitation Limit (PQL) Check Standard or low level continuing calibration verification (LLCCV) is analyzed at the beginning (after the ICV and ICB samples) and at the end of each run. Element concentrations in this solution are at the laboratories practical quantitation limit. Element recoveries for the PQL check Standard must fall between 70-130% of the expected values. If the PQL Check Standard fails, the results for the failing elements may not be reported from the run,

unless the PQL Check Standard recovery is greater than 130% and the samples results are less than the PQL.

If DoD QSM acceptance criteria are being used, recoveries must fall between 80-120%. If the PQL Check Standard fails, the results for the failing elements may not be reported from the run.

PREPARATION BATCH QC SAMPLES

8.13 Each digestion batch of twenty or fewer samples will contain a preparation blank and a laboratory control sample. Each batch will also contain one or more of the following QC samples: laboratory control sample duplicate, sample duplicate, matrix spike sample or matrix spike sample duplicate.

8.14 A preparation blank (PBW or PBS), consisting of reagent water carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. The results of preparation blanks must be less than the Practical Quantitation Level (PQL) for each element. For DoD QSM acceptance criteria the results must be less than ½ the PQL except for common contaminants which must be less than the PQL. If a preparation blank fails, results for the failing elements may not be reported from the digestion batch, and all associated samples must be redigested, with the following exception. If the result for a preparation blank is greater than the PQL (greater than ½ PQL for DoD), associated sample results that are less than the PQL (less than ½ PQL for DoD) or greater than or equal to ten times the measured preparation blank concentration may be reported.

8.15 A laboratory control sample (LCS), consisting of spiked reagent water or a solid reference material carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. Results for laboratory control samples must fall within 80% to 120% of the expected value, unless vendor-supplied limits (for solid reference materials) or laboratory-generated statistical limits are available. If a laboratory control sample fails, results for the failing elements may not be reported from the digestion batch, and all associated samples must be redigested with the following exception. If the LCS fails high, sample results less than the PQL may be reported.

If DoD QSM 4.2 acceptance criteria are being used, recovery for solid matrix samples must fall between 80% to 120% except for Ag, which must fall between 75% and 120%. If DoD QSM 5.0 acceptance criteria are being used, recovery for water and solid matrix samples must fall between the limits stated in Tables 3 & 4 of the QSM. Results may not be reported without a valid LCS and will be qualified and explained if reanalysis cannot be performed.

SAMPLE MATRIX QC SAMPLES

8.16 Matrix spiked duplicate samples are prepared at a minimum frequency of one per digestion batch. The recovery for each element in a spiked sample or spiked duplicate sample must fall within 75% to 125% of the actual value if the result for the unspiked sample is less than four times the amount of spike added. If one or both spike recoveries fail, the associated sample result must be flagged on the report of analysis. If DoD QSM acceptance criteria are being used, recoveries must be the same as stated for laboratory control samples.

The relative percent difference between sample duplicate, matrix spiked duplicate or LCS duplicate, is calculated as follows:

$$RPD\ (\%) = \frac{|D_1 - D_2|}{(|D_1 + D_2|)/2} \times 100$$

where: D_1 = sample result
D_2= duplicate sample result

A control limit of 20% RPD is applied to duplicate analysis if the original sample result is greater than 50X the IDL. If the matrix spike duplicate analysis fails, the associated sample result must be flagged on the report of analysis.

8.15 A serial dilution is analyzed to check for chemical or physical interferences. If the analyte concentration of a sample is sufficiently high (minimally, 50 x IDL or 50 x LOQ if using DoD QSM acceptance criteria), the measured concentration of a serial dilution (1:5 dilution) of the sample should agree within 90% to 110% of the original determination. The percent difference between the original sample and the serial dilution should be calculated as follows:

$$Difference\ (\%) = \frac{|L-S|}{S} * 100\%$$

where: L = Serial dilution result (corrected for dilution)
S = Original sample result

If the serial dilution analysis fails, a matrix interference should be suspected. The associated sample result should be flagged on the report of analysis or the sample should be reanalyzed at dilution to eliminate the interference.

For DoD QSM samples a Post-digestion Spike (PDS) addition must be performed if the serial dilution is not within acceptance criteria.

8.16 Post-digestion Spike (PDS) additions must be performed for DoD QSM samples if the serial dilution is not within acceptance criteria or if the analyte concentrations in

all samples are less than 50x the LOD. The spike addition should produce a concentration that is between 10 and 100x the LOQ. The recovery of the PDS must be within 75-125%. If the PDS fails, all samples must be run by method of standard additions or appropriately flagged.

9.0 METHOD PERFORMANCE

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 value is above zero. The MDLs shall be determined and verified one time per type of instrument unless otherwise required by the method.

A Limit of Detection (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent. LODs must be determined for all parameters for which the laboratory is accredited under the DoD Environmental Laboratory Accreditation Program. LOD's must be verified for every preparation and analytical method combination and on every applicable instrument on a quarterly basis.

The Limit of Quantitation (LOQ) is the minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ shall be set at the lowest point in the calibration curve for all analyses utilizing an initial calibration. LOQ's must be verified quarterly for every preparation and analytical method combination and on every applicable instrument on a quarterly basis for all parameters included in the DoD Scope of Accreditation. The LOQ must be verified at least once annually if the analysis is not included in the DoD Scope of Accreditation.

MDLs are filed with the Inorganic Department Manager and then with the QAO. LOD and LOQ verifications are filed with the QAO

Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revision of Method 6010 for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846, Third Edition, Final Updates I (1993), II (1995), IIA (1994), IIB (1995), III (1997), IIIA (1999), IIIB (2005), IV (2008), and V (2015), Method 6010C.

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 5.1, January 2017.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP QA-806, Method Detection Limit and Instrument Detection Limit Studies, current revision.

List of Tables & Figures

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

TABLE 1

QC REQUIREMENTS

Method	QC Sample	Minimum Frequency	Acceptance Criteria	Corrective Action
USEPA 6010	Initial Calibration, minimum 1 point plus a calibration blank.	Daily prior to sample analysis.	Correlation coefficient ® ≥ 0.998	Recalibrate
	Initial Calibration Verification (ICV), prepared from a second source.	Before beginning a sample run.	Recovery within ± 10% of true value.	1) Do not use results for failing elements unless the ICV > 110% and the sample < the PQL. 2) Investigate and correct 3) DoD: No samples may be run until calibration is verified
	Initial Calibration Blank (ICB)	Immediately after the ICV.	Absolute value of ICB < PQL.	1) Do not use results if ≥ PQL and 10x< CCB level. 2) Investigate and correct problem.
	Continuing Calibration Verification (CCV)	At beginning of run, after every 10 samples, and at end of run.	Recovery within ± 10% of true value.	1) Do not use results for failing elements unless the CCV > 110% and the sample < the PQL. 2) Investigate and correct problem.
	Continuing Calibration Blank (CCB)	After every 10 samples and at end of the run.	Absolute value of CCB < PQL.	1) Do not use results if ≥ PQL and < 10x CCB level. 2) Investigate and correct problem.
	Practical Quantitation Level Check Standard (PQL) (LLCCV)	At beginning and end of run.	Recovery within ± 30% of true value.	1) Do not use results for failing elements unless the LLCCV > 110% and the sample < the PQL. 2) Investigate and correct problem.
	Interference Check Solution A (ICSA)	At beginning and end of run.	For Al, Ca, Fe, and Mg, recovery within ± 20% of true value. For analytes not spiked, ± PQL, or, if PQL ≤ 0.01 mg/L, ± 2x PQL.	1) Do not use results for failing elements. 2) Investigate and correct problem.
	Interference Check Solution AB (ICSAB)	At beginning and end of run.	Recovery of each analyte within ± 20% of true value.	1) Do not use results for failing elements. 2) Investigate and correct problem.
	Preparation Blank (PBW/PBS)	One per digestion batch of 20 or fewer samples.	Less than PQL.	1) Investigate source of contamination. 2) Redigest and reanalyze all associated samples if sample concentration ≥ PQL and <10x the blank concentration.
	Laboratory Control Sample (LCSW/LCSS)	One per digestion batch of 20 or fewer samples.	Recovery within ± 20% of true value, unless vendor-supplied or statistical limits have been established.	1) Investigate source of problem. 2) Redigest and reanalyze all associated samples. 3) DoD: Flag specific analytes if samples cannot be reanalyzed.
	Matrix Spike Sample (S)	One per digestion batch of 20 or fewer samples.	Recovery ± 25% of true value, if sample < 4x spike added.	1) Flag results.
	Matrix Spike Duplicate Sample (P) or sample duplicate	One per digestion batch of 20 or fewer samples.	Recovery ± 25% of true value, if sample < 4x spike added. RPD ≤20% for duplicate spikes and sample duplicates.	1) Flag results.

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

TABLE 1

QC REQUIREMENTS

Method	QC Sample	Minimum Frequency	Acceptance Criteria	Corrective Action
USEPA 6010 (cont.)	Serial Dilution (L)	One per digestion batch.	If original sample result is at least 50x IDL, 5-fold dilution must agree within ± 10% of the original result. Flag result or dilute and reanalyzed sample to eliminate interference	Perform post digestion spike addition (PDS)
	Post-Digestion Spike Sample (A)	When dilution test fails or analyte concentration in all samples <50x LOD	Recovery within ± 25%.	Run associated samples by method of standard addition or flag results.
	Internal Standard	Every sample	± 20% (compared to the initial calibration blank)	Dilute sample and reanalyze.
	Instrument Detection Limit (IDL) Study	Quarterly.	IDL < MDL PQL > 2-3 * the IDL	1) Repeat IDL study. 2) Raise PQL.
	Method Detection Limit (MDL) Study	Refer to KAS SOP QA-806, "Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications", current revision.		
	Lower Limit of Quantitation Check (LLQC) Sample	Digest and analyze annually or as needed to confirm PQLs	70% - 130% of true value	Re-evaluate PQLs
	Linear Range Study	Every six months	Run succeedingly higher stds until recovery not within ± 10%. Use highest passing concentration as upper limit of linear range.	Only accept data to highest passing concentration until next linear range study.
	Limit of Detection (LOD) Determination	Quarterly	LOD = 1-4X MDL	Repeat LOD Determination
	Limit of Quantification (LOQ) Determination	Quarterly	LOQ > LOD	

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria.	NA.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD determination and verification	Refer to current revision of SOP QA-806				
LOQ establishment and verification	Refer to current revision of SOP QA-806				
Instrument detection limit (IDL) study (ICP only)	At initial set-up and after significant change in instrument type, personnel, test method, or sample matrix.	IDLs shall be ≤ LOD.	NA.	NA.	Samples may not be analyzed without a valid IDL.
Linear dynamic range or high-level check standard (ICP only)	Every 6 months.	Within ± 10% of true value.	NA.	NA.	
Initial calibration (ICAL) for all analytes ICP: minimum one high standard and a calibration blank	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, r ≥ 0.995.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed.
Second source calibration verification (ICV)	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analyte(s) within ± 10% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Continuing calibration verification (CCV)	ICP: within ± 10% of true value; GFAA: within ± 20% of true value; CVAA: within ± 20% of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	After every 10 field samples and at the end of the analysis sequence.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Low-level calibration check standard	Daily, after one-point ICAL.	Within ± 20% of true value.	Correct problem, then reanalyze.	Flagging criteria are not appropriate.	No samples may be analyzed without a valid low-level calibration check standard. Low-level calibration check standard should be less than or equal to the reporting limit.
Method blank	One per preparatory batch.	No analytes detected > ½ RL (> RL for common lab contaminants) and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For negative blanks, absolute value < LOD.	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Calibration blank	Before beginning a sample run, after every 10 samples, and at end of the analysis sequence.	No analytes detected > LOD. For negative blanks, absolute value < LOD.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.	Apply B-flag to all results for specific analyte(s) in all samples associated with the blank.	
Interference check solutions (ICS)	At the beginning of an analytical run.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ± 20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.	If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
LCS containing all analytes to be reported	One per preparatory batch.	Water and Soil: Recovery must be within + 20% of the true value	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix spike (MS)	One per preparatory batch per matrix	For matrix evaluation, recovery must be within +/- 20% of the true value.	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests are required to evaluate matrix effects.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate (MSD) or sample duplicate	One per preparatory batch per matrix.	MSD: For matrix evaluation, recovery must be within +/- 20% of the true value. MSD or sample duplicate: RPD ≤ 20% (between MS and MSD or sample and sample duplicate).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Dilution test	One per preparatory batch.	If sample concentrations > 50 x LOQ, then the five-fold dilution must agree within ± 10% of the original measurement.	Perform post-digestion spike (PDS) addition.	Flagging criteria are not appropriate.	Only applicable for samples with concentrations > 50 x LOQ.
Post-digestion spike (PDS) addition	When dilution test fails or analyte concentration in all samples < 50 x LOD.	Recovery within 75-125%.	Run all associated samples in the preparatory batch by method of standard additions (MSA) or see flagging criteria.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Spike addition should produce a concentration of 10 – 100 x LOQ.
Method of standard additions (MSA)	When matrix interference is confirmed.	NA.	NA.	NA.	Document use of MSA in the case narrative.
Results reported between DL and LOQ	NA.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

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TABLE 3

DoD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Linear Dynamic Range (LDR) or high-level check standard	At initial set up and checked every 6 months with a high standard at the upper limit of the range.	Within ± 10% of true value.	Dilute samples within the calibration range, or re-establish/ verify the LDR.	Flagging is not appropriate.	Data cannot be reported above the high calibration range without an established/passing high-level check standard.
Initial Calibration (ICAL) for all analytes	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, r2 = 0.99.	Correct problem, then repeat ICAL.	Flagging is not appropriate.	Minimum one high standard and a calibration blank. No samples shall be analyzed until ICAL has passed.
Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 10% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed until calibration has been verified with a second source.
Continuing Calibration Verification (CCV)	After every 10 field samples, and at the end of the analysis sequence.	All reported analytes within ± 10% of the true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Low-level Calibration Check Standard (Low-level ICV)	Daily.	All reported analytes within ± 20% of true value.	Correct problem and repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed without a valid low-level calibration check standard (LLICV). Low-level calibration check standard should be less than or equal to the LOQ.
Method Blank (MB)	One per preparatory batch.	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

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TABLE 3

DoD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Initial and Continuing Calibration Blank (ICB/CCB)	Before beginning a sample run, after every 10 field samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed.	Flagging is not appropriate.	Results may not be reported without a valid calibration blank. For CCB, failures due to carryover may not require an ICAL.
Interference Check Solutions (ICS) (also called Spectral Interference Checks)	After ICAL and prior to sample analysis.	ICS-A: Absolute value of concentration for all non-spiked project analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ± 20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.	If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the failed ICS.	All analytes must be within the LDR. ICS-AB is not needed if instrument can read negative responses.
Laboratory Control Sample (LCS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Must contain all reported analytes. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike(MS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	If MS results are outside the limits, the data shall be evaluated to the source(s) of difference, i.e., matrix effect or analytical error.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. MSD or MD: RPD of all analytes = 20% (between MS and MSD or sample and MD)	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J- flag if acceptance criteria are not met and explain in the case narrative.	The data shall be evaluated to determine the source of difference.

TABLE 3

DoD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Dilution Test	One per preparatory batch if MS or MSD fails	Five-fold dilution must agree within ± 10% of the original measurement.	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J- flag if acceptance criteria are not met and explain in the case narrative.	Only applicable for samples with concentrations > 50 x LOQ (prior to dilution). Use along with MS/MSD and PDS data to confirm matrix effects.
Post-Digestion Spike (PDS) Addition (ICP only)	Perform if MS/MSD fails. One per preparatory batch (using the same sample as used for the MS/MSD if possible)	Recovery within 80-120%	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	Criteria applies for samples with concentrations <50 X LOQ prior to dilution.
Method of Standard Additions (MSA)	When dilution test or post digestion spike fails and if required by project.	NA	NA	NA	Document use of MSA in the case narrative.

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TABLE 4

SUMMARY OF METHOD MODIFICATIONS

Topic	Katahdin SOP CA-608-17	Method 6010, current revision
Apparatus/Materials		
Reagents		
Sample preservation/ handling		
Procedures		
QC - Spikes		
QC - LCS		
QC - Accuracy/Precision		
QC - MDL		
QC - Calibration Blanks	Acceptance criteria employed for 6010: ± PQL	Acceptance criteria stated in 6010: less than 10% of PQL

TABLE 5

PREPARATION OF CALIBRATION AND QUALITY CONTROL STANDARDS

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
Calibration Standard (STD1 or S1)	ICP- intermediate Standard	Lab Prepared (see Table 6)	10.0
	QCS 26	High Purity Standards	1.0
Initial Calibration Verification (ICV)	Calibration Standard 3	Claritas PPT	0.96
	1000 mg/L Si	Inorganic Ventures	0.98
	1000 mg/L Al	High Purity Standards	0.96
	IV-28	Inorganic Ventures	0.4
	1000 mg/L Sn, Au	Inorganic Ventures	0.04
Interference Check Sample A (ICSA)	CLPP-ICS-A	Inorganic Ventures	10.0
Interference Check Sample AB (ICSAB)	CLPP-ICS-A	Inorganic Ventures	10.0
	CLPP-ICS-B4	Inorganic Ventures	1.0
	ICSAB-INT	Lab Prepared (see Table 6)	5.0
Continuing Calibration Verification (CCV)	ICP intermediate standard	Lab Prepared (see Table 6)	5.0
	QCS 26	High Purity Standards	0.5
Practical Quantitation Limit Sample (PQL)	PQL-INT	Lab Prepared (see Table 6)	1.0

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TABLE 6

PREPARATION OF INTERMEDIATE STANDARDS

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
PQL-INT	1000 mg/L Li, Sn, Au	High Purity Standards or Inorganic Ventures	1.0 each
	10000 mg/L K, Na	High Purity Standards or Inorganic Ventures	1.0 each
	1000 mg/l B	High Purity Standards	0.50
	1000 mg/l Zn	High Purity Standards	0.20
	1000 mg/L Cu	High Purity Standards	0.25
	10000 mg/L Si	High Purity Standards	0.20
	1000 mg/L Ti, Tl	High Purity Standards	0.15 each
	1000 mg/L Se, Mo, Co, Ni, Ag, Sr, V, Cr	High Purity Standards	0.1 each
	10000 mg/L Al	High Purity Standards	0.3
	1000 mg/L As,Sb	High Purity Standards	0.08 each
	1000 mg/L Ba, Be, Cd, Mn, Pb	High Purity Standards	0.05 each
	10000 mg/L Fe, Ca, Mg	High Purity Standards	0.1 each
ICSAB-INT	10000 mg/L K,Na	High Purity Standards or Inorganic Ventures	4.0 each
	10000 mg/L B, Li, Mo,Sr,Sn,Ti, Au	High Purity Standards	1.0 each
	10000 mg/L Si	High Purity Standards	0.40
ICP-INT STD (Intermediate)	10000 mg/L Si	High Purity Standards	2.5
	10000 mg/L Ca, Mg, Fe, Al, Na	High Purity Standards	2.4
	10000 mg/L K	High Purity Standards	1.5
	1000 mg/L Au, Li, Sn. Sr	High Purity Standards	1.0

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TABLE 7

ELEMENT CONCENTRATIONS IN WORKING STANDARDS

	CONCENTRATION IN SOLUTION, mg/L								
Element	**STD1**	**ICV**	**PQL**	**ICSA**	**ICSAB**	**CCV**	**AL_IEC**	**FE_IEC**	**MN_IEC**
Aluminum	25	10	0.3	500	500	12.5	500		
Antimony	1	0.4	0.008		0.6	0.5			
Arsenic	1	0.4	0.008		0.1	0.5			
Barium	1	0.4	0.005		0.5	0.5			
Beryllium	1	0.4	0.005		0.5	0.5			
Boron	1	0.4	0.05		0.5	0.5			
Cadmium	1	0.4	0.005		1.0	0.5			
Calcium	25	10	0.10	500	500	12.5			
Chromium	1	0.4	0.01		0.5	0.5			
Cobalt	1	0.4	0.01		0.5	0.5			
Copper	1	0.4	0.025		0.5	0.5			
Iron	25	10	0.1	200	200	12.5		200	
Lead	1	0.4	0.005		0.05	0.5			
Lithium	1	0.4	0.1		0.5	0.5			
Magnesium	25	10	0.10	500	500	12.5			
Manganese	1	0.4	0.005		0.5	0.5			10
Molybdenum	1	0.4	0.01		0.5	0.5			
Nickel	1	0.4	0.01		0.5	0.5			
Potassium	25	13.6	1		20	12.5			
Selenium	1	0.4	0.01		0.05	0.5			
Silicon	1	0.4	0.2		2	0.5			
Silver	1	0.4	0.01		0.2	0.5			
Sodium	25	10	1		20	12.5			
Strontium	1	0.4	0.01		0.5	0.5			
Thallium	1	0.4	0.015		0.1	0.5			
Tin	1	0.4	0.1		0.5	0.5			
Titanium	1	0.4	0.015		0.5	0.5			
Vanadium	1	0.4	0.01		0.5	0.5			
Zinc	1	0.4	0.02		1.0	0.5			
Gold	1	.04	0.1		0.5	0.5			

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TABLE 8

ELEMENT CONCENTRATIONS IN INTERMEDIATE STANDARDS

Element	CONCENTRATION IN SOLUTION, mg/L		
	ICP Intermed STD	PQL-INT	ICSAB-INT
Aluminum	240	30	
Antimony		0.8	
Arsenic		0.8	
Barium		0.5	
Beryllium		0.5	
Boron		5	10
Cadmium		0.5	
Calcium	240	10	
Chromium		1.0	
Cobalt		1.0	
Copper		2.5	
Iron	240	10	
Lead		0.5	
Lithium	10	10	10
Magnesium	240	10	
Manganese		0.5	
Molybdenum		1.0	10
Nickel		1.0	
Potassium	150	100	400
Selenium		1.0	
Silicon	250	20	40
Silver		1.0	
Sodium	240	100	400
Strontium	10	1.0	10
Thallium		1.5	
Tin	10	10	10
Titanium		1.5	10
Vanadium		1.0	
Zinc		2.0	
Gold	10	10	10

TABLE 9

ELEMENT CONCENTRATIONS IN STOCK STANDARDS

Element	CONCENTRATION IN SOLUTION, mg/L				
	IV-28	QCS-26	CLPP-ICS-A	CLPP-ICS-B4	CL-CAL-3
Aluminum	100	100	5000		
Antimony	100	100		60	
Arsenic	100	100		10	
Barium	100	100		50	
Beryllium	100	100		50	
Boron	100	100			
Cadmium	100	100		100	
Calcium	100	100	5000		1000
Chromium	100	100		50	
Cobalt	100	100		50	
Copper	100	100		50	
Iron	100	100	2000		1000
Lead	100	100		5	
Lithium	100				
Magnesium	100	100	5000		1000
Manganese	100	100		50	
Molybdenum	100	100			
Nickel	100	100		100	
Potassium	1000	1000			1000
Selenium	100	100		5	
Silicon	50	50			
Silver	100	100		20	
Sodium	100	100			1000
Strontium	100				
Thallium	100	100		10	
Tin					
Titanium	100	100			
Vanadium	100	100		50	
Zinc	100	100		100	

TABLE 10

REQUIRED ANALYTICAL SEQUENCE

Sequence Number	Standard/Sample	Purpose
1	Blank (Calibration Blank)	Initial calibration
2	S1 (Calibration Standard)	Initial calibration
3	ICV (Initial Calibration Verification)	Check calibration accuracy
4	ICB (Initial Calibration Blank)	Check calibration accuracy
5	PQL (Practical Quantitation Level Sample)	Check calibration accuracy near PQL, repeat before final CCV, CCB
6	ICSA (Interference Check Solution A)	Verify accuracy of IEC factors, repeat before final CCV, CCB
7	ICSAB (Interference Check Solution AB)	Verify accuracy of IEC factors, repeat before final CCV, CCB
8	CCV (Continuing Calibration Verification)	Check calibration stability
9	CCB (Continuing Calibration Blank)	Check calibration stability
10-19	Analyze up to 10 samples	
20	CCV (Continuing Calibration Verification)	Check calibration stability
25	CCB (Continuing Calibration Blank)	Check calibration stability
…	Continue analyzing sequences of up to 10 samples, followed by a CCV and a CCB	

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

ATTACHMENT 1

HARDNESS BY CALCULATION

As referenced in "Standard Methods for the Examination if Water and Wastewater," Methods 2340 A & B, Hardness Introduction and Hardness by Calculation, American Public Health Association, 18th Edition, Revised 1992, total hardness is the sum of the calcium and magnesium concentrations, both expressed as calcium carbonate, in milligrams per liter.

Once the calcium and magnesium concentrations have been determined by EPA methods 6010, 6020, 200.7 or 200.8, the total hardness of an aqueous sample may be calculated as follows:

$$\text{Total Hardness, mg equivalent } CaCO_3/L = 2.497\ (Ca, mg/L) + 4.118\ (Mg, mg/L)$$

The calcium hardness of an aqueous sample may also be calculated as follows:

$$\text{Calcium Hardness, mg equivalent } CaCO_3/L = 2.497\ (Ca, mg/L)$$

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

ATTACHMENT 2

ANALYSIS OF PALLADIUM BY SW846 6010

Palladium may be analyzed by EPA Method SW846 6010C following the method outlined in this SOP. However, due to significant spectral interferences caused by addition of palladium to the calibration and check standards used in this method, palladium is added to aliquots of the regular standards as needed for analysis. Two stock standards (1000 mg/L) are currently kept for palladium analysis. One is purchased from High Purity Standards and is used for calibration, PQL, ICSAB, and CCV. The other is purchased from Inorganic Ventures and is used as the independent check standard (ICV). Analysts should add palladium stock to the regular standards according to the table below:

Name of Working Standard	Volume of Standard Aliquot (mL)	Volume of Palladium Stock Added (mL)	Concentration of Palladium (mg/L)	Source of Palladium Stock
Calibration Std.	50	0.05	1.0	High Purity
ICV	50	0.02	0.4	Inorganic Ventures
PQL	50	0.005	0.1	High Purity
ICSAB	50	0.025	0.5	High Purity
CCV	50	0.025	0.5	High Purity

Prior to starting the run, a palladium-only standard should be analyzed along with the iron and aluminum standards to evaluate interelement correction factors as outlined in Katahdin SOP CA-632, Section 7.1.

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

Prepared By: George Brewer Date: 12/97

Approved By:

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Operations Manager: Jeb C. Bustin Date: 1/29/01

QA Officer: Deborah J. Nadeau Date: 1.29.01

General Manager: Dennis F. Murphy Date: 1/29/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
02 7471A	Format changes, added pollution prevention, other minor changes to sections 7, 8 and QA Table.	DM	1.29.01	1/29/01
03 7471A	Changed Leeman PS200 Automated Mercury Analyzer to Cetac M6100 Mercury analyzer. Revised sect. 10 to show correct reference material. Removed fig. 2 Revised sect. 4.8, 5.7 and 8.9 to reflect current practises. minor changes through out	LAD	021605	021605
04 7471A	Sect. 5.9 and 5.10 - changed preparation of Intermediate mercury standards from daily to monthly. Sect. 7.8 - removed calibration blanks (LCB/CCB). They are prepared in sect. 7.6. Added weighing of boiling chips for the prep blanks. Sect. 8.3 - Removed intermediate standards	LAD	03/08	03/08
05	Revised Sections 8 and 10, and Tables 1 and 2 to update compliance from method 7471A to method 7471B.	LAD	02/09	02/09
06	Added LOD definition. Updated sections 8, 9, 10 and Table 1 for DoD QSM version 4.1 compliance.	DM	08/09	08/09

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
07	Added Table 2 with DoD QSM Version 4.1 QC Requirements	LAD	04/10	04/10
08	Sect. 4.6 - Changed thermometer type. Added LCS0 - A LCS prepped using aqueous mercury LCS spike. Updated type of marker used to label digestion bottles. Updated corrective action for failing PQL standard.	LAD	12/10	12/10
09	Sect. 7 - Changed calibration digestion from digestion of all points to digestion of high point and dilution of rest. Changed prep from 3 x 0.2g aliquots to 1 x 0.6g aliquot. Added additional prep info. Added Serial dilution and PDS to sect. 8. Added MDL, LOD, LOQ info. to sect. 9. Updated and added references to Sect. 10.	LAD	04/12	04/12
10	Sect. 7 - Corrected Calibration preparation, changed digestion temperature to 95 +/- 3°C. Sect. 10 - Added and updated references. Added Table 3 - DoD QSM 5.0 QC Requirements	LAD	06/14	06/14

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document SOP CA-611-10, Titled Digestion and Analysis of Solid Samples for Mercury by USEPA Method 7471.

Recipient: _____ Date: _____

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

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.

Recipient: _____ Date: _____

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedure used by Katahdin Analytical Services, Inc. personnel for the digestion and analysis solid samples for mercury using cold vapor atomic absorption spectrophotometry.

This method is applicable to the determination of mercury in soils, sediments, bottom deposits, and sludges under USEPA Method 7471 (Test Method for Evaluating Solid Wastes, USEPA SW 846, Third Edition).

1.1 Definitions

ICB - Initial Calibration Blank - An analyte-free solution consisting of acidified laboratory reagent grade water used to verify calibration accuracy.

CCB - Continuing Calibration Blank - An analyte-free solution consisting of acidified laboratory reagent grade water used to verify calibration accuracy periodically during analysis.

ICV - Initial Calibration Verification - A standard made from a source independent from the calibration standards and with analyte concentrations different from those in the CCV; used to verify the accuracy of the instrument calibration.

CCV - Continuing Calibration Verification - A midrange standard used to verify calibration accuracy periodically during analysis.

LCS - Laboratory Control Sample - A standard or solid reference material that has been brought through the sample preparation process. LCSS utilizes the standard reference material. LCSO is spiked with aqueous mercury LCS spike.

PB - Preparation Blank - Laboratory reagent grade water that has been brought through the sample preparation process.

Matrix Spike - An aliquot of a sample to which a known amount of analyte has been added before digestion.

Duplicate - A second aliquot of a sample that is prepared and analyzed in the same way as the original sample in order to determine the precision of the method.

SERIAL DILUTION - The dilution of a sample by a factor of five. When corrected by the dilution factor, the measured analyte concentrations of the diluted sample should agree with those of the original undiluted sample within specified limits. Serial dilution may reflect the influence of interferents.

IDL - Instrument Detection Limit - The lowest concentration of an analyte that can be determined with 95% confidence by the instrument.

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

LOD – Limit of Detection – An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix-specific and is used for DoD QSM acceptance criteria.

PQL - Practical Quantitation Limit - The lowest concentration of an analyte that is routinely reported by the laboratory; nominally three to five times the IDL.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of mercury by USEPA Method 7471. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in analysis of mercury by USEPA Method 7471 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to ensure that members of their group follow this SOP, to ensure that their work is properly documented, and to initiate periodic review of the associated logbooks.

1.3 Safety

Many of the samples and reagents used in cold vapor atomic absorption are toxic or corrosive. Gloves, safety glasses, lab coats, and other protective clothing should be worn whenever these materials are handled. Because of the toxic nature of mercury vapor, care must be taken to avoid its inhalation. The instrument exhaust fan must be in operation whenever the mercury analyzer is in use (the fan should never be shut off).

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this

method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address there waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Plan for further details on pollution prevention techniques.

Samples, sample digestates, standards, and other reagents used in cold vapor atomic absorption may contain high concentrations of acids, mercury, and other toxic metals. They should be disposed of in a manner appropriate to the types of hazards they present. All digested mercury samples and standards and excess reagents and standards should be disposed of in the satellite waste container for corrosive wastes (labeled “Waste Stream A”) that is located in the Metals Prep lab. Further information regarding waste classification and disposal may be obtained by consulting the laboratory's Katahdin Analytical Environmental Health and Safety Manual and the Department Manager.

2.0 SUMMARY OF METHOD

The cold vapor atomic absorption technique is based on the absorption of radiation at 253.7 nm by mercury vapor. It relies on the volatility of elemental mercury at room temperature. During preparation, organic mercurials are oxidized and elemental mercury is ionized to Hg^{3+}. During instrumental analysis, mercuric ions are reduced to elemental mercury by the addition of stannous chloride. Elemental mercury is then aerated from solution and passes through a cell positioned in the path of a mercury spectrophotometer, where absorbance (peak height) is measured as a function of mercury concentration and recorded by the associated computer. The mercury vapor is then swept out of the instrument into an exhaust hood, where it is evacuated from the laboratory.

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

3.0 INTERFERENCES

In addition to inorganic forms of mercury, organic mercurials may be present in environmental samples. These organo-mercury compounds will not respond to the cold vapor atomic absorption technique unless they are first broken down and converted to mercuric ions. The presence of undigested organo-mercurials in samples will result in a low bias for analytical results. Certain volatile organic materials will also non-specifically absorb radiation at the 253.7 nm analytical wavelength. The presence of such compounds may result in a high bias for analytical results. For these reasons, complete digestion using potassium permanganate is required for all environmental samples. Complete digestion is indicated by the persistence of the purple permanganate color (indicating the presence of excess permanganate) following digestion.

Samples that are high in chlorides may require additional permanganate to maintain a persistent purple color following digestion. During the oxidation step, chlorides are converted to free chlorine, which will absorb radiation at the 253.7 nm analytical wavelength. Any free chlorine thus generated will be present in the headspace of the digestion vessel following digestion. Because samples are poured into autosampler tubes prior to analysis by the mercury analyzer, any free chlorine present in the headspace of the digestion vessels is not sampled by the instrument and the analysis is free of chlorine interference.

4.0 APPARATUS AND MATERIALS

4.1 250 mL Pyrex media bottles with plastic screw caps, for use as digestion vessels.

4.2 Water bath capable of maintaining a constant temperature of 95^{o} C.

4.3 Analytical balance capable of weighing to 0.01 g.

4.4 Adjustable volume automatic pipettes - 2 to 20 uL, 10 to 100 uL, 100 to 1000 uL. Calibrated Eppendorf Reference pipets and Finn digital pipets are appropriate.

4.5 Repipetters (adjustable repeating pipetters with reservoirs) for dispensing concentrated nitric acid, concentrated sulfuric acid, and other reagents.

4.6 Battery powered Traceable Pocket-Size Thermometer from Fisher Scientific, NIST-traceable, covering the range from -50^{o} to 750^{o} C, for monitoring the temperature of the water bath. Mercury-filled thermometers are not acceptable for use in the metals laboratory, due to the possibility of breakage and consequent contamination.

4.7 Disposable graduated polystyrene sample cups, 200 mL capacity.

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

4.8 CETAC M6100 Mercury Analyzer and associated peripherals and parts.

Refer to Katahdin SOP CA-629, current revision, "Operation and Maintenance of the CETAC M6100 Mercury Analyzer" for additional required materials.

5.0 REAGENTS

5.1 Laboratory reagent grade water – mercury-free water.

5.2 Concentrated nitric acid (HNO_3), trace metal grade

5.3 Concentrated hydrochloric acid (HCl), trace metal grade

5.4 Aqua regia: Prepare an appropriate amount immediately before use by carefully adding three volumes of concentrated HCl to one volume of concentrated HNO_3 in a heat-proof beaker or flask. Preparation of aqua regia must be performed in a fume hood.

5.5 Potassium permanganate solution, 5% w/v: Dissolve 50 g of potassium permanganate in 1 L laboratory reagent grade water. The source reagent should be labeled as suitable for use in mercury determination.

5.6 Sodium chloride – hydroxylamine hydrochloride solution: Dissolve 120 g sodium chloride and 120 g hydroxylamine hydrochloride in laboratory reagent grade water and dilute to a final volume of 1 L.

5.7 Stannous chloride solution: Add 70 mL concentrated hydrochloric acid to 500 mL of laboratory reagent grade water. Add 100 g stannous chloride and bring to a final volume of 1 L. Mix to dissolve. Reagent should be labeled as suitable for use in mercury determination.

5.8 Mercury Stock Standards: Two 10.0 mg/L mercury stock standards, obtained from separate sources, are required. The mercury concentrations of these standards must be certified by the manufacturers as traceable to NIST reference standards.

5.9 Intermediate Mercury Standard A: Appropriately dilute a mercury stock standard to obtain a solution containing 1000 ug of mercury per liter in 2% nitric acid. This intermediate standard is used to prepare calibration standards, matrix spikes, CCVs, and laboratory control samples (refer to Section 8). The identity of the stock standard currently used to prepare this intermediate standard and instructions for its dilution may be obtained by consulting the Standards Preparation Logbook maintained in the Section. Intermediate Mercury Standard A must be prepared monthly, and disposed of appropriately after use. (Note: the concentrations of all

stock standards must be certified by the vendors as traceable to NIST reference materials).

5.10 Intermediate Mercury Standard B: Appropriately dilute a mercury stock standard to obtain a solution containing 1000 ug of mercury per liter in 2% nitric acid. The source of the stock standard used to prepare Intermediate Mercury Standard B must be distinct from that used to prepare Intermediate Mercury Standard A (i.e. obtained from a separate vendor). Intermediate Mercury Standard B is used to prepare the ICV (refer to Section 8.0). The identity of the stock standard currently used to prepare this intermediate standard and instructions for its dilution may be obtained by consulting the Standards Preparation Logbook maintained in the Section. Intermediate Mercury Standard B must be prepared monthly, and disposed of appropriately after use.

5.11 Solid Reference Material: A soil with a known or empirically-established mercury concentration for use in preparing the laboratory control sample for soils. Solid reference materials should be purchased with certificates listing reference values and quality control acceptance limits. See Figure 3 for an example certificate of analysis for a solid reference material.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Soil samples to be analyzed for mercury should be collected and preserved as described in the following table.

Matrix	Container[1]	Collection Volume/ Weight	Preservation/ Treatment	Holding Time
Solid	P, G	40 g	Cool to 4°C ± 2°	28 days

[1] P = polyethylene, G = glass

7.0 PROCEDURES

BOTTLE PREPARATION

7.1 Mercury digestion bottles are reused, and must be cleaned between uses. After the previous contents of the bottles have been discarded, bottles are segregated according to whether the measured mercury concentrations of the previous contents were above the PQL (contaminated bottles) or below the PQL (uncontaminated bottles). Labels are removed from the bottles by wiping with a paper towel saturated with toluene. Both contaminated and uncontaminated bottles are then cleaned with Liquinox and water, if necessary, to remove visible grime, and rinsed thoroughly with tap water.

7.2 Uncontaminated bottles are then triple-rinsed with laboratory reagent grade water, and are ready for reuse.

7.3 Contaminated bottles are placed in a bath containing 10% HCl for at least 12 hours. After acid-leaching, these bottles are triple rinsed with laboratory reagent grade water, and are then ready for reuse.

PREPARATION OF STANDARDS, QC SAMPLES, AND BLANKS

7.4 Prior to performing the digestion, make a list of the samples that are to be digested. Enter digestion information (Katahdin Sample Numbers, Bottle IDs, QC Batch ID, preparation date, analyst initials, etc.) into the ACCESS computer database and print out a copy of the benchsheet. All necessary details of sample preparation (standards preparation information, digestion times, digestion temps, initial weights and final volumes, pertinent observations, etc.) must be recorded on this benchsheet, which will be bound in the Mercury Preparation Logbook. Refer to Figure 1 for an example page from the Mercury Preparation Logbook.

7.5 Using an industrial marker with super permanent ink, label clean digestion bottles with the appropriate sample numbers and standard identifications for each sample, preparation blank, laboratory control sample and matrix spike sample to be digested.

7.6 Calibration Preparation - Use a bottle-top dispenser to add 100 mL of laboratory grade reagent water to a standard digestion bottle (250 mL media bottles). Using a calibrated adjustable pipette, prepare the high calibration standard by adding 1000 uL of Intermediate Mercury Standard A to an appropriately labeled media bottle containing 100 mL of laboratory grade reagent water. The mercury concentration of this calibration standard is 10.0 ug/L. Calibration levels 0.2 ug/L, 0.5 ug/L, 1.0 ug/L, 5.0 ug/L are made by diluting the 10.0 ug/L standard into calibration blank solution. See below for amounts. The 0.2 ug/L and 5.0 ug/L standards are analyzed after calibration as the PQL standard and the CCV (refer to Section 8.0), respectively, as well as being used in the creation of the calibration curve.

Calibration Level	Amount added	Amount Calibration Blank Solution
0.2 ug/L	0.3 mL	14.7 mL
0.5 ug/L	0.5 mL	9.5 mL
1.0 ug/L	1 mL	9 mL
5.0 ug/L	5 mL	5 mL

7.7 Using a calibrated adjustable pipette, prepare the initial calibration verification (ICV) standard (refer to Section 8) by adding 600 uL of Intermediate Mercury Standard B

to an appropriately labeled digestion bottle. The mercury concentration of the ICV will be 6.0 ug/L.

7.8 Prepare an appropriate number of preparation blanks (PBS) by adding 1.0 g of Teflon boiling chips to labeled digestion bottles.

7.9 Prepare an appropriate number of laboratory control samples (LCSS or LCSO) by weighing appropriate masses of solid reference material or by adding 500 uL of Intermediate Mercury Standard A respectively into labeled digestion bottles. The mercury concentration of the LCSS will depend on the solid reference material used, and the mass of each aliquot. Refer to Figure 3 for an example certificate of analysis for a solid reference material. The mercury concentration of the LCSO will be 5.0 ug/L.

7.10 Matrix spikes are prepared by adding 100 uL of Intermediate Mercury Std A to each matrix spike sample. The amount of mercury added to each matrix spike increases the final digestate concentration by 1.0 ug/L.

7.11 Preparation blanks, laboratory control spike and matrix spikes are digested in the same manner as client samples. Refer to Sample Preparation and Digestion, Steps 7.12 through 7.16 of this SOP. Calibration standards are not digested.

SAMPLE PREPARATION AND DIGESTION

7.12 Do not decant any water on the sediment sample. **Note:** Some workorders may have to decant samples in the work notes. This is **always** done during login and **never** at the time of extraction. Samples decanted during login will be marked accordingly.

Mix sample with a wooden spatula to ensure homogeneity of the sample. Please refer to the current revision of Katahdin Analytical Services SOP CA-108, “Basic Laboratory Technique“, for more detailed guidance on sub-sampling to ensure reproducibility.

Weigh an approximate 0.6 g portion of untreated, homogenized sample from the sample container and place in the bottom of a labeled digestion bottle.

7.13 Add 5 Ml of laboratory reagent grade water and 5 Ml of aqua regia to each sample, standard, and QC sample. Place bottles in a water bath located in a fume hood and heat for 2 minutes at 95 ± 3 ^{O}c. Remove the bottles from the water bath and allow them to cool in a fume hood.

7.14 Add 50 Ml of laboratory reagent grade water and 15 Ml of potassium permanganate solution to each digestion bottle, swirl to mix, and allow to stand for at least 15

minutes. Samples that contain large amounts of oxidizable organic matter may require additional 15 Ml aliquots of potassium permanganate solution. This is indicated by the failure of the purple permanganate color to persist for the entire 15 minute waiting period. Add additional 15 Ml aliquots to samples as necessary until the purple color persists for 15 minutes. If any of the samples requires these additional aliquots of permanganate, note that fact on the mercury preparation benchsheet and accordingly adjust the final volumes recorded on the benchsheet for those samples.

When a persistent purple color has been obtained for all samples, place the digestion bottles in the water bath and heat for 30 minutes at 95^{o} C. Record initial and final time and temperatures on the mercury preparation benchsheet.

7.15 Remove the bottles from water bath and allow them to cool in a fume hood. If any of the samples have become colorless during heating, add additional 15 Ml aliquots of potassium permanganate solution as necessary to obtain a persistent purple color and heat for an additional 30 minutes at 95 $\pm$3 ^{O}c. Record any information regarding additional permanganate aliquots on the mercury preparation benchsheet and accordingly adjust the final volumes recorded on the benchsheet for the samples affected.

7.16 Add 6 Ml of sodium chloride – hydroxylamine hydrochloride solution to each digestion bottle and swirl to mix. Perform this addition in a fume hood, as chlorine gas may be evolved. This will reduce the excess permanganate, and the sample will change from purple to colorless. Add 50 Ml of laboratory reagent grade water to each bottle. Wait at least 30 seconds before proceeding with analysis.

INSTRUMENTAL ANALYSIS

7.17 Digested mercury samples are analyzed using the CETAC M6100 Mercury Analyzer. Analysis is automated and is controlled by the QuickTrace software running on a dedicated PC. Detailed instructions for setting up the instrument and running samples are given Katahdin SOP CA-629, “Operation and Maintenance of the CETAC M6100 Mercury Analyzer”. The following information specifically pertains to analysis of digested samples in accordance with USEPA Method 7471, and should be used in conjunction with the instructions given in Katahdin SOP CA-629.

7.18 Instrument operating conditions and quality control acceptance limits are specified in the instrument software in “templates”. The template that is used to analyze digested samples in accordance with USEPA Method 7471 is named “SW846-7470-7471”.

7.19 Prior to analysis, digested samples, standards, and QC samples are decanted into autosampler tubes which are placed in racks on the instrument’s autosampler. The

"standards" autosampler rack has 10 positions for 25 x 100 mm autosampler tubes (50 Ml capacity). Tubes containing the calibration standards, the ICV, the CCV, the ICB/CCB, and the PQL standard are placed in the appropriately labeled positions in this autosampler rack.

7.20 Client samples, batch QC samples (preparation blanks and laboratory control samples), and matrix QC samples (duplicates and matrix spikes) are decanted into 17 x 100 mm autosampler tubes (15 Ml capacity), which are placed in the one of the "samples" autosampler racks. The "samples" autosampler racks have 60 positions for 17 x 100 mm autosampler tubes. Instructions for filling the "samples" autosampler racks, including recording the rack position of each sample, are contained in Katahdin SOP CA-629, "Operation and Maintenance of the CETAC M6100 Mercury Analyzer".

METHOD OF STANDARD ADDITIONS

7.21 The standard addition technique involves adding known amounts of standard to one or more aliquots of the processed sample solution. This technique compensates for a sample constituent that enhances or depresses the analyte signal, thus producing a different slope from that of the calibration standards. It will not correct for additive interferences that cause a baseline shift. The method of standard additions shall be used for analysis of all EP extracts, on all analyses submitted as part of a delisting petition, and whenever a new sample matrix is being analyzed.

7.21.1 The simplest version of this technique is the single-addition method, in which two identical aliquots of the sample solution, each of volume V_x, are taken. To the first (labeled A) is added a known volume V_S of a standard analyte solution of concentration C_S. To the second aliquot (labeled B) is added the same volume V_S of the solvent. The analytical signals of A and B are measured and corrected for nonanalyte signals. The unknown sample concentration C_x is calculated:

$$C_X = \frac{S_B V_S C_S}{(S_A - S_B)V_X}$$

where S_A and S_B are the analytical signals (corrected for the blank) of solutions A and B, respectively. V_s and C_s should be chosen so that S_A is roughly twice S_B on the average, avoiding excess dilution of the sample. If a separation or concentration step is used, the additions are best made first and carried through the entire procedure.

7.21.2 Improved results can be obtained by employing a series of standard additions. To equal volumes of the sample are added a series of standard solutions containing different known quantities of the analyte, and all

solutions are diluted to the same final volume. For example, addition 1 should be prepared so that the resulting concentration is approximately 50 percent of the expected absorbance from the endogenous analyte in the sample. Additions 2 and 3 should be prepared so that the concentrations are approximately 100 and 150 percent of the expected endogenous sample absorbance. The absorbance of each solution is determined and then plotted on the vertical axis of a graph, with the concentrations of the known standards plotted on the horizontal axis. When the resulting line is extrapolated to zero absorbance, the point of interception of the abscissa is the endogenous concentration of the analyte in the sample. The abscissa on the left of the ordinate is scaled the same as on the right side, but in the opposite direction from the ordinate. An example of a plot so obtained is shown in Figure 2. A linear regression program may be used to obtain the intercept concentration.

7.22 For the results of this MSA technique to be valid, the following limitations must be taken into consideration:

- The apparent concentrations from the calibration curve must be linear over the concentration range of concern. For the best results, the slope of the MSA plot should be nearly the same as the slope of the standard curve. If the slope is significantly different (greater than 20%), caution should be exercised.

- The effect of the interference should not vary as the ratio of analyte concentration to sample matrix changes, and the standard addition should respond in a similar manner as the analyte.

- The determination must be free of spectral interference and corrected for nonspecific background interference.

DATA REDUCTION AND REPORTING

7.23 Results are obtained in units of ug/L in the digestate. Results that exceed the calibration range of the instrument may not be reported – the sample must be appropriately diluted and reanalyzed. Results for diluted samples must be multiplied by the dilution factor prior to reporting. If additional aliquots of potassium permanganate were added during digestion, the change in digestate final volume must be taken into account in calculating the final result. Mercury results for solid samples are reported in units of ug/g, calculated on a dry weight basis. Calculation of mercury results for solid samples is performed automatically by the Metals reporting database, as follows:

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$$\text{Mercury Concentration in Solid (mg/kg dry wt.)} = \frac{I \times (DF) \times (FV) \times 100}{(W) \times (TS)}$$

where C = Measured digestate concentration (ug/L)
DF = Instrument dilution factor
FV = Digestate final volume (L)
W = Digested wet sample weight (g)
TS = Total Solids (%)

7.24 Results are reported down to the laboratory's practical quantitation level (PQL), unless otherwise requested. Results below the PQL should be reported as "<PQL".

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

USEPA Method 7471 requires the laboratory to perform specific quality control checks to assess laboratory performance and data quality. Minimum frequencies, acceptance criteria, and corrective actions for these control checks are tabulated in Table 1 and are described below. Preparation instructions and the resulting mercury concentrations for calibration standards, QC standards, and matrix spikes are detailed in Sections 7.6 through 7.10 of this SOP. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations and client and project specific Data Quality Objectives. The supervisor, Operations Manager, General Manager and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

INITIAL DEMONSTRATION OF PERFORMANCE

8.1 Instrument detection limits (IDL) are determined quarterly for each analyte analyzed on each instrument by each method. This determination requires seven replicate analyses of laboratory reagent grade water spiked, performed on three non-consecutive days. The standard deviation of the 21 analyses is multiplied by three to obtain the IDL. For more information on performing IDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.2 Method detection limits (MDL) are determined annually for each analyte analyzed on each instrument. This determination requires at least seven replicate digestions and analyses of laboratory reagent grade water spiked at 3-5 times the anticipated MDL for each analyte. MDLs differ from IDLs in that the replicates are digested prior to analysis, and they may be analyzed on a single day. The standard deviation of the 7 (or more) replicate analyses is multiplied by the Student's t-value to obtain the MDL. For more information on performing MDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.3 Limits of Detection (LOD) are used when evaluating data using DoD QSM. The LOD is established by spiking a quality system matrix at 2-3 times the detection limit for a single analyte standard and 1-4 times the detection limit for a multi-analyte standard. The LOD must be verified quarterly. For more information on performing LOD determinations, refer to the current revision of Katahdin SOP QA-806.

ANALYTICAL RUN QC

8.4 Instrument calibration – The instrument must be calibrated each time it is set up, and calibration standards must be digested each day that samples are digested. Calibration includes analysis of a calibration blank and five calibration standards with graduated concentrations in the appropriate range. The concentration of one of the calibration standards must be at the Practical Quantitation Level (PQL). The correlation coefficient for the calibration curve must be at least 0.995. If the calibration curve does not pass this test, analysis must be halted, the problem corrected, and the instrument recalibrated.

8.5 An Initial Calibration Verification (ICV) solution is analyzed after the initial calibration to check calibration accuracy. The ICV solution is prepared from a standard source different than that of the calibration standard and at a concentration within the working range of the instrument. The result of the ICV must fall within 90% to 110% of the expected value. If the ICV fails, results may not be reported from the run until the problem is corrected and a passing ICV has been analyzed.

8.6 The Continuing Calibration Verification (CCV) solution is analyzed after the initial calibration, after every ten samples, and at the end of the analytical run. The CCV solution is prepared using the same standard used for calibration at a concentration

near the mid-point of the calibration curve. Results of the CCVs must fall within 90% to 110% of the expected value. If a CCV fails, associated sample results may not be reported from the run until the problem is corrected and a passing CCV has been analyzed. Also, all samples analyzed after the last passing CCV must be reanalyzed. For DoD QSM acceptance criteria, samples that are below the reporting limit may be reported if the CCV reads greater than 120%.

8.7 A calibration blank is analyzed after each ICV and CCV. A calibration blank that is analyzed after the ICV is called an Initial Calibration Blank (ICB). A calibration blank that is analyzed after a CCV is called a Continuing Calibration Blank (CCB). The absolute values of results of ICBs and CCBs must be less than the Practical Quantitation Level (PQL) for each element. If samples are being run using DoD QSM criteria, the absolute values of ICBs and CCBs must be less than the Limit of Detection (LOD). If an ICB or a CCB fails, results for the failing elements may not be reported from the run until the problem is corrected and a passing ICB or CCB has been analyzed. Also, all samples analyzed after the last passing CCB must be reanalyzed.

8.8 A standard with a mercury concentration that is at the Practical Quantitation Limit (PQL) is analyzed at the beginning of the run to determine calibration accuracy at the reporting limit. Result of the PQL standard should fall within 70% to 130% of the expected values. If the PQL fails, results may not be reported from the run until the problem is corrected and a passing PQL has been analyzed.

PREPARATION BATCH QC SAMPLES

8.9 Preparation blank (PBW or PBS), consisting of reagent water carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. The results of preparation blanks must be less than the Practical Quantitation Level (PQL) for each element. For DoD QSM acceptance criteria the results must be less than ½ the PQL except for common contaminants which must be less than the PQL. If a preparation blank fails, results for the failing elements may not be reported from the digestion batch, and all associated samples must be redigested, with the following exception. If the result for a preparation blank is greater than the PQL (greater than ½ PQL for DoD), associated sample results that are less than the PQL (less than ½ PQL for DoD) or greater than or equal to ten times the measured preparation blank concentration may be reported.

8.10 A laboratory control sample (LCSS or LCSO), consisting of solid reference material or 500 Ul of Intermediate Standard A carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. If a laboratory control sample fails, results may not be reported from the digestion batch, and all associated samples must be redigested. The laboratory uses a reference value and statistical acceptance limits for laboratory control samples that are supplied by the vendor of the solid reference material. The results of the LCSO must fall with in 80% - 120% of its true value which is 5.0 ug/L. If

samples are being prepared using DoD QSM acceptance criteria, the results of the LCSS or LCSO must be within 80% - 120%.

SAMPLE MATRIX QC SAMPLES

8.11 Matrix spiked duplicate samples are prepared at a minimum frequency of one per digestion batch. Matrix spike recoveries for these samples are calculated as follows:

$$\text{Recovery (\%)} = \frac{(P - S)}{A} \times 100\%$$

where: P = Spiked sample value
S = Original sample value
A = Spike amount

The recovery for each element in a spiked sample or spiked duplicate sample must fall within 75% to 125% of the actual value if the result for the unspiked sample is less than four times the amount of spike added. If one or both spike recoveries fail, a matrix interference should be suspected and the associated sample result should be flagged on the report of analysis. If DoD QSM acceptance criteria are being used, recoveries must be the same as stated for laboratory control samples.

The relative percent difference between matrix spiked duplicate sample results is calculated as follows:

$$\text{RPD (\%)} = \frac{|D_1 - D_2|}{(|D_1 + D_2|)/2} \times 100$$

where: D_1 = Spike sample result
D_2= Spike duplicate sample result

A control limit of 20% RPD is applied to matrix spike duplicate analysis. If the matrix spike duplicate analysis fails, the associated sample result should be flagged on the report of analysis.

8.12 Serial Dilution – A serial dilution is analyzed to check for chemical or physical interferences. If the analyte concentration of a sample is sufficiently high (minimally, 50 x IDL or 50 x LOQ if using DoD QSM acceptance criteria), the measured concentration of a serial dilution (1:5 dilution) of the sample should agree within 90% to 110% of the original determination. The percent difference between the original sample and the serial dilution should be calculated as follows:

$$\text{Difference (\%)} = \frac{|L-S|}{S} * 100\%$$

where: L = Serial dilution result (corrected for dilution)
S = Original sample result

If the serial dilution analysis fails, a matrix interference should be suspected. The associated sample result should be flagged on the report of analysis or the sample should be reanalyzed at dilution to eliminate the interference.

8.13 Post-digestion Spike (PDS) additions must be performed for DoD QSM samples if the serial dilution is not within acceptance criteria or if the analyte concentrations in all samples are less than 50x the LOD. The spike addition should produce a concentration that is between 10 and 100x the LOQ. The recovery of the PDS must be within 75-125%. If the PDS fails, all samples must be run by method of standard additions or appropriately flagged.

9.0 METHOD PERFORMANCE

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 value is above zero. The MDLs shall be determined and verified one time per type of instrument unless otherwise required by the method.

A Limit of Detection (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent. LODs must be determined for all parameters for which the laboratory is accredited under the DoD Environmental Laboratory Accreditation Program. LOD's must be verified for every preparation and analytical method combination and on every applicable instrument on a quarterly basis.

The Limit of Quantiaion (LOQ) is the minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ shall be set at the lowest point in the calibration curve for all analyses utilizing an initial calibration. LOQ's must be verified quarterly for every preparation and analytical method combination and on every applicable instrument on a quarterly basis for all parameters included in the DoD Scope of Accreditation. The LOQ must be verified at least once annually if the analysis is not included in the DoD Scope of Accreditation.

MDLs are filed with the Organic Department Manager and then with the QAO. LOD and LOQ verifications are filed with the QAO

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revision of Method 7471 for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA SW846, 3rd Edition, Final Updates I, II, IIA, IIB, III, IIIA, IIIB and IV, February 2007, Method 7471B.

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 4.2, 10/25/2010.

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.0, March, 2013

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision.

QuickTrace M6100 Mercury Analyzer Operator Manual Version 1.0.1, CETAC Technologies

QuickTrace Mercury Analyzer Software Manual, CETAC Technologies.

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List of Tables and Figures

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TABLE 1

QC REQUIREMENTS

Parameter/ Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Mercury/ USEPA Method 7471B	Initial Calibration, 5 points plus a calibration blank.	Daily prior to sample analysis.	Correlation coefficient ≥ 0.995.	Correct problem and repeat calibration.
	Initial Calibration Verification (ICV), prepared from a second source.	Before beginning a sample run.	Recovery within ± 10% of true value.	Correct problem and repeat calibration.
	Initial Calibration Blank (ICB)	Before beginning a sample run.	Less than PQL.	Correct problem and repeat calibration.
	Practical Quantitation Level Standard (PQL)	Before beginning a sample run.	Recovery within ± 30% of true value.	Correct problem and repeat calibration.
	Continuing Calibration Verification (CCV)	At beginning or run, after every 10 samples, and at end of the run	Recovery within ± 10% of true value	Repeat calibration and reanalyze all samples analyzed since the last successful CCV.
	Continuing Calibration Blank (CCB)	At beginning or run, after every 10 samples, and at end of the run	Less than PQL.	Repeat calibration and reanalyze all samples analyzed since the last successful CCB.
	Preparation Blank (PBS)	One per digestion batch of 20 or fewer samples.	Less than PQL.	1) Investigate source of contamination. 2) Redigest and reanalyze all associated samples if sample concentration ≥ PQL and < 10x the blank concentration.
	Laboratory Control Sample (LCSS or LCSO)	One per digestion batch of 20 or fewer samples.	LCSS: Recovery within vendor-supplied acceptance limits. LCSO: Recovery within ± 20% of true value.	Redigest all affected samples.
	Matrix Spike Sample (S)	One per digestion batch of 20 or fewer samples.	Recovery ± 25% of true value, if sample > 4x spike value.	Flag results.
	Matrix Spike Duplicate Sample (P) or sample duplicate (D)	One per digestion batch of 20 or fewer samples.	1)Recovery ± 25% of true value, if sample < 4x spike added. 2) RPD ≤20% for duplicate spikes or duplicate samples.	Flag results
	Post-Digestion Matrix Spike Sample (PDS)	When matrix spike or MSD fail	Recovery ±20% of true value	Analyze serial dilution of sample
	Serial Dilution Test (L)	One per digestion batch or when PDS fails	1:5 dilution of sample must agree within 10% with undiluted result	If MS, MSD, PDS, and serial dilution fail, quantitate sample by method of standard additions
	Instrument Detection Limit (IDL) Study	Quarterly.	IDL < PQL	1)Repeat IDL study. 2)Raise PQL.
	Method Detection Limit (MDL) Study	Refer to KAS SOP QA-806, "Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications", current revision.		
	Limit of Detection (LOD) determination	Quarterly.	LOD = 2-3X MDL	Repeat LOD Determination.

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TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria.	NA.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD determination and verification	(Refer to current revision of SOP QA-806)				
LOQ establishment and verification	(Refer to current revision of SOP QA-806)				
Initial calibration (ICAL) for Mercury: minimum 5 standards and a calibration blank	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, r ≥ 0.995.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed.
Second source calibration verification (ICV)	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analyte(s) within ± 10% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	CVAA: within ± 20% of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Method blank	One per preparatory batch.	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. Contact Client if samples cannot be reprepped within hold time. For negative blanks,	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result. Contact Client if samples cannot be reprepped within hold	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

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TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
		absolute value < LOD.	time.		
Calibration blank	Before beginning a sample run, after every 10 samples, and at end of the analysis sequence.	No analytes detected > LOD. For negative blanks, absolute value < LOD.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.	Apply B-flag to all results for specific analyte(s) in all samples associated with the blank.	
LCS containing all analytes to be reported	One per preparatory batch.	Water: Recovery must be within ± 20% of the true value Soil: Recovery must be within vendor supplied limits (varies by lot).	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix spike (MS)	One per preparatory batch per matrix (see Box D-7).	Recovery must be within ± 20% of the true value	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests are required to evaluate matrix effects.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate (MSD) or sample duplicate	One per preparatory batch per matrix	MSD: Recovery must be within ± 20% of the true value. MSD or sample duplicate: RPD ≤ 20% (between MS and MSD or sample and sample duplicate).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Method of standard additions (MSA)	When matrix interference is confirmed.	NA.	NA.	NA.	Document use of MSA in the case narrative.
Results reported between DL and LOQ	NA.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

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TABLE 3

DoD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Initial Calibration (ICAL) for all analytes	Daily ICAL prior to sample analysis.	r2 = 0.99.	Correct problem, then repeat ICAL.	Flagging is not appropriate.	FLAA and GFAA: minimum three standards and a calibration blank. CVAA/Mercury: minimum 5 standards and a calibration blank. No samples shall be analyzed until ICAL has passed.
Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 10% of the true value.	Correct problem. Rerun ICV. If that fails, Rerun ICAL.	Flagging is not appropriate.	No samples shall be analyzed until calibration has been verified with a second source.
Continuing Calibration Verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All reported analytes within ± 10% of the true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable CCV.	Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Method Blank (MB)	One per preparatory batch.	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reprepped or reanalyzed.
Initial and Continuing Calibration Blank (ICB/CCB)	Before beginning a sample run, after every 10 field samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed.	Flagging is not appropriate.	Results may not be reported without a valid calibration blank. For CCB, failures due to carryover may not require an ICAL.
Laboratory Control Sample (LCS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to	Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be

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TABLE 3

DoD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
		not listed, use in-house LCS limits if project limits are not specified.	failed analytes, if sufficient sample material is available.	specific analyte(s) in all samples in the associated preparatory batch.	reanalyzed.
Matrix Spike (MS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed use in-house LCS limits if project limits are not specified.	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	If MS results are outside the limits, the data shall be evaluated to the source of difference, i.e., matrix effect or analytical error.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. MSD or MD: RPD of all analytes = 20% (between MS and MSD or sample and MD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	The data shall be evaluated to determine the source of difference.
Dilution Test (Flame AA and GFAA only)	One per preparatory batch if MS or MSD fails.	Five-fold dilution must agree within ± 10% of the original measurement.	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	Only applicable for samples with concentrations > 50 X LOQ (prior to dilution). Use along with MS/MSD or PDS data to confirm matrix effects.
Post-Digestion Spike (PDS) Addition (Flame AA and GFAA only)	One per preparatory batch if MS or MSD fails.	Recovery within 80-120%	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	Criteria apply for samples with concentrations < 50 X LOQ prior to dilution.
Method of Standard Additions (MSA)	When dilution or post digestion spike fails and if the required by project.	NA.	NA.	NA.	Document use of MSA in the case narrative.

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TABLE 4

SUMMARY OF METHOD MODIFICATIONS

Topic	Katahdin SOP CA-611-10	USEPA Method 7471, current revision
Reagents	Stannous chloride dissolved in hydrochloric acid to prevent clogging of mercury analyzer, per instrument manufacturer's recommendation.	Stannous chloride dissolved/suspended in sulfuric acid.
Procedures	Sampling and gas stream switching performed automatically by mercury analyzer.	Sampling and gas stream switching performed manually by analyst.
Qc _ Calibration	Calibration standards are not digested.	Sect. 7.3- Requires Calibration standards are digested
QC – Calibration Verification	1)Known reference sample (ICV) analyzed daily. 2)Calibration verified after every 10 samples with CCV.	1)Known reference sample analyzed quarterly. 2)Calibration verified after every 20 samples.
QC - Calibration Blanks and Method Blanks	Acceptance Criterion: < PQL	Acceptance criteria: Low enough not to interfere with data quality objectives, or <10% of PQL, or <10% of regulatory limit, or <10% of lowest associated sample

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FIGURE 1

EXAMPLE PAGE FROM MERCURY PREPARATION LOGBOOK

Katahdin Analytical Services, Inc. — **Metals Preparation Benchsheet**

Reagent Information:
HNO3: 66234 HCL: 56535 H2SO4: N/A
KMNO4: MR1315 K2S2O8: N/A NH2OH-HCl: MR1310

Method: 7471

REVIEWED 2-11-14 KATAHDIN ANALYTICAL METALS SECTION

Standards/Spiking Information:
1ppm A : MS14705
1ppm B : MS14706
LCSO = 500uL of 1ppm A to 100mL
Spike(S/P) = 100uL of 1ppm A to 100mL

ICV = 600uL of 1ppm B to 100 mL
S0.2 = 20uL of 1ppm A to 100 mL
S0.5 = 50uL of 1ppm A to 100 mL

S1.0 = 100uL of 1ppm A to 100 mL
S5.0 = 500uL of 1ppm A to 100 mL
S10.0 = 1000uL of 1ppm A to 100 mL

Balance ID: BAL 08
Water Bath ID : B
Digestion Start Time (@ 93 °C): 12:25
Thermometer ID : N/A
Digestion End Time(@ 96 °C): 12:55

Sample ID	Batch ID	Initial Wt/Vol	Initial Units	Final Vol	Final Units	MX	Meth	Anal.	Date	Initial Color	Initial Texture	Final Color	Final Clarity	Artifacts	Bottle
LCSOHB11HGS1	HB11HGS1	0.60	g	0.100	L	SL	HG	NT	02/11/2014	N/A	N/A	N/A	N/A		
PBSHB11HGS1	HB11HGS1	0.60	g	↓	L	SL	HG	NT	02/11/2014	N/A	N/A	N/A	N/A		
SH0548-009	HB11HGS1	0.65	g		L	SL	HG	NT	02/11/2014						A
SH0548-010	HB11HGS1	0.71	g		L	SL	HG	NT	02/11/2014						↓
SH0548-011	HB11HGS1	0.79	g		L	SL	HG	NT	02/11/2014						
SH0548-012	HB11HGS1	0.64	g		L	SL	HG	NT	02/11/2014						
SH0548-013	HB11HGS1	0.87	g		L	SL	HG	NT	02/11/2014						
SH0548-014	HB11HGS1	0.82	g		L	SL	HG	NT	02/11/2014						
SH0548-015	HB11HGS1	0.75	g		L	SL	HG	NT	02/11/2014						
SH0548-015P	HB11HGS1	0.79	g		L	SL	HG	NT	02/11/2014						
SH0548-015S	HB11HGS1	0.74	g		L	SL	HG	NT	02/11/2014						
SH0722-001	HB11HGS1	0.66	g		L	SL	HG	NT	02/11/2014						↓
SH0722-002	HB11HGS1	0.61	g		L	SL	HG	NT	02/11/2014						B
SH0722-003	HB11HGS1	0.65	g		L	SL	HG	NT	02/11/2014						A
SH0722-004	HB11HGS1	0.68	g		L	SL	HG	NT	02/11/2014						A
SH0817-001	HB11HGS1	0.65	g	✓	L	SL	HG	NT	02/11/2014						A

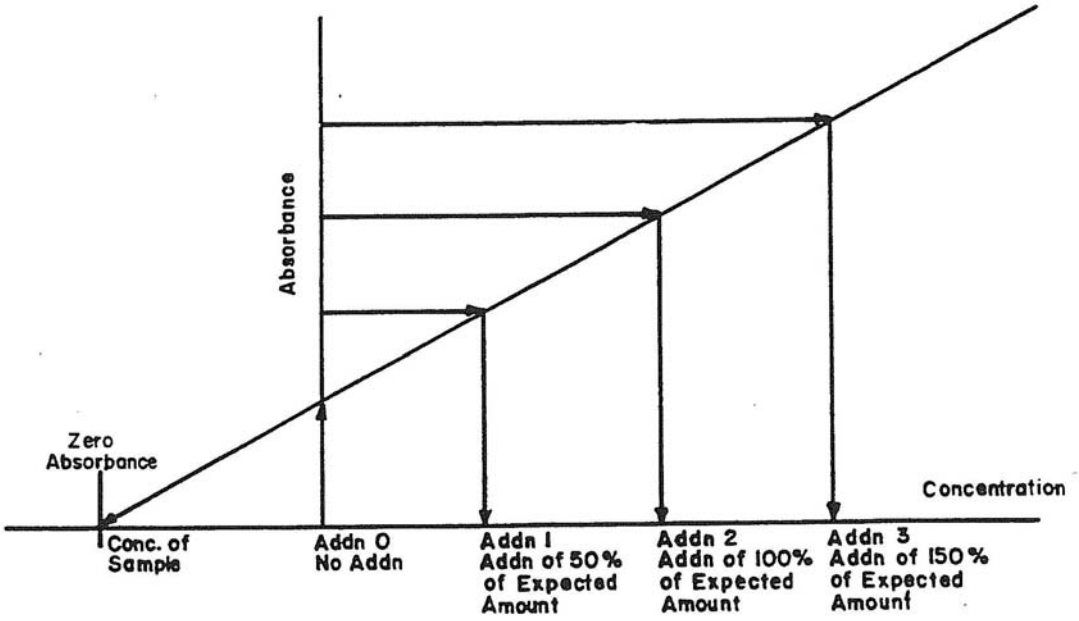
NT 2/11/14

QA-067-Revision 1 - 09/23/2010 Digestion performed by: NT On: 2/11/14 Page: HB028 Revision: 00

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

FIGURE 2

STANDARD ADDITIONS PLOT



TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

FIGURE 3

EXAMPLE CERTIFICATE OF ANALYSIS FOR A SOLID REFERENCE MATERIAL

ENVIRONMENTAL RESOURCE ASSOCIATES®
The Industry Standard™

MS1475

DataPacK™
Lot No. D051-540

Trace Metals in Soil
Catalog No. 540

Certification

Method 3050 HNO3, H2O2, HCl Parameter	Total Concentration [1] (mg/Kg)	Certified Value [2] (mg/Kg)	Performance Acceptance Limits™ [3] (mg/Kg)
aluminum	55600*	7870	4630 - 11100
antimony	160	70.5	D.L. - 149
arsenic	316	289	234 - 344
barium	869	211	174 - 247
beryllium	60.9	54.4	45.2 - 63.6
boron	129	91.3	58.8 - 124
cadmium	114	101	82.9 - 119
calcium	9750*	3680	2970 - 4390
chromium	249	224	180 - 268
cobalt	113	101	82.7 - 119
copper	94.9	88.0	73.3 - 103
iron	24400*	15700	6610 - 24900
lead	184	158	129 - 187
magnesium	3780*	2260	1760 - 2750
manganese	703	420	343 - 497
mercury	5.32	5.18	3.42 - 6.87
molybdenum	80.2	69.6	55.5 - 83.7
nickel	137	120	99.1 - 141
potassium	33000*	3000	2200 - 3800
selenium	146	130	101 - 159
silver	127	104	68.9 - 139
sodium	15600*	1080	692 - 1470
strontium	326	113	90.5 - 135
thallium	106	94.0	72.8 - 115
tin	175	149	104 - 194
titanium	3100*	284	116 - 453
vanadium	151	111	85.1 - 137
zinc	311	272	215 - 329

Method 3050 HNO3, H2O2 Parameter	Total Concentration [1] mg/Kg	Certified Value [2] mg/Kg	Performance Acceptance Limits™ [3] mg/Kg
aluminum	55600*	7380	4440 - 10300
antimony	160	75.2	D.L. - 198
arsenic	316	284	225 - 343
barium	869	217	177 - 257
beryllium	60.9	53.6	42.7 - 64.5
boron	129	89.5	58.9 - 120
cadmium	114	103	83.6 - 122
calcium	9750*	3540	2800 - 4270
chromium	249	224	172 - 275
cobalt	113	101	82.0 - 120
copper	94.9	85.5	70.4 - 100
iron	24400*	12500	5480 - 19500
lead	184	162	132 - 192
magnesium	3780*	2160	1650 - 2670
manganese	703	415	330 - 500
mercury	5.32	5.18	3.42 - 6.87
molybdenum	80.2	68.8	52.7 - 84.9
nickel	137	119	98.5 - 140
potassium	33000*	2840	2160 - 3520
selenium	146	135	104 - 166
silver	127	107	49.8 - 164
sodium	15600*	1010	709 - 1310
strontium	326	111	89.0 - 133
thallium	106	99.3	76.8 - 122
tin	175	148	70.6 - 225
titanium	3100*	283	104 - 463
vanadium	151	104	70.5 - 138
zinc	311	275	222 - 328

ADDENDUM

SOP NO CHANGE FORM

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: G. Brewer

Review Date: 06/14/16

SOP Number: CA-611-10

SOP Title: Mercury Analysis of Soils by Method 7471

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: G. Brewer **Date:** 06/14/16

QAO Signature: Leslie Dimond **Date:** 06/14/16

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

Prepared By: George Brewer Date: 01/01

Approved By:

Group Supervisor: George Brewer Date: 01/29/01

Operations Manager: Joel C. Burton Date: 1/29/01

QA Officer: Deborah J. Nadeau Date: 1·29·01

General Manager: Dennis F. Hogan Date: 1/29/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
00 7470A	NA	DH	1·29·01	1/29/01
01	Revised Sect. 4, 5 and 7 to reflect current practice. Revised Sect. 8 to reflect current QC limits. Revised sect. 10 to reflect current Applicable Documents and references. Removed figure 2. Update table 1 to reflect current QC limits. Minor changes throughout	LAD	02·16·05	02·16·05
02	Updated Fig. 1 - new prep logbook page	LAD	04/08	04/08
03	Updated Figure 1 - Example of a mercury Preparation Logbook page	LAD	03/09	03/09
04	Added LOD definition. Updated sections 8, 9, 10 and Table 1 for DOD QSM version 4.1 compliance.	DH	08/09	08/09

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
05	Added Table 2 - DoD QSM version 4.1 QC Requirements.	LAD	04/10	04/10
06	Sect. 4.6 - changed thermometer type. Sect. 7.3 - Changed type of marker used. Table 1 - Added PQL standard corrective action. Table 2 - added comments for calibration blank. Sect. 9 - Added MDL, LOD and LOQ information	LAD	05/11	05/11
07	Sect. 7 - Calibration prep from digesting all to digesting high STD. and diluting down. Added serial dilution and PDS to sect. 8. Added more MDL, LOD & LOQ information to Sect. 9. Updated and added references to Sect. 10	LAD	04/12	04/12
08	DoD QSM 5.0 References added. Sect. 7.4 and Table 3 - Updated Calibration Standard prep - removing digesting all standards. Added to digest high point	LAD	06/14	06/14
09	Updated figure 1. Change title of section 5.0. Update method references for NELAC and DoD. Minor additions to sections 4.1, 4.2, 4.6, 7.1, 7.10, 7.12.	LAD	09/17	09/17

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-615-09,** titled **DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470.**

Recipient: _____ Date: _____

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-615-09,** titled **DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470.**

Recipient: _____ Date: _____

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedure used by Katahdin Analytical Services personnel for the digestion and analysis aqueous samples for mercury using cold vapor atomic absorption spectrophotometry.

This method is applicable to the determination of mercury in groundwaters, aqueous wastes, and mobility-procedure extracts under USEPA Method 7470 (Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods, SW-846, 2nd edition, 1982 (revised 1984), 3rd edition, 1986, and Updates I, II, IIA, and III 1996, Office of Solid Waste and Emergency Response, U.S. EPA.

1.1 Definitions

CCB - Continuing Calibration Blank - An analyte-free solution consisting of acidified laboratory grade reagent water used to verify calibration accuracy periodically during analysis.

CCV - Continuing Calibration Verification - A midrange standard used to verify calibration accuracy periodically during analysis.
ICB - Initial Calibration Blank - An analyte-free solution consisting of acidified laboratory grade reagent water used to verify calibration accuracy.

ICV - Initial Calibration Verification - A standard made from a source independent from the calibration standards and with analyte concentrations different from those in the CCV; used to verify the accuracy of the instrument calibration.

PB - Preparation Blank - Laboratory grade reagent water that has been brought through the sample preparation process.

LCS - Laboratory Control Sample - A standard or solid reference material that has been brought through the sample preparation process.

Matrix Spike - An aliquot of a sample to which a known amount of analyte has been added before digestion.

Duplicate - A second aliquot of a sample that is prepared and analyzed in the same way as the original sample in order to determine the precision of the method.

Serial Dilution - The dilution of a sample by a factor of five. When corrected by the dilution factor, the measured analyte concentrations of the diluted sample should agree with those of the original undiluted sample within specified limits. Serial dilution may reflect the influence of interferents.

IDL - Instrument Detection Limit - The lowest concentration of an analyte that can be determined with 95% confidence by the instrument.

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

LOD – Limit of Detection – An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix-specific and is used for DoD QSM acceptance criteria.

PQL - Practical Quantitation Limit - The lowest concentration of an analyte that is routinely reported by the laboratory; nominally three to five times the IDL.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of mercury by USEPA Method 7470. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in analysis of mercury by USEPA Method 7470 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to ensure that members of their group follow this SOP, that their work is properly documented, and to indicate periodic review of the associated logbooks.

1.3 Safety

Many of the samples and reagents used in cold vapor atomic absorption are toxic or corrosive. Rubber gloves, safety glasses, lab coats, and other protective clothing should be worn whenever these materials are handled. Because of the toxic nature of mercury vapor, care must be taken to avoid its inhalation. The instrument exhaust fan must be in operation whenever the mercury analyzer is in use (the fan should never be shut off).

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with the Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and follow appropriate procedures such as wearing safety glasses and gloves when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location and use of all safety equipment.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Plan for further details on pollution prevention techniques.

Samples, sample digestates, standards, and other reagents used in cold vapor atomic absorption may contain high concentrations of acids, mercury, and other toxic metals. They should be disposed of in a manner appropriate to the types of hazards they present. All digested mercury samples and standards and excess reagents and standards should be disposed of in the satellite waste container for corrosive wastes (labeled “Waste Stream A”) that is located in the Metals Prep lab. Further information regarding waste classification and disposal may be obtained by consulting the laboratory's Hazardous Waste Management Plan and Safety Manual and the Department Manager.

2.0 SUMMARY OF METHOD

The cold vapor atomic absorption technique is based on the absorption of radiation at 253.7 nm by mercury vapor. It relies on the volatility of elemental mercury at room temperature. During preparation, organic mercurials are oxidized and elemental mercury is ionized to Hg^{3+}. During instrumental analysis, mercuric ions are reduced to elemental mercury by the addition of stannous chloride. Elemental mercury is then aerated from solution and passes through a cell positioned in the path of a mercury spectrophotometer, where absorbance (peak height) is measured as a function of mercury concentration and

recorded by the associated computer. The mercury vapor is then swept out of the instrument into an exhaust hood, where it is evacuated from the laboratory.

3.0 INTERFERENCES

In addition to inorganic forms of mercury, organic mercurials may be present in environmental samples. These organo-mercury compounds will not respond to the cold vapor atomic absorption technique unless they are first broken down and converted to mercuric ions. The presence of undigested organo-mercurials in samples will result in a low bias for analytical results. Certain volatile organic materials will also non-specifically absorb radiation at the 253.7 nm analytical wavelength. The presence of such compounds may result in a high bias for analytical results. For these reasons, complete digestion using potassium permanganate and potassium persulfate is required for all environmental samples. Complete digestion is indicated by the persistence of the purple permanganate color (indicating the presence of excess permanganate) following digestion.

Sea waters, brines, and industrial effluents high in chlorides may require additional permanganate to maintain a persistent purple color following digestion. During the oxidation step, chlorides are converted to free chlorine which will absorb radiation at the 253.7 nm analytical wavelength. Any free chlorine thus generated will be present in the headspace of the digestion vessel following digestion. Because samples are poured into autosampler tubes prior to analysis by the mercury analyzer, any free chlorine present in the headspace of the digestion vessels is not sampled by the instrument and the analysis is free of chlorine interference.

4.0 APPARATUS AND MATERIALS

4.1 40 mL, 50 mL or 70 mL digestion tubes and appropriate watch glasses, for use as digestion vessels.

4.2 250 mL Pyrex media bottles with plastic screw caps, for use in preparation of calibration standards.

4.3 Water bath capable of maintaining a constant temperature of 95^{o} C.

4.4 Adjustable volume automatic pipettes - 2 to 20 uL, 10 to 100 uL, 100 to 1000 uL. Calibrated Eppendorf Reference pipets and Finn digital pipets are appropriate.

4.5 Repipetters (adjustable repeating pipetters with reservoirs) for dispensing concentrated nitric acid, concentrated sulfuric acid, and other reagents

4.6 Battery powered Traceable Pocket-Size Thermometer from Fisher Scientific, NIST-traceable, covering the range from -50^{o} to 750^{o} C, for monitoring the temperature of the water bath. Mercury-filled thermometers are not acceptable for use in the metals laboratory, due to the possibility of breakage and consequent contamination.

4.7 Disposable graduated polystyrene sample cups, 200 mL capacity

4.8 CETAC M-6100 automated mercury analyzer and associated peripherals and parts

4.9 Disposable graduated dose cups, 30 mL capacity

Refer to Katahdin SOP CA-629, current revision, "Operation and Maintenance of the CETAC M-6100 Automated Mercury Analyzer" for additional required materials.

5.0 REAGENTS AND STANDARDS

5.1 Laboratory grade reagent water – mercury-free water meeting the specifications of ASTM Type II water

5.2 Concentrated sulfuric acid, trace metals grade

5.3 Concentrated nitric acid, trace metals grade

5.4 Concentrated hydrochloric acid, trace metal grade

5.5 Potassium permanganate solution, 5% w/v: Dissolve 50 g of potassium permanganate in 1 L laboratory grade reagent water. The source reagent should be labeled as suitable for use in mercury determination.

5.6 Potassium persulfate solution, 5% w/v: Dissolve 50g of potassium permanganate in 1L laboratory grade reagent water. The source reagent should be labeled as suitable for use in mercury determination.

5.7 Sodium chloride – hydroxylamine hydrochloride solution: Dissolve 120 g sodium chloride and 120 g hydroxylamine hydrochloride in laboratory grade reagent water and dilute to a final volume of 1 L.

5.8 Stannous chloride solution: Add 70 mL concentrated hydrochloric acid to 500 mL of laboratory grade reagent water. Add 100 g stannous chloride and bring to a final volume of 1 L. Mix to dissolve. Reagent should be labeled as suitable for use in mercury determination.

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

5.9 Intermediate Mercury Standard A: Appropriately dilute a mercury stock standard to obtain a solution containing 1000 ug of mercury per liter in 2% nitric acid. This intermediate standard is used to prepare calibration standards, matrix spikes, CCVs, and laboratory control samples (refer to Section 8). The identity of the stock standard currently used to prepare this intermediate may be obtained by consulting the Standards Preparation Logbook maintained in the Section. Intermediate Mercury Standard A must be prepared fresh monthly ,and disposed of appropriately after use. (Note: the concentrations of all stock standards must be certified by the vendors as traceable to NIST reference materials).

5.10 Intermediate Mercury Standard B: Appropriately dilute a mercury stock standard to obtain a solution containing 1000 ug of mercury per liter in 2% nitric acid. The source of the stock standard used to prepare Intermediate Mercury Standard B must be distinct from that used to prepare Intermediate Mercury Standard A (i.e. obtained from a separate vendor). Intermediate Mercury Standard B is used to prepare the ICV (refer to Section 8). The identity of the stock standard currently used to prepare this intermediate standard may be obtained by consulting the Standards Preparation Logbook maintained in the Section. Intermediate Mercury Standard B must be prepared fresh monthly, and disposed of appropriately after use.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Aqueous samples to be analyzed for mercury should be collected and preserved as described in the following table.

Matrix	Container[1]	Collection Volume/ Weight	Preservation/ Treatment	Holding Time
Aqueous (total)	P, G	250 mL	HNO_3 to pH < 2	28 days
Aqueous (dissolved)	P, G	250 mL	HNO_3 to pH < 2	28 days

[1] P = polyethylene or G = glass

7.0 PROCEDURES

BOTTLE PREPARATION

7.1 Mercury digestions are performed in two different types of vessels. Calibration standards, the Initial Calibration Verification (ICV) standard, and the Initial/Continuing Calibration Blank (ICB/CCB) are prepared in 250 mL Pyrex media

bottles. Large bottles are used to provide sufficient volumes of these standards to allow for multiple reanalyses when required. Field samples, Method Blanks, and Laboratory Control Samples are digested in 40 mL, 50 mL or 70 mL digestion tubes. These smaller vials provide enough digestate to allow one or two reanalyses when required, but reduce the amounts of samples consumed and waste generated.

VOA vials are reused if the samples they have contained have no measurable mercury above the PQL. After the previous contents of the vials have been discarded, these vials are segregated according to whether the measured mercury concentrations of the previous contents were above the PQL (contaminated vials) or below the PQL (uncontaminated vials). Labels are removed from the vials by wiping with a paper towel saturated with toluene. Uncontaminated vials are rinsed with laboratory grade reagent water. Contaminated vials are discarded.

The Pyrex media bottles in which standards are prepared are emptied, rinsed, and reused. Each of these bottles is permanently marked with the concentration of the standard it contains.

PREPARATION OF STANDARDS, QC SAMPLES, AND BLANKS

7.2 Prior to performing the digestion, make a list of the samples that are to be digested. Enter digestion information (Katahdin Sample Numbers, QC Batch ID, preparation date, analyst initials, etc.) into the ACCESS Metals database and print out a copy of the sample prep bench sheet. All necessary details of sample preparation (standards preparation information, digestion times, initial and final volumes, pertinent observations, etc.) must be recorded on this spreadsheet, which will be bound in the Mercury Preparation Logbook. Refer to Figure 1 for an example page from the Mercury Preparation Logbook.

7.3 Using an industrial marker with super permanent ink, label clean sample containers with the appropriate sample numbers and standard identifications for each sample, preparation blank, laboratory control spike and matrix spike and standard to be digested.

7.4 Calibration Preparation - Use a bottle-top dispenser to add 100 mL of laboratory grade reagent water to a standard digestion bottle (250 mL media bottles). Using a calibrated adjustable pipette, prepare the high calibration standard by adding 1000 uL of Intermediate Mercury Standard A to an appropriately labeled media bottle containing 100 mL of laboratory grade reagent water. The mercury concentration of this calibration standard is 10.0 ug/L. Calibration levels 0.2 ug/L, 0.5 ug/L, 1.0 ug/L, 5.0 ug/L are made by diluting the 10.0 ug/L standard into calibration blank solution. See below for amounts. The 0.2 ug/L and 5 ug/L standards are analyzed

after calibration as the PQL standard and the CCV (refer to Section 8.0), respectively, as well as being used in the creation of the calibration curve.

Calibration Level	Amount added	Amount calibration blank solution
0.2 ug/L	0.3 mL	14.7 mL
0.5 ug/L	0.5 mL	9.5 mL
1.0 ug/L	1 mL	9 mL
5.0 ug/L	5 mL	5 mL

7.5 Add 100 mL of laboratory grade reagent water to the media bottle labeled “ICV”. Using a calibrated adjustable pipette, prepare the Initial Calibration Verification standard (refer to Section 8) by adding 600 uL of Intermediate Mercury Standard B to the water in this bottle, and record the bottle number in the Mercury Preparation Logbook. The mercury concentration of the ICV is 6.0 ug/L.

7.6 Prepare an appropriate number of preparation blanks (PBW) by adding 25 mL of laboratory grade reagent water to labeled vials.

7.7 Prepare an appropriate number of laboratory control samples (LCSW) by adding 125 uL of Intermediate Mercury Standard A to labeled digestion vials containing 25 mL of laboratory grade reagent water. The mercury concentration of each LCSW is 5.0 ug/L.

7.8 Matrix spikes are prepared by adding 25 uL of Intermediate Mercury Std A to 25 mL aliquots of samples. The concentration of mercury added to each matrix spike is 1.0 ug/L.

7.9 Preparation blanks, laboratory control spikes and matrix spikes are digested in the same manner as client samples. Refer to Sample Preparation and Digestion, sections 7.10 through 7.13 of this SOP. The volumes of reagents added to the standards prepared in the media bottles are four times those listed in sections 7.10 through 7.13 but the standards are not heated.

SAMPLE PREPARATION AND DIGESTION

7.10 Using a graduated disposable dosecup or pour directly into graduated sample tube, transfer 25 mL of sample, or an aliquot diluted to 25 mL, to a digestion vial. Add 1.25 mL of concentrated sulfuric acid and 0.625 mL of concentrated nitric acid, swirling to mix after each addition. Add 3.75 mL of potassium permanganate solution, swirl to mix, and allow to stand for at least 15 minutes. Samples that contain large amounts of organic substances may require additional 3.75 mL aliquots of potassium permanganate solution. This is indicated by the failure of the purple permanganate color to persist for the entire 15 minute waiting period. Add

additional 3.75 mL aliquots to samples as necessary until the purple color persists for 15 minutes. If any of the samples require these additional aliquots of potassium permanganate solution, record the additional volume used for each sample on the mercury preparation benchsheet.

Some samples may require dilution to 25 mL with potassium permanganate for digestion to be performed in the digestion vessel. Prepare method blank and LCS with equal amounts of potassium permanganate to check for potential mercury contamination.

7.11 Add 2 mL of potassium persulfate solution to each sample. Cap the vials, for 50 mL or 70 mL tubes, add ribbed watch glasses, and place them in a preheated water bath or heat source. Monitor the temperature of the bath with a thermometer throughout the digestion. The temperature of the water bath will fall below 90-95^{o} C upon addition of the digestion vials. After the temperature of the bath has risen back to 90-95^{o} C, continue heating the samples at 90-95^{o} C for two hours. Record initial and final digestion times and temperatures in the mercury prepareation benchsheet.

7.12 Remove bottles from the water bath or heat source and allow to cool to room temperature. If the purple permanganate color has failed to persist after digestion in any of the samples, add additional 3.75 mL aliquots of potassium permanganate solution as required to the samples, and record these additions in the mercury preparation benchsheet. Heat the samples that required additional permanganate in the water bath at 90-95^{o} C for an additional two hours. Remove the bottles from the water bath and allow to cool to room temperature. If the purple color fails to persist after the second heating step, consult the Department Manager for advice on how to proceed.

7.13 Add 1.5 mL of sodium chloride – hydroxylamine hydrochloride solution to each digestion vial and swirl to mix. This will reduce the excess permanganate, and the sample will change from purple to colorless. Wait at least 30 seconds before proceeding with analysis.

INSTRUMENTAL ANALYSIS

7.14 Digested mercury samples are analyzed using the CETAC M-6100 Automated Mercury Analyzer. Analysis is automated and is controlled by the QuickTrace Mercury Analyzer software running on a dedicated PC. Detailed instructions for setting up the instrument and analyzing samples are given Katahdin SOP CA-629, “Operation and Maintenance of the CETAC M-6100 Automated Mercury Analyzer”.

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METHOD OF STANDARD ADDITIONS

7.15 The standard addition technique involves adding known amounts of standard to one or more aliquots of the processed sample solution. This technique compensates for a sample constituent that enhances or depresses the analyte signal, thus producing a different slope from that of the calibration standards. It will not correct for additive interferences which cause a baseline shift. The method of standard additions shall be used for analysis of all EP extracts, on all analyses submitted as part of a delisting petition, and whenever a new sample matrix is being analyzed.

7.15.1 The simplest version of this technique is the single-addition method, in which two identical aliquots of the sample solution, each of volume V_x, are taken. To the first (labeled A) is added a known volume V_S of a standard analyte solution of concentration C_S. To the second aliquot (labeled B) is added the same volume V_S of the solvent. The analytical signals of A and B are measured and corrected for nonanalyte signals. The unknown sample concentration C_x is calculated:

$$C_X = \frac{S_B V_S C_S}{(S_A - S_B) V_X}$$

where S_A and S_B are the analytical signals (corrected for the blank) of solutions A and B, respectively. V_s and C_s should be chosen so that S_A is roughly twice S_B on the average, avoiding excess dilution of the sample. If a separation or concentration step is used, the additions are best made first and carried through the entire procedure.

7.15.2 Improved results can be obtained by employing a series of standard additions. To equal volumes of the sample are added a series of standard solutions containing different known quantities of the analyte, and all solutions are diluted to the same final volume. For example, addition 1 should be prepared so that the resulting concentration is approximately 50 percent of the expected absorbance from the endogenous analyte in the sample. Additions 2 and 3 should be prepared so that the concentrations are approximately 100 and 150 percent of the expected endogenous sample absorbance. The absorbance of each solution is determined and then plotted on the vertical axis of a graph, with the concentrations of the known standards plotted on the horizontal axis. When the resulting line is extrapolated to zero absorbance, the point of interception of the abscissa is the endogenous concentration of the analyte in the sample. The abscissa on the left of the ordinate is scaled the same as on the right side, but in the opposite direction from the ordinate. An example of a plot so obtained is

shown in Figure 3. A linear regression program may be used to obtain the intercept concentration.

7.15.3 For the results of this MSA technique to be valid, the following limitations must be taken into consideration:

- The apparent concentrations from the calibration curve must be linear over the concentration range of concern. For the best results, the slope of the MSA plot should be nearly the same as the slope of the standard curve. If the slope is significantly different (greater than 20%), caution should be exercised.

- The effect of the interference should not vary as the ratio of analyte concentration to sample matrix changes, and the standard addition should respond in a similar manner as the analyte.

- The determination must be free of spectral interference and corrected for nonspecific background interference.

DATA REDUCTION AND REPORTING

7.16 Results are obtained in concentration units (ug/L) from the instrument. Electronic instrument data files are imported into the Metals ACCESS database for data reduction. Sample preparation information (initial sample volumes and final digestate volumes) are entered directly into the Metals ACCESS database to allow calculation of final results for reporting. Results are calculated as follows:

$$\text{Mercury concentration (ug/L)} = \frac{MC \times DF \times IV}{FV}$$

where: MC = Measured mercury concentration (ug/L)
DF = Dilution factor at instrument
IV = Initial sample volume (mL)
FV = Final digestate volume (mL)

7.17 Results that exceed the calibration range of the instrument may not be reported - the sample must be appropriately diluted and reanalyzed. Results for diluted samples should be multiplied by the dilution factor prior to reporting. If additional aliquots of potassium permanganate were added during digestion, the resulting dilution must be corrected for before reporting.

7.18 Results are reported down to the laboratory's practical quantitation level (PQL), unless otherwise requested. Results below the PQL should be reported to the PQL and flagged with a “U” qualifier.

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

USEPA Method 7470 requires the laboratory to perform specific quality control checks to assess laboratory performance and data quality. Minimum frequencies, acceptance criteria, and corrective actions for these control checks are tabulated in Table 1 and are described below. Preparation instructions and the resulting mercury concentrations for calibration standards, QC standards, and matrix spikes are detailed in Sections 7.4 through 7.8 of this SOP. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations and client and project specific Data Quality Objectives. The Department Manager, Operations Manager, General Manager and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

INITIAL DEMONSTRATION OF PERFORMANCE

8.1 Instrument detection limits (IDL) are determined quarterly for each analyte analyzed on each instrument by each method. This determination requires seven replicate analyses of a laboratory grade reagent water spiked at 3-5 times the anticipated detection limit for each analyte, performed on three non-consecutive days. The standard deviation of the 21 analyses is multiplied by three to obtain the IDL. For more information on performing IDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.2 Method detection limits (MDL) are determined annually for each analyte analyzed on each instrument. This determination requires at least seven replicate digestions and analyses of laboratory grade reagent water spiked at 3-5 times the anticipated

MDL for each analyte. MDLs differ from IDLs in that the replicates are digested prior to analysis, and they may be analyzed on a single day. The standard deviation of the 7 (or more) replicate analyses is multiplied by the Student's t-value to obtain the MDL. For more information on performing MDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.3 Limits of Detection (LOD) are used when evaluating data using DoD QSM. The LOD is established by spiking a quality system matrix at 2-3 times the detection limit for a single analyte standard and 1-4 times the detection limit for a multi-analyte standard. The LOD must be verified quarterly. For more information on performing LOD determinations, refer to the current revision of Katahdin SOP QA-806.

8.4 Instrument calibration - The instrument must be calibrated each time it is set up, and calibration standards must be digested each day that samples are digested. Calibration includes analysis of a calibration blank and five calibration standards with graduated concentrations in the appropriate range. The concentration of one of the calibration standards must be at the Practical Quantitation Level (PQL). The intermediate standards used for preparing the calibration standards are prepared at least once per month in 2% nitric acid. Because mercury may be adsorbed onto the walls of glass and plastic containers, the calibration standards must be prepared fresh daily. The correlation coefficient for the calibration curve must be at least 0.995. If the calibration curve does not pass this test, analysis must be halted, the problem corrected, and the instrument recalibrated.

8.5 An Initial Calibration Verification (ICV) solution is analyzed after the initial calibration to check calibration accuracy. The ICV solution is prepared from a standard source different than that of the calibration standard and at a concentration within the working range of the instrument. The result of the ICV must fall within 90% to 110% of the expected value. If the ICV fails, results may not be reported from the run until the problem is corrected and a passing ICV has been analyzed.

8.6 The Continuing Calibration Verification (CCV) solution is analyzed after the initial calibration, after every ten samples, and at the end of the analytical run. The CCV solution is prepared using the same standard used for calibration at a concentration near the mid-point of the calibration curve. Results of the CCVs must fall within 80% to 120% of the expected value. If a CCV fails, associated sample results may not be reported from the run until the problem is corrected and a passing CCV has been analyzed. Also, all samples analyzed after the last passing CCV must be reanalyzed.

8.7 A calibration blank is analyzed after each ICV and CCV. A calibration blank that is analyzed after the ICV is called an Initial Calibration Blank (ICB). A calibration blank that is analyzed after a CCV is called a Continuing Calibration Blank (CCB). The absolute values of results of ICBs and CCBs must be less than the Practical Quantitation Level (PQL) for each element. If samples are being run using DoD

QSM criteria, the absolute values of ICBs and CCBs must be less than the Limit of Detection (LOD). If an ICB or a CCB fails, results for the failing elements may not be reported from the run until the problem is corrected and a passing ICB or CCB has been analyzed. Also, all samples analyzed after the last passing CCB must be reanalyzed.

8.8 A standard with a mercury concentration that is at the Practical Quantitation Limit (PQL) is analyzed at the beginning of the run to determine calibration accuracy at the reporting limit. Result of the PQL standard should fall within 70% to 130% of the expected values. No corrective action has been established at this time.

PREPARATION BATCH QC SAMPLES

8.9 Preparation blank (PBW or PBS), consisting of reagent water carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. The results of preparation blanks must be less than the Practical Quantitation Level (PQL) for each element. For DoD QSM acceptance criteria the results must be less than ½ the PQL except for common contaminants which must be less than the PQL. If a preparation blank fails, results for the failing elements may not be reported from the digestion batch, and all associated samples must be redigested, with the following exception. If the result for a preparation blank is greater than the PQL (greater than ½ PQL for DoD), associated sample results that are less than the PQL (less than ½ PQL for DoD) or greater than or equal to ten times the measured preparation blank concentration may be reported.

8.10 A laboratory control sample (LCSW), consisting of spiked reagent carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. Results for laboratory control samples must fall within 80% to 120% of the expected value, unless laboratory-generated statistical limits are available. If a laboratory control sample fails, results may not be reported from the digestion batch, and all associated samples must be redigested.

SAMPLE MATRIX QC SAMPLES

8.11 Matrix spiked duplicate samples are prepared at a minimum frequency of one per digestion batch. Matrix spike recoveries for these samples are calculated as follows:

$$\text{Recovery (\%)} = \frac{(P - S)}{A} \times 100\%$$

where: P = Spiked sample value
S = Original sample value
A = Spike amount

The recovery for each element in a spiked sample or spiked duplicate sample must fall within 75% to 125% of the actual value if the result for the unspiked sample is less than four times the amount of spike added. If one or both spike recoveries fail, a matrix interference should be suspected and the associated sample result should be flagged on the report of analysis. If DoD QSM acceptance criteria are being used, recoveries must be the same as stated for laboratory control samples.

The relative percent difference between matrix spiked duplicate sample results is calculated as follows:

$$\text{RPD (\%)} = \frac{|D_1 - D_2|}{(|D_1 + D_2|)/2} \times 100$$

where: D_1 = Spike sample result
D_2= Spike duplicate sample result

A control limit of 20% RPD is applied to matrix spike duplicate analysis. If the matrix spike duplicate analysis fails, the associated sample result should be flagged on the report of analysis.

8.12 A serial dilution is analyzed to check for chemical or physical interferences. If the analyte concentration of a sample is sufficiently high (minimally, 50 x IDL or 50 x LOQ if using DoD QSM acceptance criteria), the measured concentration of a serial dilution (1:5 dilution) of the sample should agree within 90% to 110% of the original determination. The percent difference between the original sample and the serial dilution should be calculated as follows:

$$\text{Difference (\%)} = \frac{|L-S|}{S} * 100\%$$

where: L = Serial dilution result (corrected for dilution)
S = Original sample result

If the serial dilution analysis fails, a matrix interference should be suspected. The associated sample result should be flagged on the report of analysis or the sample should be reanalyzed at dilution to eliminate the interference.

8.13 Post-digestion Spike (PDS) additions must be performed for DoD QSM samples if the serial dilution is not within acceptance criteria or if the analyte concentrations in all samples are less than 50x the LOD. The spike addition should produce a concentration that is between 10 and 100x the LOQ. The recovery of the PDS must

be within 75-125%. If the PDS fails, all samples must be run by method of standard additions or appropriately flagged.

9.0 METHOD PERFORMANCE

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 value is above zero. The MDLs shall be determined and verified one time per type of instrument unless otherwise required by the method.

A Limit of Detection (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent. LODs must be determined for all parameters for which the laboratory is accredited under the DoD Environmental Laboratory Accreditation Program. LOD's must be verified for every preparation and analytical method combination and on every applicable instrument on a quarterly basis.

The Limit of Quantitation (LOQ) is the minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ shall be set at the lowest point in the calibration curve for all analyses utilizing an initial calibration. LOQ's must be verified quarterly for every preparation and analytical method combination and on every applicable instrument on a quarterly basis for all parameters included in the DoD Scope of Accreditation. The LOQ must be verified at least once annually if the analysis is not included in the DoD Scope of Accreditation.

MDLs are filed with the Organic Department Manager and then with the QAO. LOD and LOQ verifications are filed with the QAO

Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revision of USEPA Method 7470 for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Wastes, United States Environmental Protection Agency, USEPA SW 846, Third Edition, Final Update III (9/94), Method 7470A.

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.1, January, 2017.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications.

QuickTrace M6100 Mercury Analyzer Operator Manual Version 1.0.1, CETAC Technologies.

QuickTrace Mercury Analyzer Software Manual, CETAC Technologies.

List of Tables and Figures

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

TABLE 1

QC REQUIREMENTS

Parameter/ Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Mercury/ USEPA 7470	Initial Calibration, 5 points plus a calibration blank.	Daily prior to sample analysis.	Correlation coefficient $\geq$ 0.995.	Correct problem and repeat calibration.
	Initial Calibration Verification (ICV), prepared from a second source.	Before beginning a sample run.	Recovery within $\pm$ 10% of true value.	Correct problem and repeat calibration.
	Initial Calibration Blank (ICB)	Before beginning a sample run.	Less than PQL.	Correct problem and repeat calibration.
	Practical Quantitation Level Standard (PQL)	Before beginning a sample run.	Recovery within $\pm$ 30% of true value.	Correct problem and repeat calibration.
	Continuing Calibration Verification (CCV)	At beginning or run, after every 10 samples, and at end of the run	Recovery within $\pm$ 10% of true value	Repeat calibration and reanalyze all samples analyzed since the last successful CCV.
	Continuing Calibration Blank (CCB)	At beginning or run, after every 10 samples, and at end of the run	Less than PQL.	Repeat calibration and reanalyze all samples analyzed since the last successful CCB.
	Preparation Blank (PBW)	One per digestion batch of 20 or fewer samples.	Less than PQL.	1) Investigate source of contamination. 2) Redigest and reanalyze all associated samples if sample concentration $\geq$ PQL and < 10x the blank concentration.
	Laboratory Control Sample (LCSW)	One per digestion batch of 20 or fewer samples.	Recovery within $\pm$ 20% of true value.	Redigest all affected samples.
	Matrix Spike Sample (S)	One per digestion batch of 20 or fewer samples.	Recovery $\pm$25% of true value, if sample > 4x spike value.	Flag results.
	Matrix Spike Duplicate Sample (P)	One per digestion batch of 20 or fewer samples.	1) Recovery $\pm$ 25% of true value, if sample < 4x spike added. 2) RPD ≤20% for duplicate spikes.	Flag results
	Instrument Detection Limit (IDL) Study	Quarterly.	IDL < PQL	1) Repeat IDL study. 2) Raise PQL.
	Limit of Detection (LOD) determination	Quarterly.	LOD = 2-3X MDL	Repeat LOD Determination.
	Method Detection Limit (MDL) Study	Refer to KAS SOP QA-806, "Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications", current revision.		

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

TABLE 2

DOD QSM VERSION REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria.	NA.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD determination and verification	(Refer to current revision of SOP QA-806)				
LOQ establishment and verification	(Refer to current revision of SOP QA-806)				
Initial calibration (ICAL) for mercury - minimum 5 standards and a calibration blank	Daily ICAL prior to sample analysis.	5 points plus a calibration blank, r ≥ 0.995.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed.
Second source calibration verification (ICV)	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analyte(s) within ± 10% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	within ± 20% of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

TABLE 2

DOD QSM VERSION REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Method blank	One per preparatory batch.	No analytes detected > ½ RL (> RL for common lab contaminants) and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result. Contact Client if samples cannot be reprepped within hold time.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Calibration blank	Before beginning a sample run, after every 10 samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.	Apply B-flag to all results for specific analyte(s) in all samples associated with the blank.	Problem must be corrected. All samples following the last acceptable calibration blank must be reanalyzed.
LCS	One per preparatory batch.	Water: Recovery must be within + 20% of the true value Soil: Recovery must be within vendor supplied limits (varies by lot).	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix spike (MS)	One per preparatory batch per matrix (see Box D-7).	Recovery must be within + 20% of the true value.	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests are required to evaluate matrix effects.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate (MSD) or sample duplicate	One per preparatory batch per matrix (see Box D-7).	MSD: Recovery must be within + 20% of the true value. MSD or sample duplicate: RPD ≤ 20% (between MS and MSD or sample and sample duplicate).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

TABLE 2

DOD QSM QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Method of standard additions (MSA)	When matrix interference is confirmed.	NA.	NA.	NA.	Document use of MSA in the case narrative.
Results reported between DL and LOQ	NA.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

TABLE 3

SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-615-09	USEPA METHOD 7470
Reagents	Stannous chloride dissolved in hydrochloric acid to prevent clogging of mercury analyzer, per instrument manufacturer's recommendation.	Stannous chloride dissolved/suspended in sulfuric acid.
Procedures	1)Sampling and gas stream switching performed automatically by mercury analyzer. 2)Working Mercury standard prepared monthly in 2% nitric; calibration standards prepared fresh daily.	1)Sampling and gas stream switching performed manually by analyst. 2)Working Mercury standard prepared fresh daily and acidity maintained at 0.15% nitric.
QC – Calibration Verification	1) Known reference sample (ICV) analyzed daily. 2) Calibration verified after every 10 samples with CCV.	1) Known reference sample analyzed quarterly. 2) Calibration verified after every 20 samples.
QC - Calibration Blanks	Acceptance criteria employed for 245.1: ± PQL	Acceptance criteria stated in 245.1: ± MDL

TITLE: DIGESTION AND ANALYSIS OF AQUEOUS SAMPLES FOR MERCURY BY USEPA METHOD 7470

FIGURE 1

EXAMPLE PAGE FROM MERCURY PREPARATION LOGBOOK

Katahdin Analytical Services, Inc. — **Metals Preparation Benchsheet**

Method: 7470

Reagent Information:

HNO3: MSR74 H2SO4: MSR43

KMNO4: MR1846 K2S2O8: MR1849 NH2OH-HCl: MR1833

REVIEWED JS 8.18.17 KATAHDIN ANALYTICAL METALS SECTION

Standards/Spiking Information:

1ppm A : MW17209

1ppm B : MW17210

Heat Source ID : B

Start Time: 0936 /Temp. 93 °C

End Time: 1136 /Temp. 92 °C

Thermometer ID/Pos: AIC25 / 4.8

Pipet

MB — LCSW = 125uL of 1ppm A to 25mL

MB — Spike(S/P) = 25uL of 1ppm A to 25mL

MB — ICV = 600uL of 1ppm B to 100 mL

MB — S10.0 = 1000uL of 1ppm A to 100 mL

Sample ID	Batch ID	Initial Wt/Vol	Initial Units	Final Vol	Final Units	MX	Meth	Anal.	Date	Bottle
LCSWKH17HGW2	KH17HGW2	0.025	L	0025	L	AQ	HG	AMJ	08/17/2017	
PBWKH17HGW2	KH17HGW2		L		L	AQ	HG	AMJ	08/17/2017	
SK7277-001	KH17HGW2		L		L	AQ	HG	AMJ	08/17/2017	D
SK7277-002	KH17HGW2		L		L	AQ	HG	AMJ	08/17/2017	
SK7277-003	KH17HGW2		L		L	AQ	HG	AMJ	08/17/2017	
SK7277-004	KH17HGW2		L		L	AQ	HG	AMJ	08/17/2017	
SK7277-004P	KH17HGW2		L		L	AQ	HG	AMJ	08/17/2017	
SK7277-004S	KH17HGW2		L		L	AQ	HG	AMJ	08/17/2017	
SK7278-001	KH17HGW2		L		L	AQ	HG	AMJ	08/17/2017	
SK7278-002	KH17HGW2		L		L	AQ	HG	AMJ	08/17/2017	

JS 8.8.17

QA-066-Revision 3 - 06/01/2017 Digestion performed by: AMJ On: 8/17/17 Page: KH057 Revision: 00

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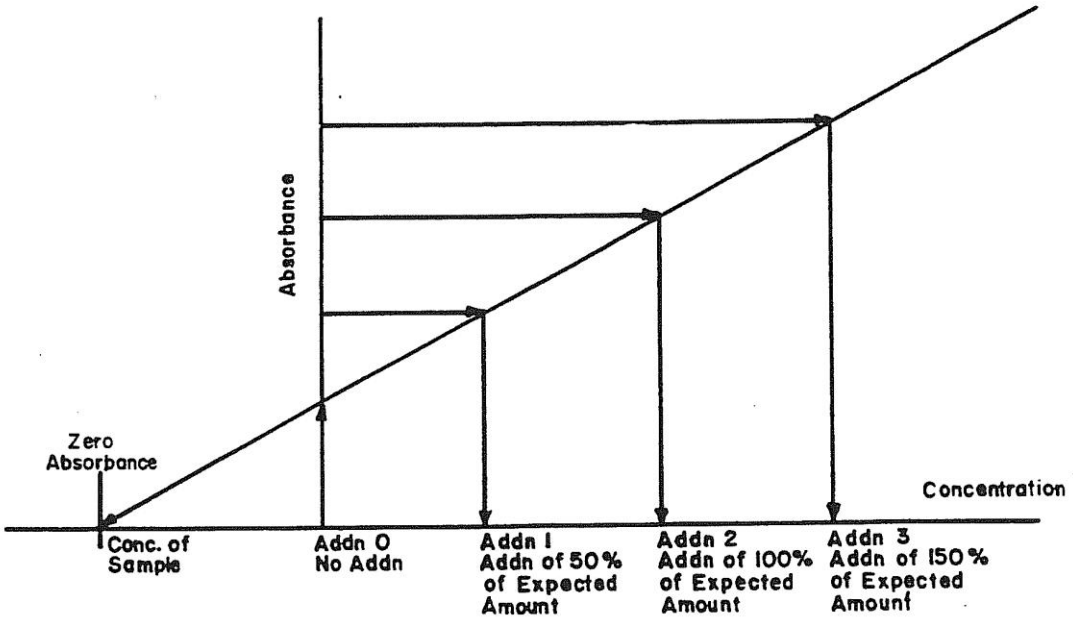
FIGURE 2

STANDARD ADDITIONS PLOT



Appendix B

Site Safety and Health Plan

AECOM

Draft Final
Site Safety and Health Plan
Military Munitions Response Program
Camp Blauvelt, Orangetown, New York

Munitions Response Site NYHQ-007-R-01
New York Army National Guard

Army National Guard

Contract No. W9133L-14-D-0001
Deliver Order No. 0006

November 2018

Signature Sheet

Site Safety and Health Plan
Remedial Investigation at
Camp Blauvelt MRS
Orangetown, New York

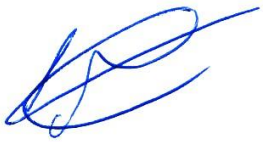
Plan Preparer:

11/6/2018

Victoria Kirkpatrick
Project Support
(30) 820-3624

Date

Plan Concurrence:



11/6/2018

Alberto Munuera
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Date

Plan Approver:

11/6/2018

Rosa Gwinn
Project Manager
(301) 820-3123

Date

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Tables

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Attachments

List of Acronyms and Abbreviations

°F	degrees Fahrenheit
AHA	Activity Hazard Analysis
bpm	beats per minute
CFR	Code of Federal Regulations
CPR	Cardiopulmonary Resuscitation
DEET	diethyl-m-toluamide
DU	Decision Unit
EM	Engineering Manual
EZ	exclusion zone
HAZWOPER	Hazardous Waste Operation and Emergency Response
HSEMS	Health, Safety, and Environment Management System
HSM	Health and Safety Manager
ISM	Incremental sampling methodology
MC	munitions constituent
MMRP	Military Munitions Response Program
MRS	Munitions Response Site
MSE	Medical Surveillance Evaluation
OSHA	Occupational Safety and Health Administration
PM	Project Manager
PPE	Personal Protective Equipment
RAC	Risk assessment code
RI	Remedial Investigation
SDS	Safety Data Sheet
SOP	standard operating procedure
SPF	Sun Protection Factor
SSHP	Site Safety and Health Plan
SZ	Support Zone
TLV	Threshold Limit Value
TZ	Transition Zone
USACE	United States Army Corps of Engineers
WBGT	Wet Bulb Globe Thermometer
WP	Work Plan

SECTION ONE: INTRODUCTION

The following Site Safety and Health Plan (SSHP) is intended solely for use during the field activities to be performed as part of the remedial investigation (RI) at Camp Blauvelt Munitions Response Site (MRS). Camp Blauvelt is located within Blauvelt State Park in Rockland County, New York, approximately 0.5 miles west of the Tappan Zee Bridge. Based on results of Site Inspection (SI), the Army National Guard (ARNG) determined an RI should be conducted under the Military Munitions Response Program (MMRP). The objective of the RI is to determine the nature and extent of munitions constituents (MC) at six range features at the MRS. Soil sampling will be performed to determine if metals associated with small arms training remain in soil at firing line and target walls in concentrations that would pose a risk to human health and the environment. Specifications herein are subject to review and revisions based on actual conditions encountered in the field.

This SSHP provides the basis for health and safety requirements, guidelines, and procedures that will be used at Camp Blauvelt during the planned field activities. This SSHP provides a site description, hazard/risk analysis, staff organization, personal protective equipment (PPE) to be used, standard operating procedures, site control measures, decontamination procedures, emergency response plans, and site record keeping requirements. This SSHP will be updated should new tasks be added.

SECTION TWO: PROJECT AND SITE DESCRIPTION

2.1 SITE DESCRIPTION

The Camp Blauvelt MRS is a former small arms range located in Blauvelt State Park, approximately 0.5 miles west of the Tappan Zee Bridge (**Figure 1**). The 447-acre MRS is owned by the Palisades Interstate Park Commission as part of Blauvelt State park, and contains vastly undeveloped, forested land. Range features are located in the central and northern portion of the MRS. There are a few residential properties within the southwester portion of the MRS, outside of the area used for former firing activities, and a water tower on the southern border of the MRS. Hiking and biking trails are maintained within the MRS. Camp Bluefields Road, a former carriage road, also transcends the MRS.

The former range includes concrete target walls 200, 300, 600, and 1,000 yards from the firing line. The range also includes concrete bunkers, interconnected aboveground and underground tunnels, and observation areas. Additionally, an earthen berm with target structures exists 800 yards from the firing line. The direction of fire of the rifle ranges was to the east/northeast (Figure 2). A hillside exists east of the 1,000-yard target wall that acted as a natural backstop during firing. The MRS surface is undulating with steep elevation change. The eastern portion of the MRS is comprised mostly of rocky surface without soil cover. The soil in the western portion of the MRS is gravelly silt loam on undulating steep slopes.

2.2 PROJECT DESCRIPTION

This purpose of the RI field work is to collect sufficient information to characterize the nature and extent of metals MC (lead, copper, antimony, and zinc) resulting from former military activities at the MRS. Data collected during field activities will be used to evaluate human health and environmental risks from metals MC. The results of the RI will be used to develop future remedial action alternatives as part of the Feasibility Study and support informed risk management decisions.

In coordination with the ARNG and stakeholders, AECOM will mobilize field teams typically comprising two to four scientists to the MRS. Field teams will have the requisite qualifications, including Hazardous Waste Operations and Emergency Response (HAZWOPER) certification, first aid/CPR, and ARNG-required security training. Each scientist will understand the WP and SSHP, and have training in sampling techniques and munitions awareness (Recognize, Retreat, Report). The field event will be 1 week or less in duration. At the Camp Blauvelt MRS AECOM will determine the lateral extent of MC and establish decision unit (DU) boundaries based on X-ray fluorescence (XRF) analysis of the surface soil. To determine vertical extent of MC, AECOM will collect subsurface soil samples by hand auger at select locations where XRF readings at the surface exceed screening thresholds. Based on DU boundaries, surface soil samples will be collected with hand tools using incremental sampling methodology (ISM).

2.3 PHASES OF WORK

The phases of work that may be conducted include:

1. Mobilization
2. Estimate lateral extent of MC using XRF
3. Determine vertical extent of MC where XRF readings exceed screening threshold
4. Establish DU boundaries based on XRF data and collect soil samples by ISM
5. Identify background DU and collect soil samples by ISM
6. Site restoration and demobilization

SECTION THREE: HAZARD AND RISK ANALYSIS

3.1 HEALTH HAZARD CONTROL PROGRAM

An objective of this SSHP is to ensure that all operations, materials, and equipment will be evaluated to determine the presence of hazardous environments or if hazardous or toxic agents could be released into the work environment.

The Activity Hazard Analysis (AHA) tables for the project work are presented at the end of this section. The AHAs identify all activities, substances and environments that present a hazard and recommend hazard control measures.

Key elements of the AHAs that are required for a Health Hazard Control Program are:

- The written procedures and AHAs are included in this SSHP as certification of the hazard/risk assessment process
- Each AHA identifies the workplace and activity evaluated
- The AHA identifies the name of the person who prepared the AHA and certifies that the evaluation has been performed
- The analysis identifies the date of the evaluation

AECOM requires hazard identification, risk evaluation, control measures, and written procedures to manage health, safety, and environment risks on the job. Hazard and risk assessments were reviewed by the Project & Area Health and Safety Manager (HSM), Alberto Munuera, to ensure that all operations, materials, and equipment were evaluated and that the hazards and risks associated with the work will be communicated to personnel. The potential hazards associated with work on the site include chemical, physical, and biological hazards.

The Health and Safety Officer, Joe Witte, will manage the AHAs on site and with the help of the field crew, improve upon or add to existing analyses as new potential hazards are noticed. The AHAs will be reviewed daily to confirm the tasks covered; however, each time a new phase is begun, the corresponding analyses will be read to review the potential safety concerns with each team member prior to each phase of work. The Health and Safety Officer will conduct the required safety and health inspections on a daily basis.

3.2 STATEMENT OF SAFETY AND HEALTH POLICY

The written corporate SH&E Policy, signed by the CEO, includes a statement of management commitment to provide a safe and healthful workplace for all employees, and sets forth the goals of the program. The Health, Safety, and Environment Management System (HSEMS) detail the responsibilities of management, employees, and expectations for continued improvement toward a zero incident culture. The SH&E Policy and HSEMS are included in **Attachment A** to this SSHP.

Our key SH&E program expectations for this and every other project include:

- Excellence in safety-related behavior by our employees and our subcontractor personnel;

- Strong support of our safety programs by project management;
- High quality and properly targeted safety training;
- The development of appropriate health and safety programs and AHAs for all field projects;
- Reporting of all identified near misses and safety observations, including timely follow-up and corrective action implementation;
- Meeting or exceeding all client SH&E expectations; and
- Meeting or exceeding all regulatory requirements.

Thus, the AECOM accident experience objective for this project is the same as for any other: ZERO ACCIDENTS. We strive to accomplish this through established programs that require training, pre-job briefings/hazard analyses, periodic site safety inspections, mandatory follow-up of site safety violations, and, if necessary, penalties for employee non-compliance.

AECOM's primary goal is that all employees go home at the end of each workday without having sustained an injury. Additional safety objectives and goals for this task include the following:

- Conduct work in accordance with applicable OSHA, ARNG, and other applicable safety regulations;
- Complete the project with zero injuries and illnesses and no property damage;
- Provide prompt identification and correction of health and safety concerns; and
- Obtain 100 percent participation of employees in the maintenance of a safe work environment.

The AECOM SH&E Program is behavior-based, with the conviction that accidents causing injuries or illness to personnel, or having an impact on the environment, are preventable. The key to prevention is the modification of behaviors at all levels of the organization. AECOM employees have the right and the responsibility to stop work if they observe conditions or actions that are placing themselves or others at risk.

3.3 HAZARD COMMUNICATION PROGRAM

Elements of the AECOM written Hazard Communication Program are presented below and follow the guidance of U.S. Army Corps of Engineers (USACE) Engineer Manual (EM) 385-1-1 06.B.01 (USACE, 2014).

Materials to be brought onsite will have a safety data sheet (SDS) maintained in an accessible location for workers to review.

Materials anticipated to be brought onsite include:

- Liquinox (for decontamination)
- Sample preservative (nitric acid in small volumes)

As part of the Health and Safety Officer daily activities, an inventory of hazardous materials will be prepared with the quantities expected to be on site. The inventory will be updated if any

additional materials are brought on site, and as frequently as necessary to reflect accurate quantities.

Unless each container has appropriate labeling, all chemical containers will be labeled with the following information:

- Product name and identity of the hazardous chemical(s)
- Appropriate hazard warnings
- Name and address of the chemical manufacturer, importer, or other responsible party

Labels on incoming containers of hazardous materials will not be removed or defaced. Labels are also required when a hazardous substance is transferred from a primary container to a secondary container. Labels on secondary containers must indicate the product name or the names of the hazardous substances contained therein, as well as related physical and health hazards and their associated target organs. Labels may incorporate words, pictures, symbols, or combinations thereof to ensure the appropriate information is provided to the end user.

Acceptable labeling systems must include Global Harmonize Standards information including pictograms and other elements. Additional information includes the National Fire Protection Association Diamond, the Hazardous Materials Identification System, the Chemical Hazard Identification and Training system, or similar can also be present.

Employee requirements for reviewing SDS for specific safety and health protection procedures are presented.

AHAs incorporate information contained in the SDSs, which are provided in **Attachment B**.

SDS information will be followed in the use and disposal of material and selection of hazard control and emergency response measures.

The Health and Safety Officer will obtain an SDS for each chemical before it is used. SDSs will generally be received by the person ordering the product. SDSs for products frequently used should be kept on file because additional copies may not be included in repeat shipments.

The Health and Safety Officer will review each SDS when it is received to evaluate whether the information is complete and to determine whether existing protective measures are adequate.

The Health and Safety Officer will maintain a collection of all applicable and relevant material SDSs in an area that is accessible by all employees at all times. An electronic database is an acceptable method of maintaining the SDSs.

The Health and Safety Officer will replace SDSs when updated sheets are received and will communicate any significant changes to those who work with the chemical.

SDSs are required for all hazardous materials brought on site by project personnel.

General household products to be used for their specific purpose, as well as food, drugs, and cosmetics brought into the workplace for employee consumption, are exempt, as are supplies in the first-aid kit, such as isopropyl alcohol and antibacterial wipes.

Employees bringing hazardous materials on to a site or project must submit SDSs to the Health and Safety Officer. The Health and Safety Officer may restrict the use of certain hazardous

materials on a site or project due to occupational health risk, hazardous physical properties of the material, or potential employee sensitivity to odor or irritating properties of the material.

Other personnel working in the same area shall be provided with the following information on chemicals used by or provided to AECOM personnel:

1. Names of hazardous chemicals to which they may be exposed while on the jobsite.
2. Precautions the employees may take to lessen the possibility of exposure by usage of appropriate protective measures, such as ventilation or isolation of the work. In some cases, as an administrative control measure, a task may be delayed to a time when a minimal number of employees are present in the area.
3. Location of SDSs.

Employees will be trained initially and periodically when use of hazardous or toxic agents is altered or modified to accommodate changing on-site work procedures.

Training shall cover the following topics:

1. Requirements and use of the hazard communication program on the project
2. The location of all hazardous or toxic agents at the project site
3. Identification and recognition of hazardous or toxic agents on the project site
4. Physical and health hazards of the hazardous or toxic agents pertinent to project activities
5. Protective measures employees can implement when working with project-specific hazardous or toxic agents

Periodically, employees are required to perform hazardous non-routine tasks. Prior to starting work on such projects, each employee must be provided with information about hazards to which they may be exposed, as follows:

1. Specific chemical hazards associated with munitions (metals MC in soil)
2. Protective/safety measures that must be taken
3. Measures that have been taken to lessen the hazards, including ventilation, respirators, presence of another employee, and emergency procedures as applicable

Provide training to all employees who have the potential to be exposed to hazardous materials: a) at the time of the initial task assignment; b) whenever new chemicals are introduced into the workplace, and c) more frequently where required by site-specific conditions or client-specific requirements.

This training will include the following:

1. Applicable regulatory requirements
2. Location of the program, inventory, and SDS
3. Site-specific chemicals used and their hazards (chemical, physical, and health), including:

a. General characteristics of chemicals
b. Signs and symptoms of exposure

4. How to detect the presence or release of chemicals including the location, types, and usage of any portable and fixed monitoring or detection equipment and their associated alarms, where applicable
5. Safe work practices and methods employees can take to protect themselves from chemical hazards, including the use of respiratory protection
6. How to read a SDS
7. Site- or project-specific information on hazard warnings and labels in use at the location, if applicable
8. Site-specific evacuation and rescue procedures in the event of chemical release, including the location of staging areas and personnel accounting procedures

The following documentation will be maintained in the project file:

1. Chemical Inventory
2. SDSs
3. Training records

3.4 HAZARD ASSESSMENT

The potential hazards associated with work on the site include chemical, physical and biological hazards. AECOM policies require hazard identification, risk evaluation, control measures, and written procedures to manage health, safety, and environment risks on the job. Hazard and risk assessments were conducted by the HSM to ensure that all operations, materials, and equipment were evaluated and that the hazards and risks associated with the work will be communicated to personnel.

Written procedures addressing each identified hazard and AHAs for each critical task were prepared (**Section 3.8**). These procedures and AHAs are included in this section as certification of the hazard/risk assessment process.

Risk Assessment Codes (RACs) were assigned using Department of the Army methods, taking into account the mitigation of risk by instituting the controls and procedures described herein. The Health and Safety Officer will manage the AHAs on site and with the help of field personnel, improve upon or add to existing analyses as new potential hazards are noticed. The AHAs will be reviewed daily to confirm the tasks covered; however, each time a new phase is begun, the corresponding analyses will be read to review the potential safety concerns with each team member prior to each phase of work. The Health and Safety Officer will conduct the required safety and health inspections.

3.5 CHEMICAL HAZARDS

Based on prior studies, contaminants of concern on the site have been determined to include the metals (lead, copper, antimony, and zinc). The main routes of exposure for field personnel

include inhalation, ingestion, skin or eye contact, and dermal absorption of contaminants in soil. In order to protect site personnel from the hazards associated with site contaminants of concern, a personal protection program will be implemented to control potential chemical exposures.

3.6 PHYSICAL HAZARDS

There is a risk of injury from physical hazards at the site. Personnel should be aware of the fact that when protective equipment is worn, visibility, hearing, and manual dexterity are impaired. Slips, trips, and falls are the most common cause of on-site injuries.

3.6.1 Slip/Trip/Fall Hazards

As with any field project, uneven work surfaces and other slipping or tripping hazards may be present. Tripping is the most likely physical hazard that will be encountered. The terrain at the Camp Blauvelt MRS is mostly clear with some tall grasses, shrubs, and small trees. Personnel must use caution when walking on unstable or uneven terrain. Proper site housekeeping, removal of trash, and orderly stacking and removal of materials will reduce slipping and tripping hazards. Proper site housekeeping will be the responsibility of all site personnel. The Health and Safety Officer will conduct regular inspections assessing slip, trip and fall hazards.

3.6.2 Hand Tools and Portable Equipment

Field personnel will use hand tools and portable equipment during field activities. To prevent possible injury to the body, some general guidelines should be applied:

1. Keep tools in good repair and used only for the task for which they were designed.
2. Remove damaged or defective tools from service.
3. Keep surfaces and handles clean and free of excess oil to prevent slipping.
4. Do not carry sharp tools in pockets.
5. Clean tools and return to the toolbox or storage area upon completion of a job.
6. Do not throw tools from place to place, from person to person, or drop from heights.
7. Use non-sparking tools in atmospheres with flammable or explosive characteristics.
8. Inspect all tools prior to start-up or use to identify any defects.

3.6.3 Portable X-ray Fluorescence Analyzer

The U.S. Department of Agriculture's (USDA) Office of Homeland Security & Emergency Coordination Radiation Safety Division has guidelines for the use and possession of portable X-ray fluorescence analyzers. In addition to following the all recommendations for use outlined in the manufacturer's user manual, field personnel will conform to the following as specified by the USDA (USDA, 2017):

- All servicing or cleaning of an XRF analyzer involving exposure of the radioactive sources must be performed by the manufacturer or by an authorized representative of the

manufacturer. Note: XRF analyzer models used during this project will be tube based and not contain a radiation source.

- Before removing the XRF analyzer from its place of storage, make sure it is locked in the transport case.
- When transporting the XRF analyzer in a vehicle, block and brace it to prevent shifting or movement, and lock the XRF in the vehicle when it is unoccupied.
- When the indicator light is flashing, and the shutter is open, the primary x-ray beam is on and radiation is being emitted from the front of the XRF analyzer.
- When the radiation shutter is open:
    - do not place hands, feet, or other body parts in the radiation field;
    - do not look into the beam path;
    - do not point the XRF at anyone;
    - do not hold the XRF from the front.
- After completing each measurement, immediately close the radiation shutter.
- Always maintain the XRF analyzer under constant view and immediate control when it is not in storage. At job sites, do not walk away from the XRF when it is left on the ground.
- When the XRF analyzer is not in use at a temporary job site, it must be securely locked in the operator's vehicle (or other appropriate locked storage location).
- Return the XRF analyzer to its proper locked storage location at the end of the work shift.

The model of XRF used will be tube based and will not contain a radiation source. Field personnel will wear radiation dosimeters during XRF use to monitor exposure. Dosimeter data will be downloaded and reviewed at the end of each field day. Field personnel will review AECOM Radiation safety policy S3AM-120-PR1 (Attachment D) and take the online safety training provided by ThermoScientific on "Radiation Safety for X-ray Tube Based Instruments" prior to working with XRF analyzers.

3.6.4 Hand Safety

Personnel are to perform work that could expose them to hand injury. All personnel are to wear protective gloves specific to their task at hand. If cold conditions exist, glove liners should be worn underneath all protective gloves. Physical protection gloves (i.e., leather) should be worn as necessary. Hands are to be kept clean to prevent slipping and contamination. Hand tools should be kept in good repair and sharp tools should be handled with extra care. All tools should be properly stored. The use of fixed open blades is prohibited.

Nitrile gloves will be worn when contact with contaminated soil or water is anticipated. If both chemical and physical protection are required, nitrile will be worn under the leather or work gloves.

3.6.5 Manual Lifting

Back injuries are among the leading occupational injuries reported by industrial workers. Back injuries such as pulls and disc impairments can be reduced by using proper manual lifting techniques. Leg muscles are stronger than back muscles, so workers should lift with their legs and not with their backs. If the load is too heavy, workers should not attempt to lift it alone. Lifting is always easier when performed with another person, and manual or mechanical assistance should always be used when it is available.

The following guidelines will be followed whenever lifting objects that are of odd size or shape, or that weigh over 50 pounds.

1. Get help when lifting heavy loads. Heavy loads will only be lifted using a two-person lift.
2. When moving heavy objects such as containers, use a dolly or other means of assistance.
3. Plan the lift. If lifting a heavy object, plan the route and where to place the object. In addition, plan communication signals to be used (i.e., "1, 2, 3, lift," etc.).
4. Wear sturdy shoes that are in good condition and supply traction when performing lifts.
5. Keep your back straight and head aligned during the lift and use your legs to lift the load; do not twist or bend from the waist. Keep the load in front of you; do not lift or carry objects from the side. Keeping the heavy part of the load close to your body will help maintain your balance.

3.6.6 Noise

The use of heavy equipment is not anticipated, and no investigation activities are anticipated to produce noise at or above the action level of 85 decibels on the A-weighted scale. However, should conditions warrant, all AECOM personnel within 25 feet of operating equipment, or near an operation that creates noise levels high enough to impair conversation, shall wear hearing protective devices (either muffs or plugs). AECOM personnel who are in the Medical Surveillance program are automatically enrolled in the AECOM Hearing Conservation Program and have had baseline and, where appropriate, annual audiograms. Personnel will wash their hands with soap and water prior to inserting earplugs to avoid initiating ear infections.

3.6.7 Temperature Extremes

Local weather conditions and the required use of PPE may produce an environment that requires restricted work schedules to protect employees from heat or cold stress. The Health and Safety Officer will observe workers for any potential symptoms. Please see **Section 8** for more information on heat and cold stress.

3.6.8 Other Weather-Related Hazards

Other weather-related hazards include heavy rains, damaging winds, thunderstorms, tornados, floods, wildfires, and lightning, etc. These hazards correlate with the season in which site activities occur. Weather forecasts will be checked prior to site work each day on the National

Oceanic and Atmospheric Administration website and will be monitored throughout the day by cell phone or radio. If threatening weather conditions are predicted, the Health and Safety Officer will determine if work can continue without endangering the health and safety of site personnel by using the following guidelines:

1. Potential for lightning strikes
2. Potential for heat or cold stress
3. Limited visibility
4. Inclement weather-related working conditions
5. Roads becoming impassable

Outside work will be suspended during severe weather, including electrical storms. The Health and Safety Officer will monitor storms and activate a lightning safety plan at the count of 30 seconds from the flash to the bang (6 miles away) and activities will not resume for 30 minutes from the last observed strike. This is called the 30:30 Rule. Personnel will seek shelter in the vehicles or a nearby building, as designated during the morning safety briefing.

3.6.9 Flammable and Combustible Materials

All work areas shall be kept free of unnecessary debris. No flammable and combustible liquids will be brought on site. During all on-site activities, the following practices will be used for fire prevention and protection:

1. Smoking on site is prohibited in designated work areas and other areas where smoking may create a fire hazard (e.g., dry vegetation)
2. A designated smoking area will be established when operations on site begin
3. Fire extinguishers will be available at all work and support areas
4. A fire extinguisher will be available in all project vehicles (10-B:C)
5. Fire extinguishers will be inspected monthly
6. Defective firefighting equipment will be replaced immediately
7. Fires or open flame devices are prohibited on site

All employees will be trained in the use of fire extinguishers and the hazards involved in incipient stage firefighting before being allowed to work on the project site as per 29 Code of Federal Regulations (CFR) 1910.157(g)(1)

Only fires in the incipient stage will be addressed using portable fire extinguishers. Regardless of the size and nature of the fire, and the Team's ability to respond, all fires will be reported immediately to the local fire department

For this project, fire extinguishers will be placed in each motor vehicle (10B:C) one ABC rated extinguisher will be available (2A:20B:C). Only UL-listed extinguishers will be used.

The potential for fire will be low; if a fire should occur, it would be expected to fall into Class A, B, or C. These classifications are defined as follows:

- **Class A** – Fires in ordinary combustible materials such as wood, cloth, paper, trash, rubber, and plastic.
- **Class B** – Fires in flammable liquid, oil, grease, tar, oil-based paint, lacquer, and flammable gas.
- **Class C** – Fires involving energized electrical equipment or systems, resulting in the extinguishing media conducting electricity. When electrical equipment or systems are de-energized, extinguishers for Class A or B fires can be used safely.

Extinguishers are rated according to the classification and size of the fires against which they are effective. Extinguisher ratings are found on the extinguisher label. A rating consists of a letter indicating the classification of fire on which the extinguisher is effective and a rating number indicating the relative extinguishing effectiveness. The significance of the rating number varies with the classification of fire for which the extinguisher is rated. The following rating criteria are used:

For extinguishers rated for Class A fires, the rating number indicates relative effectiveness, the higher the number, the more effective the extinguisher. The minimum recommended rating for extinguishers rated for Class A fires is 2A.

For extinguishers rated for Class B fires, the rating number represents the average size (in square feet) of the fire the extinguisher could put out.

No number is used for extinguishers rated for Class C fires, because Class C fires are essentially either Class A or B fires involving energized electrical wiring and equipment.

3.6.10 Illumination

It is expected that site activities will be conducted only during daylight hours.

3.6.11 Vehicle Safety

Personnel must use caution when operating personal or company vehicles. The following field/site vehicle safety items should be followed:

1. All staff members operating a motor vehicle must possess a current, valid driver's license. AECOM authorized drivers have completed the AECOM vehicle safety either online or through one of the approved training resources.
2. All local speed limits and traffic regulations will be followed. Headlights will be used from sunset to sunrise, during fog, or other unfavorable conditions. All uncontrolled intersections (no traffic lights or traffic signs) will be treated as a four-way stop. The driver will exercise extreme caution at uncontrolled intersections.
3. Cell phone use (even with a hands-free device) is prohibited when driving. The use of any other portable headphones, earphones, or other listening devices is also prohibited. Operators will not eat, drink, or smoke, while the vehicle is in motion. Driving includes the time spent in traffic or while stopped at red lights or stop signs. If a Global Positioning System (GPS) is used, it must be mounted such that it does not interfere with the driver's range of vision. The GPS will not be programmed while driving. GPS units

and GPS units on smart phones may only be used if factory installed or secured to the vehicle with a bracket that allows the driver to view the image without having to take their eyes off the road.

4. Rental vehicles are maintained by the rental company and inspected prior to release. Drivers are responsible for inspecting the vehicle prior to use. Basic safety checks include tire condition/pressure; lights; turn signals; a clean windshield and adequate window washer fluid; gauges/warning lights indicating normal condition; mirrors properly adjusted; and brakes with adequate pedal pressure for proper breaking. Form SAM-005-PR will be used to document the inspection on a weekly basis.
5. Specific vehicle travel routes and parking areas will be identified at field sites. Traffic cones, or other markings, will be used as needed, to define roads and parking. If parking on the shoulder of an active road, employees will park as far off the road as possible. If work is required alongside an active road, park the vehicle behind the area of work to provide a barrier against out of-control vehicles.
6. The operator and all passengers shall use seat belts at all times when a motor vehicle is in motion. No employee may ride in the bed of a pickup truck unless seating and restraints are provided for this specific use. Articles, tools, equipment, etc. placed in vehicles will be stored so as not to interfere with vision or the proper operation of the vehicle in any way. All items in the vehicle must be secured to prevent them from flying about or out of the vehicle during sudden stops, turning, etc.
7. Trucks or vehicles with obstructed rearview mirrors must observe the following procedures when backing up: Position an employee to act as a spotter at the rear of the vehicles, in the driver's line of sight, to ensure that the area behind the truck is clear. If no other employee is present, then the driver must step out of the vehicle and check the area behind the vehicle before backing up. As an added precaution, avoid backing up whenever possible.

3.7 BIOLOGICAL HAZARDS

Potential biological hazards at Camp Blauvelt include bloodborne pathogens, hantavirus, reptiles, invertebrates, mammals, and plants. Employee awareness and knowledge of the potential biological hazards will help reduce the risks associated with these hazards. Biological agents that may cause health hazards are diverse; consequently, their health effects are also diverse.

3.7.1 Bloodborne Pathogens

During site activities, workers can potentially be exposed to bloodborne pathogens when rendering first aid or Cardiopulmonary Resuscitation (CPR). Avoiding contact with biological agents is the best way to prevent adverse health effects caused by them. Recognition of potential hazards is essential. As a general rule, employees will not come into contact with any item that may appear to result from medical waste disposal. When avoidance is impractical or impossible, such as when administering first aid, PPE and personal hygiene will be used to prevent adverse effects. Employees designated to perform tasks involving occupational exposure including

designated first-aid providers, shall receive bloodborne pathogens training at the time of initial assignment to the job.

Employees are at risk of contracting infectious diseases each time they are exposed to bloodborne pathogens. Any exposure incident may result in infection and subsequent illness. Since it is possible to become infected from a single exposure incident, it is the practice of AECOM to prevent exposure incidents whenever possible.

To ensure employees are effectively informed concerning potential workplace health hazards, and in accordance with the requirements set forth in 29 CFR 1910.1030 and EM 385-1-1 Section 3, AECOM has established an exposure control plan for bloodborne pathogens. The purpose of this plan is to identify those tasks and procedures for which occupational exposure to bloodborne pathogens may occur, to identify the positions whose duties include those tasks, and to implement controls that will significantly reduce the risk of infection by bloodborne pathogens. The plan also includes provisions for affected employees to receive Hepatitis B vaccinations, training, and, if necessary, confidential medical evaluations and follow up.

The site-specific exposure control plan includes:

- Work practice controls: Provide adequate supplies for providing first aid and CPR, and treat all contact with human blood and bodily fluids as potentially infectious. Hand washing facilities/supplies shall be readily accessible for all employees.
- PPE: Provide PPE at no cost to the employee. Typical equipment includes, but is not limited to, gloves, face masks, eye protection, and CPR shield. PPE will be considered appropriate if it does not permit blood or other potentially infectious materials to reach or pass through clothes, skin, or mucous membranes of the eyes or mouth under normal conditions of use and for the duration of time the equipment will be used. PPE must be readily accessible and will be removed prior to leaving the work area.
- Housekeeping: Use universal precautions when cleaning or decontaminating any surface or equipment that may be contaminated. Appropriate PPE will be used for protection during decontamination.
- Post-Exposure Activities:
    - Report all occupational bloodborne pathogen exposures to the Incident Hotline (800-348-5046) immediately after initial decontamination and first aid is accomplished. Following the report of an exposure incident, a confidential medical evaluation with an occupational physician will be arranged as soon as possible, ideally no later than 1-2 hours after the incident has occurred.
    - Report incident to Health and Safety Officer, Project Manager (PM), and HSM.
    - Make initial notification in IndustrySafe (https://www.industrysafe.com/AECOM/) within 24 hours.
    - AECOM PM will verbally notify the COR of an incident as soon as reasonably possible, but not more than 24 hours after the incident.

The Hepatitis B Vaccination series will be made immediately available to employees who have had an occupational bloodborne exposure incident, whether as a result of their assigned tasks, or

occurring as a result of incidental contact. An employee who declines the vaccination must sign a waiver form.

3.7.2 Hantavirus

Wild rodents (rats and mice) can be infected with hantavirus and pass it in their droppings, urine, or saliva. Avoid touching urine and droppings, or places where these animals have nested. Also, avoid disturbing dried droppings or urine, which can be stirred up in dust and inhaled.

Acute illness may be characterized by the abrupt onset of fever, myalgias, headache, and cough, followed by the rapid development of respiratory failure. Anyone with a potential exposure who develops a rapidly progressing, severe viral illness or unexplained adult respiratory distress syndrome should be evaluated for possible hantavirus infection.

3.7.3 Invertebrates

A large variety of invertebrates may be encountered at Camp Blauvelt including ticks, bees, hornets, wasps, mosquitoes, and spiders.

3.7.3.1 Ticks

Ticks typically have a three stage life cycle, larvae, nymphs, and adults. Ticks are most active in spring and early summer and are most common in open forests. At each stage of life the tick climbs to the top of grasses or shrubs (behavior known as questing). The tick extends its front legs, grabs hold of a passing animal and immediately starts looking for a place to attach, usually traveling upward. The ticks then attach with barb-like mouth parts and begin sucking blood. After one to two days of feeding the ticks drop off, molt and move to the next life stage.

The biological hazard associated with a tick bite is the possibility of contracting Lyme disease. Lyme disease is caused by bacteria called *Borrelia burgdorferi*. This bacterium inhabits the digestive tracts of Black-Legged Ticks, commonly known as a "deer tick." When ticks bite humans, the bacteria can be transmitted to the people. It typically takes 24 hours or more before the Lyme disease bacteria will enter the host, therefore prompt tick identification and removal is important to the prevention of contacting Lyme disease from a tick.

Typical short-term symptoms of Lyme disease include headache, fever, fatigue, and muscle pain that can be characteristic of the flu. A key diagnosis point is a distinctive "bulls-eye" rash, where the redness assumes a ring-shaped pattern that appears a day to a month after the tick bite. If personnel observe the rash, the Health and Safety Officer will take the site worker to get medical observation and treatment. At this initial stage Lyme disease is easily treated with a several week regimen of antibiotics. If left untreated, Lyme disease can spread to the heart, nervous system, and joints. Long term Lyme disease sufferers can have a huge list of varied symptoms including meningitis, brain inflammation, muscle twitching, chronic joint pain, arthritis, and even memory loss. Long term Lyme disease can be misdiagnosed as multiple sclerosis or even Type II diabetes.

Personnel should use the following prevention tactics when working outside:

1. Dress in light-colored clothing to make adhering ticks more visible. Wear long-sleeved shirts and tuck pants into or tape around socks.
2. Use a tick repellant containing DEET (diethyl-m-toluamide). Spray repellant containing 100% DEET onto clothing around wrists and ankles and on a head/neck covering; and repellant containing 30% DEET onto exposed skin.
3. Perform self-searches routinely when in the field to check for ticks.
4. Check body areas where ticks are commonly found: behind the knees, between the fingers and toes, under the arms, in and behind the ears, and on the neck, hairline, and top of the head. Check places where clothing presses on skin.
5. After work, place clothing in hot dryer to kill any loose ticks.
6. Shower and perform a careful whole body search for ticks.
7. If any ticks are found attached, remove using fine tweezers or a "tick tool".
8. Report tick bites and attached ticks to the Incident Hotline (800-348-5046).
9. If a tick is observed on the skin with the head burrowed, remove the tick by firmly grasping the tick's mouthparts at the skin with tweezers, and pulling straight out. Try to avoid squishing the body as this forces more digestive juices into the host, increasing the chance of infection. Ticks may be difficult and painful to remove. The Health and Safety Officer or another First Aid trained coworker may need to assist in this removal.
10. Wash the bite site with soap and treat the bite with an antiseptic. If any symptoms of Lyme disease are present, inform the Health and Safety Officer and seek medical care.

3.7.3.2 Bees, Hornets, and Wasps

Stings from bees, hornets, and wasps cause more deaths than bites and stings from all other insects and spiders. Death is usually a result of an allergic reaction. Other stinging insects include mud daubers. Though the sting from these insects can be extremely painful they are rarely serious.

Honeybees are the only stinging insects that leave a stinger in the wound. Other bees can sting repeatedly. If stung by a bee, check the wound to see if the stinger is still there. The stinger will be clearly visible. If the stinger is still there, scrape or flick it out with something stiff like a credit card. Do not try to pull the stinger out as squeezing injects more venom into the wound. Usual symptoms include a burning pain and swelling.

Unusual symptoms can signal the onset of an allergic reaction. There are two types of allergic reactions. In the first type, the bite or sting site becomes excessively swollen and the patient may experience nausea, vomiting, dizziness, and headache.

The second type of allergic reaction can be life-threatening. A severe reaction can cause body-wide skin itching, hives, or puffiness of the eyes, nose, lips, tongue, and throat. Abdominal pain and vomiting may develop. Breathing difficulties are common. The patient may collapse and go into shock. This kind of reaction presents a true medical emergency.

Allergic reactions usually do not develop after the first sting. After a second or third sting, a reaction can develop. It is difficult to predict whether a person will have a life-threatening allergic reaction. If you or family members are very allergic or have asthma, you are more likely to be allergic to stings and should be careful around stinging insects.

If breathing difficulties, difficulty swallowing, and/or body-wide itching develop, the patient is having a severe allergic reaction and should receive medical attention. If the reaction is not severe, wash the bite or sting area well with soap and water to help prevent infection. If stung or bitten on fingers or hand, remove any rings or jewelry in case of swelling. Your local pharmacist can help you select the best over-the-counter medications to help treat insect and spider bites.

To prevent bee and wasp stings, the following precautions will be taken during field activities:

1. Be aware of the presence of bees and wasps while you are working especially in the vicinity of flowers. Bees tend to sting if they feel threatened or are disturbed.
2. Avoid wearing floral patterns or using floral scents, which will attract bees.
3. Do not leave food, drinks, or garbage out and uncovered.
4. Personnel that are sensitive to bees must make the Health and Safety Officer aware of this and should carry a bee sting kit with them. Wear a Medic-Alert bracelet if extremely allergic to bee or wasp stings.
5. If you are allergic, ask your physician about prescribing an emergency epinephrine kit have on hand.
6. If bees or wasps get trapped inside your vehicle while you are driving, pull over to the shoulder and let the creature escape before you continue driving.
7. Only strike a wasp or bee if you are sure to kill it. If you strike or kill a wasp or bee you will set off its defense pheromone, which will bring unhappy relatives calling.
8. In the event of a mass sting attack, try to stay calm, cover your head if possible, and run steadily to safety. Get into anything that is sealed in such a way as not to allow insect entry, such as a vehicle.
9. All bee stings include an alarm pheromone, which incites their mates to attack, so step one is to get away from a nest/hive quickly. Scrape out stingers as soon as possible. A honeybee sting has a pump attached that continues to introduce venom for 1 minute after stinging. A wasp does not leave its stinger.
10. Apply an ice pack to minimize pain and swelling. Lift limb to heart level to reduce swelling. If the victim has been stung multiple times, is young or old, or is one of the 1% that is super sensitive to stings, watch for signs of systemic allergies. These may include:
    - Headaches;
    - Fever;
    - Nausea;
    - Vomiting;
    - Swelling of the tongue or throat;

- Difficulty in breathing;
- Cramps;
- Drowsiness; or,
- Unconsciousness.

Personnel with known sensitivity to stings should have an epinephrine kit and have it administered, followed by an ice pack and a visit to a hospital. Employees on the site who know they are allergic to bee stings should make the Health and Safety Officer and co-workers aware of that fact, and should have their epinephrine kit with them at all times. Co-workers should know where the kit is located and how to administer it in an emergency. Bee stings can be sensitizers and allergies can develop over time. Because a person has been stung in the past and has had no reaction, does not necessarily mean that the next sting will not bring on an allergic reaction. All employees will be made aware of the symptoms of anaphylactic shock, so that they can recognize it in themselves and co-workers and act accordingly.

3.7.3.3 Mosquitoes

Mosquitoes are responsible for more human deaths than any other living creature. World-wide, nearly four million people die each year from various mosquito-borne diseases.

The mosquito life cycle consists of eggs, larvae or "wrigglers," pupae or "tumblers," and adults. All life stages except adults are aquatic and can occur in a variety of wet or moist places, such as ponds, sloughs, standing pools of water, salt water marshes, artificial containers, hollow trees, low depressions of land, and moist areas of fields, bogs, and forests. Only the female mosquito bites to obtain a blood meal. The male mosquito feeds only on plant juices. The female mosquito may live as long as three weeks during the summer or many months over the winter in order to lay her eggs the following spring.

The majority of mosquitoes spend the winter as eggs within the specific habitat where they will eventually develop into larval, pupal, and adult stages. This means that female adults deposit eggs during late summer in the habitats mentioned above. These eggs then lie dormant throughout the winter until water temperatures are warm enough for hatching to occur the following spring. Mosquito eggs can sometimes lie dormant for several years, particularly when the eggs are deposited in depressions that are not flooded with water each year.

To prevent mosquito bites wear long sleeves, long pants and a hat; go where mosquitoes are not; or use bug dope (or another form of repellant) with 30% DEET. Apply repellent whenever you are outdoors, even for a short period of time. Choose repellents based on how long you plan to be outside and what you will be doing. When you are sweating, physically active, or getting wet, repellents do not last long.

For people sensitive to mosquito bites or are allergic to DEET it is recommended that they wear a head net or special anti-mosquito gear. The Health and Safety Officer should be notified of anyone with a severe allergy to mosquitoes in case of an emergency.

3.7.3.4 Other Invertebrates: Spiders and

In New York, there are common occurrences of two species of venomous spiders which are moderately poisonous to humans. The two species, *Cheiracanthium milidei* and *C. inclusum*, are both small, pale, yellow spiders commonly known as yellow sac spiders. Additionally, there are occurrences of black widow spiders; however, these are much less common.

Yellow Sac Spider (*Cheiracanthium milidei*)
Photo credit: Lousiana Office of Public Health

Sac spiders are usually light colored spiders with noticeably protruding spinnerets and dark fangs. These spiders do not weave capture webs for prey so are often times found wandering through vegetation and buildings. Although the bites are relatively painless, the venom of these spiders is necrotic and causes itchy or painful ulceration sores that are slow healing, similar to that of a brown recluse spider. Further systemic reactions are possible which include fever, malaise, muscle cramps, and nausea. Due to similar bite marks and symptoms, bites attributed to the brown recluse are almost certainly from sac spiders as the brown recluse spider is not naturally found in the state of New York. Black widow spiders are very numerous in nearly all parts of the U.S., but cases of reported bites are not common. For the most part, black widows live peacefully in close proximity to humans with little contact. The black widow appears shiny and hairless to the naked eye. The body ranges from a deep glossy black to an occasional dark brown to a reddish brown. The underside of the abdomen has a distinct red or orange hourglass shape. In immature spiders, the color can vary and the hourglass may be white or missing. The black widow bite is sharp and painful, and victims should seek immediate medical attention. The first sign of a bite is acute pain at the site of the bite, with more symptoms following 20 minutes to one hour later.

Black widow
Photo credit: Oklahoma Cooperative Extension Service

If bitten by a brown recluse or black widow:

1. Use soap and water to clean the wound and skin around the spider bite.
2. Apply a cloth dampened with cold water or filled with ice.
3. Seek immediate medical attention.

3.7.4 Venomous Snakes

According to the New York Department of Wildlife and Conservation, New York is home to a seventeen species of snakes, three of which are venomous.The venomous snake species of New York include the Timber Rattlesnake (*Crotalus horridus)*, the Eastern Massasauga (*Sistrurus catenatus*), and the Copperhead

(*Agkistrodon contortrix mokasen*)[1], all of which are uncommon. Generally, these snakes are not aggressive unless threatened or provoked.

The Timber Rattlesnake is the largest venomous snake in the state of New York, ranging from three to four and a half feet (36 to 54 inches) long. There are two common color patterns commonly found in the Timber Rattlesnake: a yellow phase, which includes black or dark brown crossbands on a lighter yellow base, and a black phase, which has dark crossbands on a dark base. The dark stippling can be heavy in some individuals, making them appear all black. The head is broad and triangular shaped with many scales on the crown of the head. The rattle is made of loosely attached horny segments on the base of the tail which makes the characteristic buzzing sound and vibration when disturbed. It is somewhat mild in disposition and will often rattle and feint before striking. Timber Rattlesnakes are active from late April until mid-October and can generally be found in deciduous forests and mountainous areas with rugged terrain. Their venom is considered a hemotoxin and, if bitten, skin around the bite will typically swell and turn black[2]. If left untreated, a bite from this snake can be lethal to humans.

Timber Rattlesnake
Photo credit: State University of New York (SUNY) College of Environmental Science and Forestry

The Eastern Massasauga Rattlesnake is the smallest of the three venomous snakes in the state of New York, averaging about 27.5 inches long. Adults are stout-bodied with a broad head. Their background and base coloration is gray or brownish-gray. The body markings are distinct with a row of large black or dark brown hourglass-shaped markings along the back as well as three rows of smaller dark spots on each side. The Massasauga, also known as the "swamp rattler", prefers wet habitats, including riverine bottomlands. There are only two known populations remaining in New York, both occurring in boggy, forested wetlands. Although normally active during the day, this docile snake tends to only strike humans when threatened or cornered. Bites can be painful and leave markings on the skin, but are generally not life threatening.

Eastern Massasauga
Photo credit: State University of New York (SUNY) College of Environmental Science and Forestry

The Copperhead is the only of the three venomous snakes without a rattle, but will still vibrate their tails when threatened. This snake generally averages two to three feet long and have a characteristically diamond-shaped, coppery-red head. Distinct reddish-brown and chestnut-colored bands, each shaped like an hourglass, are patterned along its body, being wide on the sides and narrowest across the back. The Copperhead is found in similar habitats to that of the Timber Rattlesnake, generally staying in wooded and mountainous areas.

[1] New York State Department of Environmental Conservation. http://www.dec.ny.gov/docs/administration_pdf/snakes.pdf accessed January 2018.

Bites usually just lead to temporary tissue damage around the localized area of the bite. Although painful, Copperheads are the least venomous of the put vipers, and a bite is not enough to kill a healthy adult.

The possibility of venomous snakes will be communicated to site personnel during the initial site-specific safety training. Site personnel will be warned to avoid snakes and their preferred habitats, particularly rocks, timber piles, and animal burrows. Site personnel will be required to wear sturdy steel-toed work boots. If there is a snake bite, call 911. First aid will be administered while awaiting transport of the victim to the hospital for emergency treatment.

First aid for snake bites:

1. Immobilize the bitten arm or leg and have the victim stay as quiet as possible to keep the poison from spreading through the body
2. Remove jewelry before swelling starts
3. Position the person so that the bite is at or below the level of the heart
4. Cleanse the wound and cover with a clean, dry dressing
5. Apply a splint to reduce movement of the affected area, but do not restrict blood flow
6. Do not use a tourniquet or apply ice
7. Do not cut the wound or attempt to remove the venom
8. Do not let the victim drink caffeine or alcohol
9. Do not try to capture the snake, but try to remember its color and shape

3.7.5 Mammals

Mammals such as chipmunks, ground squirrels, rats, raccoons and beaver have been known to harbor fleas carrying bubonic plague. Their bites can also transmit rabies and infections. Larger mammals inhabiting the state include the black bear, coyotes, bobcats, and the Eurasian boar.. To help avoid bears and coyotes while hiking or walking through the woods, make noise in thick cover, walk in groups, and always be aware of your surroundings. Although highly unlikely, if a black bear is encountered, do not approach the bear; quietly back away and leave the area. Always carry bear pepper spray in case a bear attempts to attack. In the event a bear becomes aggressive and approaches you, make yourself look bigger by raising your arms. Repeat "Hey bear" while backing away. If a bear starts to follow you, stay together; do not run but continue to back away. If the bear tries to charge you, stand your ground, remain calm, and dispense bear pepper spray in a circular motion. If the bear makes contact with you, fight back with anything available such as a knife, sticks, rocks, binoculars, backpack, or by kicking.

Coyotes and bobcats tend to be shy and are generally not a threat to humans, unless provoked. Similar to the bear, if you encounter a coyote or bobcat, be as big and loud as possible as to scare them away. Do not turn your back; wave your arms, clap your hands, and shout loudly.

A new threat to the state of New York, the Eurasian boar is a highly adaptable, destructive, non-native, invasive species. The boars have a long, straight, narrow snout with a long straight tail with a tuft at the end. The boar has razor sharp tusks and is known to be aggressive towards humans. They carry and can transmit several serious diseases including swine brucellosis, E. coli, trichinosis, and pseudorabies. If you encounter a boar, remain calm and move slowly away from the animal, avoiding startling or scaring it.

Eurasian Boar
Photo credit: New York State Department of Environmental Conservation

Some animals pose a special problem because people tend to try to feed them or pet them; the increased contact brings a greater possibility of danger. Avoid wildlife when possible. Identify an evacuation route and shelter when working in areas where wildlife may be encountered.

3.7.6 Plants

Hazardous plants at Camp Blauvelt may include giant hogweed, cow parsnip, wild parsnip, stinging nettle, poison sumac, and poison ivy. Contact with the sap of giant hogweed, cow parsnip, or wild parsnip followed by exposure to sun can result in painful blisters, burns, or a rash on the skin. The stinging hairs on the stems and leaves of stinging nettle can produce an intense burning or itching sensation that can last up to thirty minutes. The oil resin on the leaves and stems of poison sumac and poison ivy contains urushiol, which may cause a serious allergic reaction to the skin if touched. The oil can be transferred from contaminated clothing (typically pant legs and boots) and still cause the allergic reaction. A painful rash is created by the body's immune system. The rash shows up 12 to 48 hours after exposure and will last approximately two weeks.

Giant Hogweed

Cow Parsnip

Wild Parsnip

Photo credits: New York State Department of Environmental Conservation

Stinging Nettle

Poison Sumac

Poison Ivy

Photo credits: New York State Department of Environmental Conservation[2]

Giant hogweed can grow fifteen feet tall and have flowers up to two feet across. Giant hogweed is identifiable by white flowers with 50-150 flower rays clustered into an umbrella-shape up to two and a half feet across. In the wild, these plants typically grow seven to fourteen feet tall, but can grow taller, and are accompanied by huge, deeply lobed leaves up to five feet across. The stems are hollow, rigid, and green in color with extensive spots of purple. The stem is two to four inches thick and covered in coarse, prominent white hairs with a thick circle of hairs at the base of the stalk. The seeds are dry, flattened, and oval with tan and brown lines. Giant hogweed grows along streams, rivers, forests, yards, and roadsides. These plans prefer open sites with abundant light and moist soil. The sap contains a phototoxin that reacts with sunlight to cause skin irritations varying from a mild rash to severe blistering.

Cow parsnip grows three to ten feet tall, containing rough, hairy leaves that are 12-18 inches. The plant grows in a variety of habitats including woodlands, forest openings, grasslands, steam edges, and along roadsides. Leaves are divided into three segments, with coarsely toothed leaflets and a broad wing at the base of each leaf stalk. The stems are rough, hairy, hollow, and grooved. Cow parsnip contains white or cream colored flowers with a sweet fragrance that bloom in mid-summer. The flowers have five petals of different sizes are arranged in broad, flat-topped clusters at the top of short stalks. Like giant hogweed, the sap contains a phototoxin that reacts with sunlight to cause skin irritations varying from a mild rash to severe blistering.

Wild parsnip tends to grow along roadsides, pastures, and fields, usually standing anywhere from 2-5 feet tall. The leaves are alternate, primarily compound, and branched with saw-toothed edges. Each leaf contains 5-15 ovate to oblong leaflets with variable edges. Small, five-petaled,

[2] "Harmful Plants", New York State Department of Environmental Conservsation. http://www.dec.ny.gov/animals/105282.html, accessed January 2018

yellow flowers are arranged in a flat-topped broad umbel two to six inches across, flowering June through September. The stems are hollow and deeply grooved with a long, cone-shaped thick taproot. Similar to giant hogweed and cow parsnip, the sap contains a phototoxin that reacts with sunlight to cause skin irritations varying from a mild rash to severe blistering.

Stinging nettle is a perennial, erect herb with stinging hairs, opposite heart-shaped leaves, and small greenish flowers. Nettles can grow up to eight feet tall and prefer to grow near steams, trails, and previously disturbed areas. The stems are slender and square with occasional branches. The leaves are thin, dark green, two to four inches in length, and have a tapered tip. The leaf surface is distinctly veined and rough looking. Long, tiny clusters of flowers, usually lightly green or tan, are produced at the base of each pair of leaves. Nettles are covered in stinging hairs throughout the stem and leave. Contact with the hairs can feel similar to that of a bee sting: sharp, sudden, and quite painful. When touched, the microscopic hollow needles inject small doses of histamine and other chemicals causing a painful skin reaction, including burning, itching, or tingling for several hours.

Poison sumac is a small tree or multi-stemmed shrub with grey bark and large compound leaves, each containing 7-13 leaflets. The leaflets are not toothed and are smooth without hair. Clusters of small yellow flowers and small white berries are found on sumac, similar to that of poison ivy. Even after the leaves have fallen, the distinct hanging clusters of white berries can be seen throughout winter. Poison sumac occurs as single scattered individuals, not in groups, and grows exclusively in very wet or flooded soils, swamps, marshes, and peat bogs. All parts of the plant contain an oil that inflames the skin on contact, causing itchy blisters ad rashes. When burned, the inhalation of smoke from the leaves is extremely hazardous.

Poison ivy is identifiable by the three 3-inch deep green, ovate, sometimes coarse-toothed, shiny leaflets and has a distinguishing sticky resin on top of the leaves. The leaves are vibrant red in the early spring and late fall. The poison ivy plant grows as a lanky three to five foot high shrub or as a vine and may have tiny yellowish-white flower clusters that bloom from May to June. The plant exudes a resinous, rash-causing sap. It typically grows in rocky or shallow soil areas and often in partial shade low to the ground. Similar to poison sumac, all parts of the plant contain an oil that inflames the skin on contact, causing itchy blisters ad rashes.

Avoid any contact with the plant to prevent exposure. First aid/response to poison plant exposure:

1. Call 911 if the person has trouble swallowing or breathing; or swelling, especially near the eyes or on the face
2. Immediately wash skin thoroughly with soap and water or a product such as Technu, taking care not to touch the face or other parts of the body prior to washing
3. Wash tools and contaminated clothing in strong soap and water because the plant oils can remain active for months
4. Apply cool compresses for 15 to 30 minutes at a time
5. Oatmeal baths or the application of calamine lotion will ease itching discomfort

6. Oral antihistamine may also help, but avoid topical antihistamines, which may make skin more sensitive
7. Seek medical attention for severe cases, if the rash covers a large part of the body, or if the person has blisters or cannot sleep. Steroids may be prescribed by a physician to help stop the spread of the rash in severe cases

3.8 ACTIVITY HAZARD ANALYSES

The Activity Hazard Analyses (AHAs) below list potential hazards associated with each phase of project field work, and associated actions to eliminate or minimize the hazards.

MOBILIZATION/DEMOBILIZATION
ACTIVITY HAZARD ANALYSIS

Date Prepared: 31 October 2017

Project: Camp Blauvelt

Task: Mobilization/Demobilization

Risk Assessment Code (RAC): M

Prepared By: Joe Witte

Reviewed By: Alberto Munuera

Minimum Protective Clothing and Equipment:
PPE Level D: General work clothes, reflective vest, safety glasses, steal or composite-toe work boots, work gloves

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

SEVERITY	PROBABILITY				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	EM 385-1-1 (PARA REF)
Mobilization/demobilization of manpower, equipment and establishment of work zones.	**Biological Hazards:** Stinging and biting insects, spiders, and snakes Wild animals Poisonous plants	• Use repellents and proper clothing for protection against insects including ticks and mosquitoes • Check the area for poisonous plants and use Ivy Block • Wear long-sleeved shirts and gloves • Avoid animals, do not leave food outside • Work in pairs and stay observant of surroundings • Avoid rodent droppings as they may contain the Hantavirus • Avoid holes and rocks that are potential animal habitats • If contact with insects, animal droppings, or poisonous plants then wash area immediately • Wear protective clothing, including long pants and leather chaps as needed in areas/conditions where snakes may be active.	03.A.05 05.A.06 06.E.01 06.E.02 06.E.03

MOBILIZATION/DEMOBILIZATION
ACTIVITY HAZARD ANALYSIS

Date Prepared: 31 October 2017

Project: Camp Blauvelt

Job: Mobilization/Demobilization

Risk Assessment Code (RAC): M

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	EM 385-1-1 (PARA REF)
Mobilization/demobilization of manpower, equipment and establishment of work zones (cont.)	**Physical Hazards:** Driving/vehicle movement (including trucks) Driving on poorly maintained, unpaved track road within Camp Blauvelt LTA	• Obey traffic rules. • Do not exceed15 miles per hour in the work area. • Use caution when entering roadways. • Do not operate vehicles in unsafe conditions (e.g, in deep mud). • Do not use cell phones when operating vehicles. • Wear seat belts • Use caution and wear reflective vests if working near active roads or around heavy equipment. • Leave enough time to get to your destination without hurrying. • Verify back-up alarms are functional for pick-ups or SUVs with obstructed rear view; use a back-up alarm or a spotter when backing up. • Exit vehicle and inspect road conditions prior to driving over questionable terrain/roads. • Use a spotter when driving through narrow passageways • Follow advice from NYARNG points of contact regarding site access and conditions. • Do not drive or park vehicle on unstable roads or terrain	18.A 18.B 08.B 18.B.03 18.B
	Moving or operation of equipment	• Use trained/experienced operators to run equipment as needed • Inspect equipment prior to use • Back up alarms will be functional • Maintain safe distance from moving mechanical parts; personnel will stay out of swing area of all equipment and from under loads • Maintain eye contact with operator when around moving equipment • No personnel will ride on equipment unless seats are provided • Use caution and wear reflective vests if working near active roads or around heavy equipment • Wear proper PPE (i.e., hard hats, as appropriate)	18.G.02

MOBILIZATION/DEMOBILIZATION
ACTIVITY HAZARD ANALYSIS

Date Prepared: 31 October 2017

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Task: Mobilization/Demobilization

Risk Assessment Code (RAC): M

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	EM 385-1-1 (PARA REF)
Mobilization/demobilization of manpower, equipment and establishment of work zones (cont.)	Slips, trips, and falls	• Make sure you have good solid footing and that walking/working surfaces are as clean and dry as possible • Keep work area free of debris • Clear ice, snow and mud from steps to reduce slip hazards • Inspect areas daily and findings are recorded on daily inspection reports. • Personnel will wear sturdy all leather work boot with traction sole and composite safety toe	14.D.01 14.D.04 14.D.06 14.D.07 14.D.08
	Use of hand tools (manual and power)	• Inspect tools prior to use • Use tools for their intended use only • Do not use damaged tools • Push, do not pull wrenches • Use, inspect and maintain power tools according to manufacturer's recommendations • Equip power tools with designed guards • Provide electrical power control on each power tool to make it possible for the operator to cut off the power without leaving the point of operation	13.A.02 13.A.02 13.A.02 13.A.02 13.A.02 13.A.03 13.A.13
	Hands or fingers caught between objects, abrasions and lacerations	• Avoid rough or sharp edges of materials/objects being handled • Avoid placing hands between objects/pinch points • Wear leather work gloves	05.H.
	Lifting and handling of equipment and materials	• Use safe lifting techniques, bending at the knees and lifting with the legs. • Use caution and do not twist the back when carrying a load. • Get assistance or use mechanical devices to move loads; one person will not lift more than 50 pounds. • Wear protective gloves when handling materials.	14.A.01 14.A.01 14.A.03 14.A.04 14.A.05

MOBILIZATION/DEMOBILIZATION
ACTIVITY HAZARD ANALYSIS

Date Prepared: 31 October 2017

Project: Camp Blauvelt

Job: Mobilization/Demobilization

Risk Assessment Code (RAC): M

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	EM 385-1-1 (PARA REF)
Mobilization/demobilization of manpower, equipment and establishment of work zones (cont.)	Inclement weather (cold stress)	• Monitor temperature, precipitation, and wind speed when working outdoors in damp and cool (below 50 degrees Fahrenheit [°F]) conditions or anytime temperatures are below 32°F • Wear cold weather clothing and provide shelter as needed based on site conditions. • Have warm liquids for drinking; avoid caffeine • Have a change of clothing available in case clothes become wet	06.I.04
	Inclement weather (heat stress)	• Make drinking water available to all workers and encourage workers to drink small amounts of water frequently. • Monitor conditions using Wet Bulb Globe Thermometer (WBGT) • Adjust work/rest regimens based on readings • Use sun screen. • Avoid consuming caffeine.	06.I.06 06.J.01 06.J.03
	Extreme weather	• When there are warnings or indications of severe weather, monitor conditions and take precautions to protect personnel. • Identify evacuation routes and places of shelter prior to starting work each day • Health and Safety Officer will monitor conditions and will call a safety stand down in the event of inclement weather.	01.E
	Fire	• Provide portable fire extinguishers in all equipment and vehicles • Inspect fire extinguishers monthly	09.F.01 09.F.02
	Unsanitary conditions	• Toilet and washing facilities will be accessible nearby (Y-Line area and at A100 near gate) • Potable water will be provided for drinking • Provide type II 16-unit first aid kits and make these kits accessible at the site.	02.C 02.D 02.E 02.F 03.B
Mobilization/demobilization of manpower, equipment and establishment of work zones (cont.)	Dust inhalation	• Minimize generation of dust during activities • Stay out of visible dust clouds • Use soil wetting techniques to eliminate visible dust	06.A.04

MOBILIZATION/DEMOBILIZATION
ACTIVITY HAZARD ANALYSIS

Date Prepared: 31 October 2017

Project: Camp Blauvelt

Task: Mobilization/Demobilization

Risk Assessment Code (RAC): M

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	EM 385-1-1 (PARA REF)
	Noise exposure	• Use hearing protection during operation of heavy equipment, as necessary	05.C.01
Equipment to be Used Hand tools Vehicles	**Training Requirements & Competent or Qualified Personnel name(s)** Vehicle training	**Inspection Requirements** All equipment will be properly stored, inspected, and/or maintained on a daily basis, or according to manufacturer's recommendations. Records of inspection will be maintained on site. Fire extinguishers, vehicles, and first-aid kits will be inspected by the Health and Safety Officer.	

SOIL SAMPLING
ACTIVITY HAZARD ANALYSIS

Date Prepared: 31 October 2017

Project: Camp Blauvelt

Job: Soil Sampling

Risk Assessment Code (RAC): **M**

Prepared By: Joe Witte Reviewed By: Alberto Munuera,

Minimum Protective Clothing and Equipment:
PPE Level D: General work clothes, safety glasses, hard hat, safety-toed boots, leather work gloves, chemical resistant gloves (when handling soil with potential metals constituents).

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

SEVERITY	PROBABILITY				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	EM 385-1-1 (PARA REF)
Sample Collection	**Physical Hazards:** Slips, trips, and falls	• Make sure you have good solid footing and that walking/working surfaces are as clean and dry as possible • Keep work area free of debris • Clear ice, snow and mud from steps to reduce slip hazards • Inspect areas daily and findings are recorded on daily inspection reports. • Personnel will wear sturdy all leather work boot with traction sole and composite safety toe	14.D.01 14.D.04 14.D.06 14.D.07 14.D.08
	Hands or fingers caught between objects, abrasions and lacerations	• Avoid rough or sharp edges of materials/objects being handled • Avoid placing hands between objects/pinch points • Wear leather work gloves	05.H
	Lifting and handling of equipment and materials	• Use safe lifting techniques, bending at the knees and lifting with the legs • Use caution and do not twist the back when carrying a load • Wear protective gloves when handling materials	14.A.01 14.A.01 05.A

SOIL SAMPLING
ACTIVITY HAZARD ANALYSIS

Date Prepared: 31 October 2017

Project: Camp Blauvelt

Job: Soil Sampling

Risk Assessment Code (RAC): M

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	EM 385-1-1 (PARA REF)
Sample Collection	**Biological Hazards:** Stinging and biting insects, spiders, and snakes Rabid or defensive animals Poisonous plants	• Use repellents and proper clothing for protection against insects including ticks and mosquitoes • Check the area for poisonous plants and use Ivy Block • Wear protective clothing, including long-sleeved shirts/pants, gloves and leather boots. • Avoid animals, do not leave food outside • Work in pairs and stay observant of surroundings • Avoid rodent droppings as they may contain the Hantavirus • Avoid holes and rocks that are potential animal habitats • If contact with fauna, animal droppings, or poisonous plants then wash area immediately	03.A.05 05.A.06 06.E.01 06.E.02 06.E.03
	Contaminants (metals constituents) in soil	• Properly use specified PPE – safety glasses and nitrile gloves • Practice contamination avoidance • Follow proper decontamination procedures (disposal of gloves, wash glasses as needed) • Observe good personal hygiene practices (wash hands after removing gloves; wash hands and face prior to eating, drinking, or smoking)	
	Inclement weather (cold stress)	• Monitor temperature, precipitation, and wind speed when working outdoors in damp and cool (below 50°F) conditions or anytime temperatures are below 32°F • Wear cold weather clothing and provide shelter as needed based on site conditions. • Have warm liquids for drinking; avoid caffeine • Have a change of clothing available in case clothes become wet	06.I.04

SOIL SAMPLING
ACTIVITY HAZARD ANALYSIS

Date Prepared: 31 October 2017

Project: Camp Blauvelt

Job: Soil Sampling

Risk Assessment Code (RAC): M

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	EM 385-1-1 (PARA REF)
Sample Collection (cont.)	Inclement weather (heat stress)	• Make drinking water available to all workers and encourage workers to drink small amounts of water frequently. • Monitor conditions using WBGT • Adjust work/rest regimens based on readings • Use sun screen. • Avoid consuming caffeine.	06.I.06 06.J.01 06.J.03
	Extreme weather	• When there are warnings or indications of severe weather, monitor conditions and take precautions to protect personnel. • Health and Safety Officer will monitor conditions and will call a safety stand down in the event of inclement weather.	01.E
	Fire	• Provide portable fire extinguishers in all equipment and vehicles. • Inspect fire extinguishers monthly	09.F.01 09.F.02
Equipment to be Used Hand tools Vehicles XRF Analyzer	**Training Requirements & Competent or Qualified Personnel name(s)**	**Inspection Requirements** All equipment will be properly stored, inspected, and/or maintained on a daily basis, or according to manufacturer's recommendations. Records of inspection will be maintained on site. Fire extinguishers, first-aid kits, and vehicles will be inspected by the Health and Safety Officer. **XRF** When the radiation shutter is open: •do not place hands, feet, or other body parts in the radiation field; •do not look into the beam path; •do not point the XRF at anyone; •do not hold the XRF from the front.	

SECTION FOUR: STAFF ORGANIZATION, QUALIFICATIONS AND RESPONSIBILITIES

Roles and responsibilities for key safety personnel are provided in **Table 4-1**. Copies of resumes for safety personnel are presented in **Attachment C**.

Table 4-1: Roles and Responsibilities of Key Safety Personnel

Position	Description of Key Responsibilities
Health and Safety Officer Joe Witte	• Being present during operations to implement the SSHP • Inspecting site activities to identify safety and occupational health deficiencies and correcting them • Coordinating changes/modifications to the SSHP with the HSM and PM. • Conducting project-specific training • Has stop work responsibility related to safety and health concerns • Implements and enforces the SSHP, along with safety concerns contained in the SOP and reports violations to the PM. • Controls access to established work zones and exclusion zones, if any. • Securing the site until emergency response personnel assume control in the event of an accident or an emergency. • Assisting in the investigation of accidents/incidents and “near misses”. • Notifying and coordinating off-site emergency and medical response agencies. • Enforcing the “buddy system”. • Conducting visitor orientations, on-site safety training, and maintains the visitor log. • Coordinating with health and safety professionals to identify personnel on site for whom special PPE, exposure monitoring, or work restrictions may be required. • Conducting daily field site inspections and safety briefing. • Maintains qualification/certification records for site personnel on electronic and hard copy.
Project Health and Safety Manager Alberto Munuera	• Developing, maintaining, and overseeing implementation of the SSHP • Visiting the project site, as requested, to audit the effectiveness of the SSHP • Remaining available, and responding to, project emergencies • Developing modifications to the SSHP, as needed • Evaluating occupational exposure monitoring data and adjusting SSHP requirements, as necessary • Reviewing and signing the SSHP • Determining the need for periodic audits of the operation to evaluate compliance with this plan • Providing health and safety support as requested by the Health and Safety Officer and PM. • Developing, maintaining, and implementing this SSHP. • Responding, as appropriate, to project emergencies. • Overseeing munitions response health and safety program and personnel, establishing policies and standards, and providing guidance • Review and concur with the SSHP • Verify SSHP implementation and compliance • Verify compliance with MR-related Department of Defense publications, USACE documents, as well as local, state, and federal statutes and codes • Issuing a stop work order for unsafe conditions • Interface with PM in matters of health and safety

4.1 PREVENTION OF ALCOHOL AND DRUG ABUSE

Drug and alcohol abuse pose a serious threat to the health and safety of employees, clients, and the general public as well as the security of our job sites, equipment and facilities. AECOM is committed to the elimination of illegal drug use and alcohol abuse in its workplace and regards any misuse of drugs or alcohol by employees to be unacceptable. The company Substance Abuse

Prevention Procedure (SAM-019-PR1) prohibits the use, possession, presence in the body, manufacture, concealment, transportation, promotion or sale of the following items or substances on company premises. Company premises refer to all property, offices, facilities, land, buildings, structures, fixtures, installations, aircraft, automobiles, vessels, trucks and all other vehicles and equipment - whether owned, leased, or used.

- Illegal drugs (or their metabolites), designer and synthetic drugs, mood or mind altering substances, and drug use related paraphernalia unless authorized for administering currently prescribed medication;
- Controlled substances that are not used in accordance with physician instructions or non-prescribed controlled substances; and
- Alcoholic beverages while at work or while on any customer- or company-controlled property.

This policy does not prohibit lawful use and possession of current medication prescribed in the employees name or over-the-counter medications. Employees must consult with their health care provider about any prescribed medication's effect on their ability to perform work safely and disclose any restrictions to their supervisor.

Although some states may pass laws legalizing medical or recreational marijuana use, the use, sale, distribution and possession of marijuana are violations of federal law and company policy, and will subject an employee to disciplinary action up to and including termination in accordance with controlling law.

4.2 PRE-TASK SAFETY AND HEALTH ANALYSIS

Pre-task safety and health analyses are required and have been conducted by the HSM. AHAs are included in the SSHP**.** The Health and Safety Officer will review project tasks and the AHAs each day prior to and during site activities to ensure that the proper procedures are in place and communicated to the project team. Daily Tailgate Meeting Forms and Task Hazard Assessments will also be completed and reviewed by the Health and Safety Officer with the field team prior to and during site activities (**Attachment D**).

If revisions or additions to tasks or work procedures are needed, these will be identified by the Health and Safety Officer, in conjunction with the HSM, as necessary. If required, an addendum to this SSHP will be prepared and submitted to the ARNG for review and concurrence prior to implementing field changes or additions that are not addressed by this SSHP.

4.3 LINES OF AUTHORITY

The Health and Safety Officer has the authority to enforce safety policies and procedures on the project site, and to stop work if an unsafe condition or act is observed. Any corrective actions instituted will be reported to the HSM, the Area SH&E Manager and the PM. If further action or clarification of policies is required, the situation will be brought to the attention of higher levels of operations and SH&E management.

4.4 NON COMPLIANCE, CORRECTIVE ACTION AND SAFETY INCENTIVES

In accordance with AECOM policy, each violation of written safety procedures is evaluated on a case-by-case basis, with input from project management, human resources, and the SH&E department. Disciplinary actions may range from verbal reprimands to removal from the project to termination, depending on the severity of the infraction.

AECOM adheres to policies of continuous improvement for the safety program. Every individual receives annual training with instructions on reporting near misses (in addition to accident reporting). The AECOM Germantown Office, which is performing the work described in this SSHP, has an awards program for which individuals are recommended by their peers for contributions to safety procedures and process improvements. The Safety Award is presented annually in this program.

4.4.1 Management Accountability

In accordance with AECOM's HSEMS (**Attachment A**), the ultimate leadership on safety is our CEO. He, in turn, holds accountable the Operations Managers for communicating and implementing the HSEMS. Supervisors implement safety systems on programs that are under their control, and the PM is accountable for ensuring that safe operations will be followed on this project at all times. In accordance with AECOM policy, each violation of written safety procedures is evaluated on a case-by-case basis, with input from project management, human resources, and the SH&E department. Disciplinary actions for all employees, including managers and supervisors, may range from verbal reprimands to removal from the project to termination, depending on the severity of the infraction. Safety performance is evaluated as part of the AECOM annual job performance review.

SECTION FIVE: SAFETY AND HEALTH INSPECTIONS

5.1 SPECIFIC ASSIGNMENTS OF RESPONSIBILITIES

The Health and Safety Officer will conduct safety and health inspections daily. The Health and Safety Officer will document observations in the project logbook and on the Daily Health and Safety Report (DHSR). Forms are contained in **Attachment D**. Other inspections will be conducted by the Health and Safety Officer as required by individual project activities and company-specific safety, health, and environment procedures.

At a minimum, the Health and Safety Officer is responsible to perform the following:

Vehicle inspections prior to driving (SAM-005-PR)

Daily housekeeping inspections (SAM-013-PR)

Check contents of the field first aid kits prior to beginning field work (SAM-012-PR)

Review the AHAs prior to beginning field work, or as needed

Daily PPE inspections (SAM-208-PR)

The HSM or designee will conduct any monthly and/or quarterly inspections as necessary during the duration of the project.

5.2 DEFICIENCY TRACKING SYSTEM AND FOLLOW UP PROCEDURES

The Health and Safety Officer will identify and note deficiencies with an assigned due date for corrective actions. In most cases, discrepancies can be corrected immediately or before the following work day. The Health and Safety Officer will perform a review of corrective actions as part of the daily safety briefing. Follow-up inspections will be conducted to ensure correction of any identified deficiency and will also be documented in inspection reports.

The HSM or the Area SH&E Manager may conduct formal audits documented in accordance with AECOM procedures. The results of these audits will be reported to the PM, the Regional Safety Manager, and the Vice President, SH&E.

5.3 EXTERNAL INSPECTIONS AND CERTIFICATIONS

AECOM does not expect any external inspections/certifications during this project. However, regulatory agencies can conduct inspections periodically. If this is the case, the regulatory agency inspector should introduce himself/herself to the Health and Safety Officer and present credentials to verify that he/she is representing a recognized regulatory agency, such as OSHA or New York Department of Health. Persons who cannot demonstrate their affiliation with a recognized regulatory agency should not be allowed access to the project site or office.

Prior to escorting an inspector on site, the Health and Safety Officer will contact the HSM, and the PM. All site visitors will be required to sign the visitors log and will be given a site safety brief by the Health and Safety Officer. Coordination of any regulatory agency inspection is the responsibility of the Health and Safety Officer who will accompany the inspector during all stages of the inspection.

SECTION SIX: TRAINING

6.1 NEW EMPLOYEE ORIENTATION

AECOM employees complete an initial New Employee Health and Safety Orientation designed to introduce new employees to the AECOM HSEMS at the beginning of their employment and before starting tasks or assignments. In the course of the orientation, the employee's direct supervisor will determine which additional training course the new employee must compete prior to being assigned to specific job tasks. All employees will receive an orientation in the following topics:

The AECOM Corporation HSEMS

- SH&E Policy
- SH&E Philosophy and Employee Responsibilities
- SH&E organization and responsibilities
- SH&E Website

Incident Reporting Requirements

Incident Reporting, Notifications and Investigation

Medical Screening and Surveillance Requirements

Behavior-Based Safety (BBS) principals

Vehicle Safety Requirements

Health and Safety Training Programs

Obtaining and Reviewing Health and Safety Plans and Safe Work Plans

Obtaining Personal Protective Clothing and Equipment

Site Orientation

Hazards Unique to Project Sites

Task-Specific Hazards

Project Specific Requirements

6.2 SITE SPECIFIC TRAINING

Before starting site work, all personnel assigned to the project will attend initial site-specific safety training. This training will cover corporate health and safety policies as well as the activities, procedures, and equipment applicable to the site operation. The Health and Safety Officer will conduct this training, which will specifically include:

Site layout

Potential hazards

Hazard controls

Hazard Communication (HazCom)

- Requirements and use of the project HazCom program
- Location of the hazardous materials on site
- Identification and recognition of hazardous materials on site
- Physical and health hazards of the materials pertinent to project activities
- Protective measures employees can implement when working with hazardous materials on site
- How to detect the presence or release of chemicals used on site

Monitoring protocols

PPE

Safety procedures

Emergency response services, as outlined in this SSHP

The training session will allow site personnel to clarify any issues they do not understand and will reinforce individual responsibilities regarding health and safety during site work.

Workers will fill out the Safety Compliance Agreement (**Attachment D**) during this training session.

SDSs for materials to be brought on site for each day's use are included in **Attachment B**; the Health and Safety Officer will obtain copies of SDS for any additional chemicals brought on site and maintain these in an accessible location. SDS will be reviewed with employees to identify specific safety and health procedures that should be implemented. SDS will be available for use with AHAs for activities in which hazardous materials will be used. Applicable information will be followed for the proper use and disposal of the materials; and for the selection of hazard control and emergency response measures.

6.3 MANDATORY TRAINING AND CERTIFICATION REQUIREMENTS

This project has training requirements for HAZWOPER training and certification. Employees will be trained in the use of fire extinguishers and the hazards involved in incipient stage firefighting before being allowed to work on the project site.

The 40-hour HAZWOPER training requires an annual refresher course in order to maintain certification. First aid and CPR require retraining and recertification as indicated by that particular training certification. Fire extinguisher training must be provided by AECOM at least once annually.

Certifications for all site personnel will be provided as part of the project personnel package to be submitted to the Contracting Officer's Representative (COR) for approval prior to the commencement of field work. All certifications will be kept on site during field activities.

6.4 REQUIREMENTS FOR EMERGENCY RESPONSE TRAINING

AECOM personnel will provide minimal or first-line response to on-site emergencies. This response will include initial first aid/CPR before arrival of Emergency Medical Services (EMS) personnel and use of fire extinguishers for extinguishing a small or incipient fire. At least two personnel will be trained in first aid/CPR and on-site during work activities. All site personnel will be trained in the use of fire extinguishers to provide emergency response.

6.5 SUPERVISORY AND EMPLOYEE SAFETY TRAINING

Supervisors and employees who are assigned to this project are trained per 29 CFR 1910.120 and receive annual 8-hour refresher training as part of this program. These training classes address topics such as hazard recognition and control, selection and use of PPE, selection and use of monitoring equipment, site control, hazardous materials shipping, and regulatory issues. AECOM employees are required to complete courses in BBS and other selected topics, such as vehicle safety and fitness for duty, on an annual basis. Employees considered "authorized drivers" must complete the defensive driving class, either online or through AECOM approved training providers.

The Health and Safety Officer will conduct daily site safety briefings (i.e., tailgate meetings) to all personnel on site, including supervisors, prior to the start of the work shift. The purpose of the briefings is to assist personnel in safely conducting the scheduled work activities. The briefings will include tasks to be performed and work method, general description of job scope, location of work, equipment to be used, physical hazards, chemical hazards, exposure potential, hazard control, PPE, anticipated weather conditions, and emergency response procedures. The briefings will also provide an opportunity to discuss past accidents and near misses that occurred on similar projects or under similar site conditions and identify safety-related performance deficiencies noted during daily activities or safety audits to increase safety awareness. Attendance and subject matters discussed will be documented on the Tailgate Safety Briefing and Task Hazard Assessment Forms (**Attachment D**).

SECTION SEVEN: PERSONAL PROTECTIVE EQUIPMENT

PPE is considered the last line of defense in hazard control. PPE is meant to protect workers when all other methods (elimination, engineering, and administrative) have been exhausted. All employees must be trained in the proper use and maintenance of PPE. See Procedure SAM-208-PR1, Personal Protective Equipment.

A PPE assessment (see SAM-208-FM1) **Attachment D** was performed to help determine PPE requirements. PPE upgrades for individual tasks or steps of a task are to be identified in Job Safety Analyses or AHAs.

7.1 LEVEL D PROTECTION

Level D PPE provides minimal protection against potential chemical hazards such as metals o constituents in soil, and should not be worn in any area with respiratory or skin hazards. Minimum Required PPE:

- Hard hat (when overhead hazards exist)
- Safety glasses w/ side shields (may be clear or shaded)
- Safety-toe work boots
- Long pants and shirts with sleeves (short or long- cover shoulders no tank or muscle shirt styles)
- Leather work gloves for materials handling
- ANSI Class 2 retro-reflective vest (Class 3 during periods of limited visibility), when working near vehicular traffic or heavy equipment
- Leather chaps (when operating chain saws or as required in areas/conditions where snakes may be active)
- Face shields (as required in areas/conditions where debris may be airborne)

Level D PPE will be adequate for the majority of tasks conducted during this project, due to the type of activities planned.

7.2 MODIFIED LEVEL D PROTECTION

Modified Level D PPE includes the items listed in Section 5.2 above, *and one or more* of the following items:

- Regular (white) or poly-coated Tyvek (yellow) or Polyvinyl Chloride rain suit
- Safety goggles/face shield
- Chemical-resistant over-boots or chemical-resistant steel-toe/steel-shank boots
- Inner latex (i.e., surgical) gloves

- Chemical-resistant outer gloves (type: nitrile rubber)
- Tape for sealing arm, leg, and zipper joints

Modified Level D PPE will be donned for tasks whenever skin (other than hands) or clothing contact with potentially contaminated soil is expected.

If the Health and Safety Officer encounters unexpected conditions requiring the use of higher levels of PPE, then work will cease until an AHA is completed, modified PPE requirements are assessed, and the SSHP is amended and reviewed

The tasks scheduled for this project should not require the use of Level A, B, or C PPE, and their use is not covered by this SSHP.

7.3 HAZARD ASSESSMENT AND CONTROL

AECOM has adopted an approach to hazard assessment and control that incorporates both qualitative and quantitative methods to identify hazards and the degree to which they may impact employees and operations. The Risk Assessment and Management procedure (SAM-209-PR1, **Attachment D**) details the process.

7.4 WHEN HAZARD ASSESSMENT WILL BE CONDUCTED

Hazard assessments were conducted as part of the initial SSHP preparation and will be conducted anytime a change in site conditions or operations occurs. Additional hazard assessments will be conducted by the HSM and the Health and Safety Officer if site conditions or operations change. AHAs are provided in Section 3.8 of the SSHP.

7.5 HOW HAZARD ASSESSMENT WILL BE CONDUCTED

Hazard assessments were initially conducted by the HSM, who evaluated the hazards expected to be present on site based on available background information and previous experience with similar projects. AHAs will be reviewed and tasks will be re-evaluated each day prior to and during site activities by the Health and Safety Officer, in conjunction with the HSM, as necessary, to ensure that the proper procedures, as identified in this SSHP, are in place and communicated to the project team. If revisions or additions to tasks or work procedures are needed, these will be identified by the Health and Safety Officer, in conjunction with the HSM. An addendum to this will be prepared and submitted to ARNG for review and approval prior to implementing changes or additions that are not covered by this SSHP.

7.6 PERSONAL PROTECTIVE EQUIPMENT TRAINING

Based on the hazard assessment for this site, Level D PPE, as defined in Section 7.1, has been determined as the initial level of protection required. The decision to require the use of optional items (hearing protection, waders, hard hats, and reflective vests) will be made by the Health and Safety Officer, based on the hazard and risk analysis in the field. The Health and Safety Officer may also make the decision to upgrade to Modified Level D, as defined in Section 7.2 of the

SSHP, if site conditions warrant an upgrade. The level of protection worn by site personnel will be enforced by the Health and Safety Officer.

Any recommended changes in the level of protection that involve the use of protective equipment not covered under this SSHP (e.g., respirators) will be documented, and a revised hazard assessment will be prepared by the HSM and submitted to ARNG for review prior to use in the field.

All site workers will have current HAZWOPER training; refresher classes address the use of PPE, including respiratory protection. Training includes:

Identifying when PPE is needed;

Selection of proper PPE;

How to properly don, doff, adjust, and wear PPE;

Limitations of the PPE;

Inspection and testing of PPE;

Care, maintenance, and storage of PPE;

Recognizing when PPE has reached the end of its useful life; and

Proper disposal of used PPE.

PPE will be inspected on a regular basis using SAM-208-FM1 (**Attachment D**).

Levels of PPE to be used for this project are discussed in Section 7.1 and 7.2.

7.7 PERSONAL PROTECTIVE EQUIPMENT RETRAINING

If there is reason to believe that any affected employee who has been trained does not have the understanding and skill required to use the assigned PPE, that employee will be removed from the job site until additional training can be completed. AECOM uses a combination of classroom instruction, on-line modules, and hands-on experience for PPE training.

7.8 IDENTIFYING EMPLOYEE TRAINING

Copies of training certifications (including names and date of training) for on-site personnel will be maintained in project files. The Health and Safety Officer will verify each person's certifications prior to the start of work activities and periodically perform reviews to ensure certifications are update.

SECTION EIGHT: EXPOSURE MONITORING

8.1 TRAINING AND MEDICAL SURVEILLANCE

All personnel must comply with the medical surveillance requirements required by Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120). The AECOM medical surveillance program meets all OSHA criteria for hazardous waste investigations. Personnel must have passed the AECOM medical surveillance examination (or equivalent) within the time frame established (annual or biennial schedule). The PM will verify that all AECOM personnel meet applicable OSHA medical surveillance requirements prior to the start of site work. Documentation regarding medical surveillance clearance will be maintained by the Health and Safety Officer

The requirements of the medical surveillance program include:

- A baseline or pre-assignment baseline exam will be conducted prior to the start of work assignments requiring medical surveillance. All employees whose work assignments involve potential exposure to harmful chemical and/or physical agents should participate in the medical surveillance program. Guidance as to harmful potential exposures is presented in SAM-128-FM1 Medical Surveillance Evaluation (MSE). The form provides the primary guidance for determining whether medical screening is required for an employee and the frequency of periodic exams. The MSE is to be completed by the employee and his/her supervisor at the time of hire for any employee who may work outside an office environment. At each annual performance review, the MSE is to be reviewed for accuracy. Other reviews are required whenever there is a change in job tasks.
- In addition, employees may be requested to participate in the medical surveillance program if they perform a task that requires an assessment for fitness for duty (e.g., lifting, climbing, etc.). The Supervisor, Operations Manager and HSM will identify activities/tasks that will require fit-for-duty assessments.
- Additional site- or project-specific biological monitoring or toxicological screening may be required in addition to this program's scheduled core exams. These medical tests will be specified by the project-specific Health and Safety Officer and will be authorized by the HSM on the exam appointment protocol. No additional medical tests are necessary for work at this project site.
- The exposure-specific examination consists of medical tests to assess the impact of occupational exposures associated with a particular activity or project. The Medical Director or HSM will require an exposure-specific examination when he/she has reason to believe occupational exposures are impacting or may be impacting the health of an employee.

All accidents and potential exposures must be reported immediately to the Health and Safety Officer, who will coordinate with the Area or Region Safety, Health, and Environment Manager to arrange for medical exams or tests that may be indicated as part of the AECOM medical surveillance program. Depending on the type of incident, it may be critical to perform tests within 24 to 48 hours. Failure to report an injury or incident immediately will result in

disciplinary action. Based on the nature of the field activities and the hazard assessment results, it is not expected that any airborne contaminants or nuisance dust level exposure limits will be exceeded; therefore, no air monitoring will be performed. Upon changes in site conditions or operations, AHAs may be amended based on an evaluation of potential work exposure. Any amendment to this SSHP will be reviewed and approved by AECOM HSM and accepted by ARNG prior to implementation.

Due to the climate at the Camp Blauvelt and the duration of project, both heat and cold stress are hazards that may be encountered. Therefore, the following control measures shall be followed, as appropriate.

8.2 HEAT STRESS

1. If a worker is wearing permeable clothing.
2. Environmental monitoring or physiological monitoring shall be conducted and work/rest regimens established.
3. Monitoring shall be conducted when temperature exceeds 75°F and 55% humidity.
4. Use of a WBGT instrument is preferred; however, if a WBGT instrument is not available, and the WBGT cannot be obtained from local weather stations, then **Figure 8-1** will be used to estimate the Heat Index.

Degrees F

Relative Humidity (%)	68	70	72	73	75	77	79	81	82	84	86	88	90	91	93	95	97	99	100	102	104	106	108
0	59	61	61	63	64	64	66	66	68	68	70	72	72	73	73	75	75	77	77	79	81	81	82
5	61	61	63	64	63	66	66	68	70	70	72	72	73	75	75	77	79	79	81	81	82	84	84
10	61	63	63	64	66	66	68	70	70	72	73	73	75	77	77	79	81	81	82	84	86	86	88
15	63	63	64	66	66	68	70	70	72	73	73	75	77	79	79	81	82	84	84	86	88	90	91
20	63	64	64	66	68	70	70	72	73	75	75	77	79	81	81	82	84	86	88	90	90	91	95
25	64	64	66	68	68	70	72	73	75	75	77	79	81	82	82	84	86	88	90	91	93	95	97
30	64	66	68	68	70	72	73	73	75	77	79	81	82	84	84	86	88	90	91	93	95	97	99
35	64	66	68	70	72	72	73	75	77	79	81	82	84	86	88	90	91	93	95	97	99	100	102
40	66	68	70	70	72	73	75	77	79	81	82	84	86	88	90	91	93	95	97	99	100	102	
45	66	68	70	72	73	75	77	79	81	81	82	84	86	90	91	93	95	97	99	100			
50	68	70	72	73	73	75	77	79	81	82	84	86	88	91	93	95	97	99	102				
55	68	70	72	73	75	77	79	81	82	84	86	88	90	93	95	97	99	100					
60	70	72	73	75	77	79	81	82	84	86	88	90	91	95	97	99	100						
65	70	72	73	75	77	79	81	82	84	88	90	91	93	97	99	100							
70	72	73	75	77	79	81	82	84	86	88	91	93	95	97	100	102							
75	72	73	75	77	79	81	84	86	88	90	91	95	97	99	102								
80	73	75	77	79	81	82	84	86	90	91	93	97	99	100									
85	73	75	77	79	82	84	86	88	90	93	95	99	100	102									
90	75	77	79	81	82	84	88	90	91	95	97	99	102										
95	75	77	79	81	84	86	88	91	93	95	99	100											
100	75	79	81	82	84	88	90	91	95	100	100	102											

Chart assumes full sunshine and light wind. Using this chart on a cloudy or windy day will result in an overestimation of heat stress

F=Fahrenheit

Figure 8-1: Approximate Wet-Bulb Globe Temperature Chart

5. If **Figure 8-1** is used, direct radiant sun exposure, air velocity, temperature, and humidity and adjustment factors for various work clothing should be taken into consideration.

6. Employees exposed to solar radiation with the potential for sunburn, should be encouraged to use sun screen with a sun protection factor (SPF) of 30 or greater, and should wear hats, long sleeve shirts, sunglasses, and other protective attire.

Work-rest schedules and water intake will be established by the Health and Safety Officer based on the following criteria.

Table 8-1: Heat Stress Exposure Threshold Limit Value (TLV) and Action Limits

Work Cycle (per hour)	TLV (^{o}F)			Action Limit (^{o}F)		
	Light	Moderate	Heavy	Light	Moderate	Heavy
75 to 100% Work	87.8	82.4	NR	82.4	77.0	NR
50 to 75% Work	87.8	84.2	81.5	83.3	78.8	75.2
25 to 50% Work	89.6	86.0	84.2	85.1	80.6	77.9
0 to 25% Work	90.5	88.7	86.9	86.0	84.2	82.4

NR = Not recommended
^{o}F= Fahrenheit

It is expected that workloads will fall into the moderate category (walking about with moderate lifting or pushing, or carrying 10 pounds or less). If the Heat index exceeds 77.0 ^{o}F (for personnel wearing standard work clothing) a work-rest cycle will be established and physiological monitoring will be conducted to assess the effectiveness of the heat stress controls.

Heat Stress Controls

The best approach to avoiding heat-related illness is through preventive heat stress management. Measures to be implemented for this project will include:

Rest Areas – A relatively cool, shaded area will be provided for breaks when ambient temperatures exceed 80^{o}F and workers are wearing regular work clothes. If shade is not available, a canopy will be constructed, or workers will have access to air-conditioned buildings or vehicles. Employees will have access to these rest areas at break times and at any other time a recovery period is needed.

Liquids – Water and electrolyte replacement drinks will be made available. Employees will have access to potable drinking water equivalent to one quart of water per employee per hour during the work shift. Workers should drink 16 ounces before starting work in the morning and after lunch, and 8 to 16 ounces at each break. The water shall be kept reasonably cool (50-60^{o} F) to encourage consumption. Employees will be encouraged to avoid alcohol during non-work hours and caffeine during work hours when heat stress conditions are anticipated.

Acclimatization – When working in a heat stress environment, employees will need to adapt to the hot conditions. Workloads should start at 50% capacity and increase 10 % each day to

achieve 100% capacity. Acclimatization will start to decrease after 3-4 days, and will be gone after one week of not working in a hot environment.

Heat stress controls to be implemented include:

- Allow workers to become acclimatized to the heat (3 to 6 days);
- Provide shaded or air-conditioned break areas;
- Provide sun screen to prevent sun burn; and
- Provide drinking water and electrolyte-replenishing fluids.

Whenever the WBGT reading exceeds the values on the table above for the identified work-rest regime, the Health and Safety Officer will monitor workers for heat stress by measuring temperature and pulse. The Health and Safety Officer will further adjust individual work/rest schedules based on results of physiological monitoring.

- Heart Rate – Heart rate should be measured by the radial pulse as early as possible in the initial rest period (P1) and after two minutes (P2). If P1 is greater than or equal to 110 beats per minute (bpm) and P1-P2 is less than or equal to 10 bpm, shorten the next work cycle by 1/3 without changing the rest period. If the same condition exists at the end of the next work period, that individual should not return to work until repeated measurements are in the acceptable range and they are fully recovered.
- Body Temperature – The body temperature may be measured using a clinical oral thermometer or a clinical ear thermometer. If the body temperature exceeds 99.6°F, shorten the following work period by 1/3 without changing the rest period. If at the next rest period, the temperature still exceeds 99.6°F, that individual should not return to work until their body temperature drops below 99.6°F and they are fully recovered.

The Health and Safety Officer will assess conditions that may cause heat stress in site workers. All site workers will be familiar with the symptoms of heat stress illness described below and will report any symptoms to the Health and Safety Officer immediately. Personnel should monitor themselves and each other for the development of symptoms such as sudden fatigue, nausea, dizziness, irritability, malaise, flu-like symptoms, and lightheadedness.

Conditions related to heat stress:

Heat Rash may result from continuous exposure to heat or humid air. It appears as red papules, usually in areas where the clothing is restrictive, and gives rise to a prickly sensation, particularly as sweating increases.

To prevent heat rash, shower after work, dry off thoroughly, and put on clean, dry clothes. Try to stay in a cool place after work. See a physician if the rash continues to develop.

Heat Cramps are caused by heavy sweating with inadequate electrolyte replacement. Symptoms include muscle spasms and pain in the hands, feet and abdomen.

First Aid for Heat Cramps: Leave the work area, and rest in a cool, shaded place. Drink beverages that contain salt or eat salty food. Taking adequate breaks and drinking electrolyte replacement drinks should prevent cramps from returning.

Heat Exhaustion occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include:

- Pale, cool, moist skin
- Heavy sweating
- Dizziness
- Nausea
- Fainting
- Headache
- Blurred vision
- Vomiting

The key here is that the victim is still sweating, so the cooling system is still working; it's just under severe stress. The body core temperature may be elevated, but not higher than 104ºF. It is important to recognize and treat these symptoms as soon as possible, as the transition from heat exhaustion to the very hazardous heat stroke can be quite rapid.

First Aid for Heat Exhaustion: Treatment involves replacing fluids (rehydration) and salts and removing the person from the hot environment. If symptoms are mild, sipping cool, slightly salty beverages every few minutes may be all that is needed. Removing or loosening clothing and applying a wet cloth or ice packs to the skin also aid cooling.

Heat Stroke is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels, typically at or above 104ºF. Immediate action must be taken to cool the body before serious injury and death occurs. Competent medical help must be obtained. Signs and symptoms are:

- Red, hot, usually dry skin
- Lack of or reduced perspiration (lack of perspiration may be masked for those wearing chemical protective clothing since perspiration from earlier in the day will be present)
- Nausea
- Vomiting
- Dizziness and confusion
- Strong, rapid pulse
- Coma

First Aid for Heat Stroke - THIS IS A MEDICAL EMERGENCY! SUMMON MEDICAL ASSISTANCE IMMEDIATELY!

While awaiting transportation to the hospital, a person should be wrapped in cold, wet bedding or clothing; immersed in a lake, stream, or cool bathtub; or cooled with ice. At the hospital, body cooling is usually accomplished by removing the clothes and covering the exposed skin with

water or ice. To speed evaporation and body cooling, a fan may be used to blow air on the body. Body temperature is measured frequently, often constantly. To avoid overcooling, cooling is stopped when the body temperature is reduced to about 102°F.

8.3 COLD STRESS

Cold stress is a concern when field crews are working outdoors in damp and cool (below 50°F) conditions or anytime temperatures are below 32°F. Personnel should monitor weather forecasts each day and schedule work for the warmer part of the day. While working, ambient temperature, wind speed, and precipitation should be monitored, and a warming regimen should be implemented to allow workers breaks from the cold. Shelter to escape cold, wind, and precipitation, and a source of heat (such as warm packs or portable heaters) should be provided at the worksite. Other cold stress prevention controls include:

1. Changing clothes when work clothes become wet with sweat
2. Avoiding caffeine (which has diuretic and circulatory effects)
3. Ensuring workers drink plenty of warm liquids. It is easy to become dehydrated in cold weather.

When site conditions are as described above, workers should wear at least three layers of clothing, with an inner layer of cotton or synthetic material, a middle layer of down, wool, or similar material to provide insulation, and an outer layer to break the wind and allow some ventilation (e.g., Gortex® or nylon). A hat or hardhat liner will help maintain body heat, and insulated boots and gloves will reduce the chance of frostbite. Workers should keep a change of dry clothing available in case work clothes become wet; drink plenty of warm liquids, avoiding caffeine and alcohol; eat high-calorie snacks to help maintain body metabolism; and work in pairs and watch for signs of cold stress.

Signs of and treatment for cold stress-related illness is presented below in **Table 8-2**.

Hypothermia: Hypothermia results when the body loses heat faster than it can be produced. When this situation first occurs, blood vessels in the skin constrict in an attempt to conserve vital internal heat. Hands and feet are first affected. If the body continues to lose heat, involuntary shivers begin. This is the body's way of attempting to produce more heat, and it is usually the first real warning sign of hypothermia. Further heat loss produces speech difficulty, confusion, loss of manual dexterity, collapse, and finally death. Wet clothes or immersion in cold water greatly increases the hypothermia risk. The progressive clinical presentation of hypothermia is described in the table below.

Frostbite: Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite can be categorized into:

Frost Nip or Initial Frostbite: (1st degree frostbite) Characterized by blanching or whitening of skin.

Superficial Frostbite: (2nd degree frostbite) Skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient. Blistering and peeling of the frozen skin will follow exposure.

Deep Frostbite: (3rd degree frostbite) Tissues are cold, pale, and solid; extremely serious injury with possible amputation of affected area.

Frostbite can occur without hypothermia when the extremities do not receive sufficient heat. The toes, fingers, cheeks, and ears are the most commonly affected. Frostbite occurs when there is freezing of the fluids around the cells of the affected tissues. The first symptom of frostbite is an uncomfortable sensation of coldness, followed by numbness. There may be tingling, stinging, or cramping. Contact by the skin with tools or other metal objects below 20°F (-7°C) may result in contact frostbite.

Table 8-2: Signs of Cold Stress-Related Illness and Treatment

Condition	Signs/Symptoms	Treatment
Hypothermia **Mild** Body temperature (98° - 90° F)	• Shivering • Lack of coordination • Stumbling, fumbling hands • Slurred speech • Memory loss • Pale, cold skin	• Move to warm area • Stay active • Remove wet clothes and replace with dry clothes or blankets • Cover the head • Drink warm (not hot) sugary drink for hydration
Hypothermia **Moderate** Body temperature (90° - 86° F)	• Shivering stops • Unable to walk or stand • Confused and irrational	• Move to warm area • Stay active • Remove wet clothes and replace with dry clothes or blankets • Cover the head • Drink warm (not hot) sugary drink for hydration • Call for an ambulance • Cover all extremities completely • Place very warm objects, such as hot packs or water bottles on the victim's head, neck, chest and groin
Hypothermia **Severe** Body temperature (86° - 78° F)	• Severe muscle stiffness • Very sleepy or unconscious • Ice cold skin death	• Call for an ambulance • Treat the victim very gently • Do not attempt to re-warm -- the victim should receive treatment in a hospital
Frostbite	• Cold, tingling, stinging or aching feeling in frostbitten area • Numbness • Skin color turns red, then purple, then white or very pale skin, cold to the touch • Blisters in severe cases	• Seek medical attention • Do not rub the area • Wrap in soft cloth • If help is delayed, immerse in warm, not hot, water
Trench Foot	• Tingling, itching or burning sensation • Blisters	• Soak feet in warm water, then wrap with dry cloth bandages • Drink a warm, sugary drink for hydration

SECTION NINE: SITE CONTROL

AECOM personnel will keep the NYARNG informed of RI activities as well as report any suspicious activities noticed during field operations.

9.1 EXCLUSION ZONES

Although not anticipated in the scope of this project, should site conditions require the establishment of site zones (Section 11.4) the Health and safety Officer will coordinate on-site access control. Only essential personnel will be allowed in the EZ during sampling. Site control will be maintained by communication and the following:

- Sampling will cease if nonessential personnel are present within the EZ
- A Site Control Log will be maintained to ensure accountability of all personnel on-site
- Authorized visitors will sign a Site Visitors Log and wear proper PPE
- Authorized visitors will be escorted at all times by the, Health and Safety Officer, or their designee
- A safety briefing will be provided by the Health and Safety Officer to all personnel or visitors to inform them on the potential hazards. All personnel and visitors must acknowledge this briefing via signature.
- Designated safety areas will be established in case of an emergency. The Health and Safety Office will notify the onsite, HSM, and PM if an emergency warrants site evacuation.

9.2 SITE COMMUNICATION, HAND SIGNALS AND EMERGENCY COMMUNICATIONS

A cellular phone will be available on site for emergency use. Emergency numbers will be provided to project personnel and will be available at all times workers are on site. Work will not be conducted on site if there is not access to a telephone, and site personnel will be informed of the nearest available telephone.

9.2.1 Emergency Signals

Emergency signals are critical for alerting workers of danger and to maintain site control during an emergency. All field personnel will be trained to recognize the emergency communications and signals described in **Table 9-1**.

Table 9-1: Emergency Communication Signals

Signal	Meaning
One long sound/blast of the emergency alarm signal, air horn, siren, whistle	Emergency situation, face safety watch and watch or listen for directions
Pause; followed by a number of short sounds, 1, 2, 3, or 4	Evacuate to the predestinated emergency meeting place indicated by the number of sounds
Two long blasts of the emergency alarm signal, air horn, siren, whistle	All clear
Point one arm in direction of evacuation, make a large circling motion with the other arm in direction of evacuation	Evacuate the area
Point index finger toward self	I; me
Point index finger toward object	It; them
Point index finger toward person	You; them
Circle index finger at group	We; us; all of us
Pointed finger on extended arm	Look in that direction
Beckon with index finger	Come here
Point with thumb in a particular direction	Move this way; go this way
Hold index finger up near head	Wait
Slowly ease palm face down	Relax; slow down
Put palm over brow	Scout it out; check it out
Move hand far away from body	Stay away
Hands on top of head	Need assistance
Grip partner's wrist or place both hands around partner's arm	Leave area immediately
Thumbs up	OK; I'm all right
Thumbs down	No; negative; bad; not OK
Hand gripping throat	Cannot breathe; out of air
Wave hands over head from side-to-side	Attention; stand-by for the next signal
Swing hand from direction of person receiving signal to directly overhead and through in circle	Come here
Clenched fist of extended arm	Stop motion/hold position
Draw index finger across front of throat	Shut off engine; cut off power; quit
Place palm face down and rotate from side to side	Unsure; cannot decide
Form a circle with thumb and index finer	OK; I understand; agree
Military salute	I understand and will comply

SECTION TEN: EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

When an emergency occurs, decisive action is required. Decisions must often be made immediately and personnel must be ready to respond immediately to an emergency. For this purpose, pre-emergency planning is an essential part of each project's Emergency Response Plan. Pre-emergency planning tasks will be developed and established prior to the start of site work. Pre-emergency planning for the site includes the following tasks:

- Development and approval of this Emergency Response Plan in accordance with SAM-010-PR1), Emergency Response Planning Procedures.
- Review of this Emergency Response Plan with AECOM and AECOM subcontractor personnel prior to starting work.
- Coordination of the Emergency Response Plan with local health and emergency response agencies.
- Training of site personnel in appropriate emergency procedures.
- Maintaining emergency response equipment on site, such as fire extinguishers, first aid supplies, and spill response equipment.
- Performance of an emergency response practice drill during site mobilization and before site activities begin.
- Modification of the Emergency Response Plan, if necessary, as work progresses.

Expected site conditions and operations have been evaluated by the HSM during the preparation of the Emergency Response Plan to formulate a hazard control program for the types of emergencies that may occur. For other events not anticipated, personnel will stop work, secure the site, and follow procedures as directed

If needed, client requirements will be incorporated into this Emergency Response Plan and communicated to all personnel onsite.

10.1 RESPONSE PRIORITIES

Only if it is safe to do so, AECOM personnel may choose to provide only minimal or first line response to all emergencies.

First Priority: Prevent further injury or illness by:

- Protecting response personnel;
- Isolating the scene to authorized personnel only;
- Notifying emergency response personnel; and
- If possible, rescuing any injured parties.

Second Priority: Provide first aid to persons with life-threatening injuries or illnesses.

Third Priority: Alleviate the immediate hazards by:

- Extinguishing incipient-stage fire;
- Reducing chemical releases; and/or
- Containing any spill.

10.2 EVACUATION ROUTES AND PROCEDURES

In a severe emergency such as a large fire, site evacuation may become necessary. **Table 10-1** provides the procedures for site evacuation. The Health and Safety Officer will be responsible for informing site personnel of the anticipated routes of evacuation during the morning safety briefings. The evacuation route and assembly area will correlate to the wind direction, topography, and the nature of the incident. Personnel will be advised to move to an upwind location at least 100 yards from any fires and/or releases, and will be advised to continually monitor wind direction for changes.

If moving upwind is not possible without encountering the incident, personnel will be advised to move crosswind or downwind to a distance out of the path of vapor releases, smoke, odors, or spills. In the event that a site evacuation becomes necessary, the procedures listed in the table below will be used.

Table 10-1: Site Evacuation Procedures

Step	Procedures
1	Site personnel will be notified of an emergency evacuation via horn signal or verbal command. All site personnel will immediately stop work.
2	All site personnel will evacuate the work area as quickly as possible and assemble at a location at least 100 yards upwind of the incident, or as instructed during the morning safety briefing.
3	The Health and Safety Officer will be responsible for roll call.
4	The Health and Safety Officer will contact emergency response personnel as all site personnel are being accounted for during roll call.
5	The Health and Safety Officer will ensure that emergency apparatus have adequate site access.
6	The Health and Safety Officer will ensure that all combustion equipment has been shut down.
7	All site personnel assembled at the designated safe evacuation area will wait for further instructions from emergency response personnel.

10.3 INJURY/ILLNESS TREATMENT

Site personnel will maintain current First Aid/CPR certifications. In the event of any illness or injury, the following steps will be taken:

- Evaluate the extent of injuries or seriousness of illness.
- When employees require urgent medical attention, transport to the hospital or call for emergency assistance. First aid should be administered while awaiting an ambulance or paramedics. All emergency medical treatment, other than first aid, will be administered by the local paramedics. In all cases, critical injuries must be immediately referred for professional medical attention.
- All first aid will be administered by on-site personnel trained and certified in CPR and first aid.
- All vehicles used to transport injured persons to the off-site medical facility will be provided with directions and a map to the medical facility. The Health and Safety Officer or designee will accompany the victim to the hospital.

- For a non-critical injury/illness, provide first-aid treatment and evaluate the need for further treatment.
  - AECOM personnel will utilize the services of AECOM safety staff or the Incident Hotline (1-800-348-5046) to make this evaluation and approve treatment.
  - If further treatment is approved, the HSM will provide the appropriate forms to the occupational medicine clinic. AECOM personnel should seek treatment from an occupational medicine clinic approved by the workers' compensation insurance carrier.
  - Subcontractor personnel will follow their company procedures for medical treatment and case management.

10.4 CHEMICAL EXPOSURE

In the event of a chemical exposure, the guidelines presented in **Table 10-2** will be followed.

Table 10-2: First Aid for Chemical Exposure

Type of Over Exposure	First-Aid Guidelines
Skin Contact	Skin: Wash/rinse the affected area thoroughly with copious amounts of soap and water.
	Eyes: Eyes should be rinsed for at least 15 minutes following chemical contamination.
	Contact emergency response personnel if required, or transport victim to the hospital.
Ingestion	Contact Poison Control Center.
	Contact emergency response personnel, or transport victim to the hospital.

10.5 DECONTAMINATION DURING A MEDICAL EMERGENCY

As previously indicated, few site operations will trigger contamination of any type. For minor medical problems or injuries, regular decontamination procedures will be followed. If emergency, life-saving first aid and/or medical treatment are required, regular decontamination procedures may need to be abbreviated or omitted:

- If the victim has been contaminated with acid, other chemicals, or contaminated soil: immediately wash or rinse the victim with water to rinse off the material.
- Outer garments can be removed if it does not cause a delay, interfere with treatment, or aggravate the problem.
- PPE can be cut away, and respiratory protective equipment must always be removed.
- If contaminated clothing cannot be safely removed, then the victim should be wrapped in a blanket or plastic sheeting to prevent the contamination of the inside of the ambulance and/or emergency response personnel.

The Health and Safety Officer will advise the medical staff of the type of contamination.

10.6 ON-SITE MEDICAL SUPPORT

AECOM field personnel will have current first aid/CPR certification. These personnel will provide initial treatment, while waiting for the local paramedics to arrive. Emergency medical assistance will be coordinated through the appropriate public emergency response resources. Local fire and police departments will respond to 911 calls and provide emergency response to incidents involving AECOM personnel. As appropriate, emergency responders will administer on-site medical treatment beyond initial first aid and will transport AECOM employees to the hospital, as required.

10.7 OFF-SITE MEDICAL SUPPORT

In all cases, critical injuries must be immediately referred for professional medical attention.

When employees require urgent medical attention, transport them to the hospital or call for emergency assistance. First aid should be administered while awaiting an ambulance or paramedics. All emergency medical treatment, other than first aid, will be administered by the local paramedics.

Figure 10-1 and Figure 10-2 provide maps and directions to the nearest hospital and occupational health clinic, respectively. **Table 10-3** lists the emergency telephone numbers for the site. In the event that 911 service is not available at the work site, NYARNG PM Greg Austin (518-852-0934) should be contacted to direct emergency personnel to the work site.

Table 10-3: Camp Blauvelt Emergency Telephone Numbers

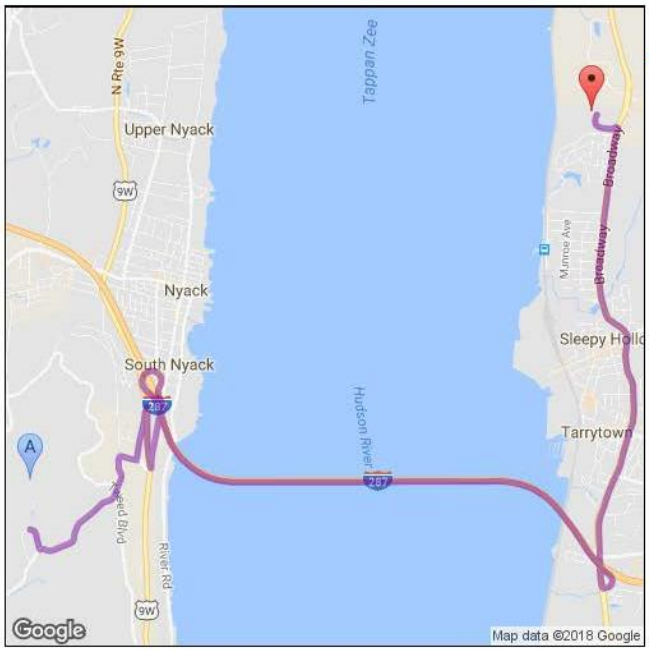
EMERGENCY TELEPHONE NUMBERS	
Ambulance Service:	911*
Fire:	911*
Police:	911*
Hospital: Phelps Memorial Hospital 701 N Broadway Sleepy Hollow, NY 10591	(914)-366-3000
National Spill Response Center	(800) 424-8802
Poison Control Center	(800) 222-1222
Federal OSHA Hot Line	(800) 321-6742
THE FOLLOWING AECOM PEOPLE WILL BE NOTIFIED IF AN INCIDENT HAS OCCURRED:	
AECOM Region SH&E Manager: Tony Indorato	Work: (813) 645-2804 Cell: (757) 298-1563
AECOM HSM & Area SH&E Manager: Alberto Munuera	Cell: (757) 408-4276
Incident Hotline	(800) 348-5046
AECOM Health & Safety Officer: Joe Witte	Work: (301) 820-3267 Cell: (301) 300-9873
AECOM PM: Rosa Gwinn	Work: (301) 820-3123 Cell: (301) 820-3131
ARNG	
ARNG PM/COR: MAJ Julie Hatcher	Work: (703) 601-7608
ARNG NY PM: Greg Austin	Work: (518) 786-4318 Cell: (518) 852-0934
ARNG NY PM: Pete Jensen	Work: (518) 786-4548

Figure 10-1: Hospital Directions

Provider	**Phelps Memorial Hospital**
Address	701 N Broadway Sleepy Hollow, NY 10591
Specialty	Hospital: Acute Care
National Provider Identifier	1366786972172018526 7
Phone	914-366-3000
Fax	914-366-1017
LOB	Au Wc
Effective Date	08-15-2013

TEXT PROVIDER INFO TO MOBILE PHONE

Type a phone number Send



DRIVING DIRECTIONS

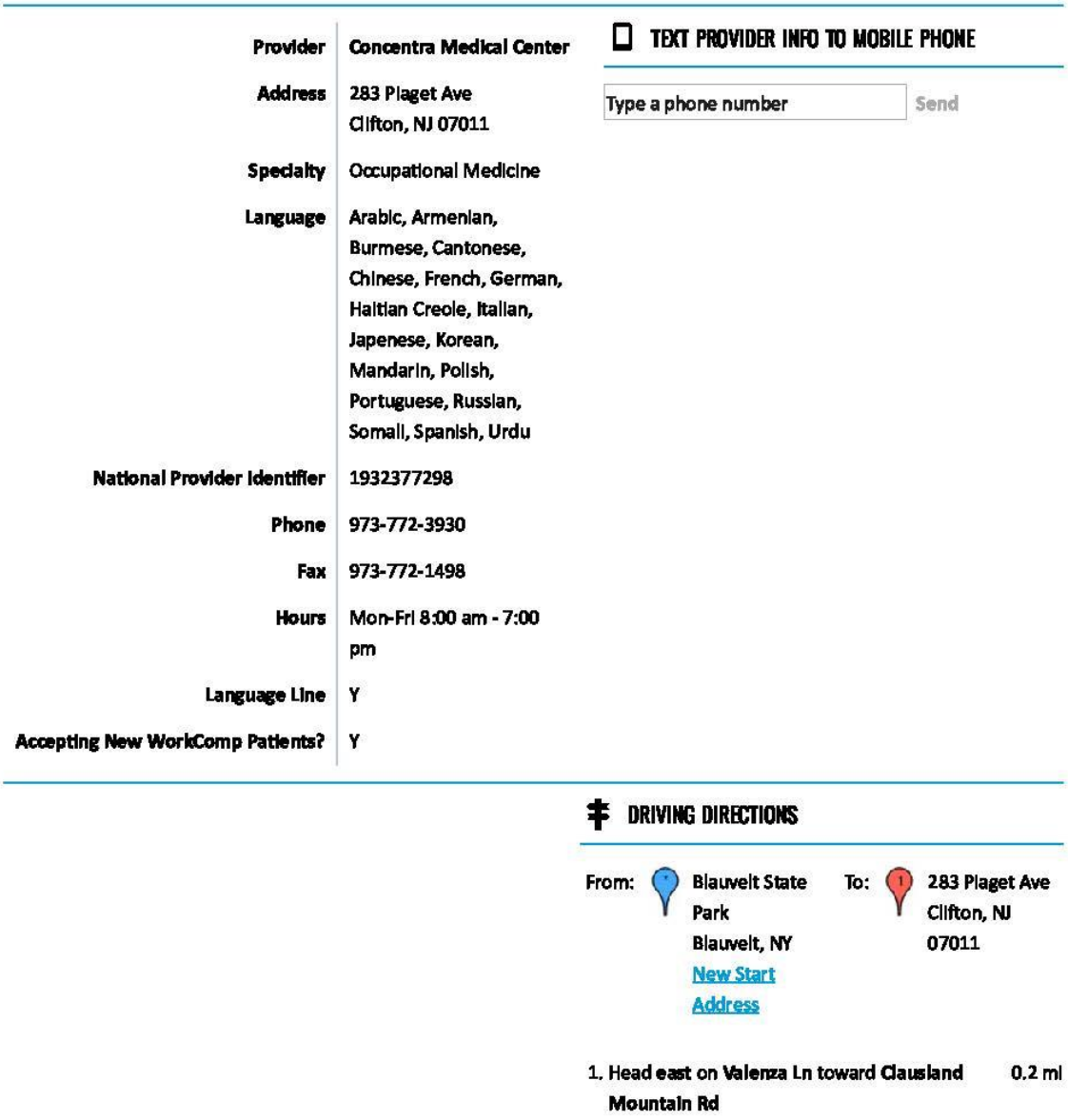
From: Blauvelt State Park Blauvelt, NY
New Start Address

To: 701 N Broadway Sleepy Hollow, NY 10591

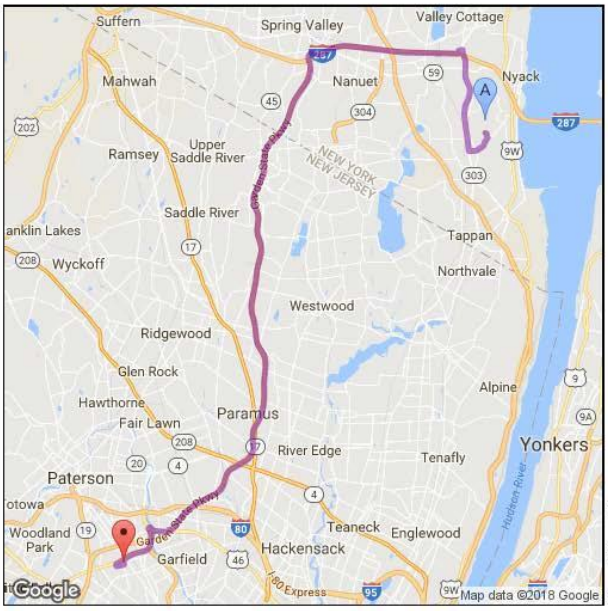
1. Head east on Valenza Ln toward Clausland Mountain Rd	0.2 mi
2. Turn left onto Clausland Mountain Rd	0.7 mi
3. Continue onto South Blvd	0.2 mi
4. Turn right onto Old Mountain Rd	0.1 mi
5. Turn left onto Shadyside Ave	0.4 mi

6. Turn **right** onto **US-9W S/Hillside Ave**	0.4 mi
7. Turn **left** onto **S Broadway**	0.5 mi
8. Turn **left** onto the ramp to **Interstate 87/New York Thruway/Interstate 287** Toll road	0.6 mi
9. Merge onto **I-287 E/I-87 S** Toll road	3.7 mi
10. Take exit **9** for **US-9** toward **Tarrytown/Sleepy Hollow** Toll road	0.2 mi
11. Turn **right** onto **U.S. 9 N/S Broadway**	3.4 mi
12. Turn **left** onto **Phelps Ln**	0.2 mi
13. Slight **right** onto **Hospital Access Rd** Destination will be on the left	472 ft
Estimated driving time: 24 minutes	10.7 mi

Figure 10-2: Clinic Directions



Provider	**Concentra Medical Center**
Address	283 Plaget Ave Clifton, NJ 07011
Specialty	Occupational Medicine
Language	Arabic, Armenian, Burmese, Cantonese, Chinese, French, German, Haitian Creole, Italian, Japanese, Korean, Mandarin, Polish, Portuguese, Russian, Somali, Spanish, Urdu
National Provider Identifier	1932377298
Phone	973-772-3930
Fax	973-772-1498
Hours	Mon-Fri 8:00 am - 7:00 pm
Language Line	Y
Accepting New WorkComp Patients?	Y



2.	Turn right onto Clausland Mountain Rd	0.5 mi
3.	Continue onto Spruce St	0.2 mi
4.	Turn right onto NY-303 N	3.1 mi
5.	Turn left onto N Palisades Center Dr	0.1 mi
6.	Turn left to merge onto I-287 W/I-87 N	4.3 mi
7.	Take exit 14A for Garden State Pkwy toward New Jersey	0.8 mi
8.	Continue onto Garden State Pkwy Partial toll road Entering New Jersey	15.6 mi
9.	Take exit 157 to merge onto US-46 W toward NJ-20/Garfield	0.6 mi
10.	Take the U.S. 46 W ramp to Clifton	0.3 mi
11.	Continue onto US-46 W	0.4 mi
12.	Take the US-46 W exit toward Dover	0.2 mi
13.	Continue onto US-46 W	1.0 mi
14.	Turn left onto 5th St	381 ft
15.	Turn left at the 1st cross street onto Barkley Ave	0.2 mi
16.	Turn left at the 2nd cross street onto 3rd St	351 ft
17.	Turn right at the 1st cross street onto Piaget Ave Destination will be on the right	69 ft
	Estimated driving time: 35 minutes	27.8 mi

10.8 MEDICAL SURVEILLANCE

AECOM's SAM-128-PR1, Medical Screening and Surveillance, details the requirements to participate in a medical monitoring program. Medical Surveillance provides a streamlined process to determine if employees meet the physical requirements to perform assigned duties as defined by applicable regulations. It is also designed to provide a means to collect data relevant to exposure to chemical and physical agents for the protection of the workers and to confirm the effectiveness of health and safety programs

All accidents and potential exposures must be reported immediately to the Health and Safety Officer, HSM, or Area or Region SH&E Manager to arrange for medical exams or tests that may be indicated as part of the medical surveillance program. Depending on the type of incident, it may be critical to perform tests within 24 to 48 hours. Failure to report an injury or incident immediately will result in disciplinary action.

10.9 EMERGENCY RESPONSE PLANS (FIRES)

10.9.1 Small Incident/Fire

A small fire is defined as a fire that can be extinguished with an available 20-pound ABC fire extinguisher. An incipient fire is a fire that is small because it has just started. In the event of a small or incipient fire, the following minimum actions will be taken:

- Evacuate nearby personnel from the area, if possible, to an upwind location, or to an area not affected by smoke or hazardous decomposition products if an upwind location is not feasible.
- Attempt to extinguish fire using portable fire extinguisher or by smothering.
- Contact emergency response personnel, as needed, for any injuries or exposures to hazardous decomposition products.
- After the fire has been extinguished, or emergency response personnel have been contacted, notify the AECOM PM and HSM.

10.9.2 Large Fire/Explosion

An explosion, large fire, or a small fire that cannot be extinguished is beyond the first line response capabilities of AECOM personnel. Professional emergency response personnel would be needed to provide emergency assistance for these types of incidents. In the event of a large fire, explosion, or a small fire that cannot be extinguished, the following minimum actions will be taken:

- Evacuate all personnel from the site, if possible, to an upwind location, or to an area not affected by smoke or hazardous decomposition products if an upwind location is not feasible.
- Perform a quick roll call to account for all site personnel.
- Contact the fire department.

- Contact emergency response personnel, as needed, for any injuries or exposures to hazardous decomposition products.
- After emergency response personnel have been contacted, notify the PM and HSM

10.9.3 Fires Involving Explosives

If a fire occurs in an area containing explosive materials, the Health and Safety Officer will immediately direct site personnel to an upwind location. The Health and Safety Officer will make notifications to the appropriate agencies. At no time will AECOM personnel fight a fire where explosive material is present.

10.9.4 Hazardous Substance Spill or Release

It is not expected that any spills of hazardous materials will occur from AECOM activities on site. In the event that a hazardous substance spill or release occurs, the following steps will be taken:

- Evacuate site personnel, if necessary. Follow the evacuation sequence outlined in Section 10.2.
- Attempt to determine the source of leak or release, the contaminants involved, and the approximate volume of the leaked or released substance.
- After the spill/release has been contained, or emergency response personnel have been contacted, notify the PM.
- A spill or release of a hazardous substance at or above its reportable quantity will require reporting to the National Spill Response Center at (800) 424-8802.

10.9.5 Emergency Equipment and First Aid Requirements

First aid/CPR support will be provided by trained AECOM personnel. In the event that specialized or elevated care is necessary, the AECOM Incident Hotline (800-348-5046) or 911ambulance service will advise or transport the injured person to the appropriate medical facility.

A supply of emergency and first aid PPE and equipment will be maintained in sufficient quantities to ensure an adequate supply for response. All emergency equipment will be fully stocked and readily accessible. American Red Cross First Aid and CPR Instruction Manuals will readily accessible. The following supplies will be available:

- Bloodborne pathogens personal protective equipment kit (minimum requirements are nitrile gloves [2 pairs] and CPR shield)
- Allergy response kit
- Portable, plastic or metal, water-resistant first-aid kit, with handle and manual
- Industrial first-aid kit (one 16-unit kit that complies with American National Standards Institute [ANSI] Z308A for every 25 persons or fewer) with the following supplies:

- Flashlight/batteries
- Bandage scissors
- Gloves, latex free: 2 pair
- Red bag for biohazard waste disposal
- CPR breathing barrier
- Individually wrapped items:
  - Compress bandages - minimum of six in sizes ranging from 2" to 4"
  - Assorted adhesive bandages (at least 16)
  - Sterile gauze compress pads: 4" x 4"
  - Sterile nonstick gauze pads 3" x 3", minimum of 4 packages
  - Water-soluble burn dressing with gel pad (for minor burns, use after cold water soak), at least 6
  - Occlusive dressings: 4"x4"
  - Butterfly strips (wound closure)
- Tape (hypoallergenic), at least 5 yards of 3/8" wide
- Antiseptic (alcohol prep pads, towelette, or swab), at least 10 individual-use packages (must meet Food and Drug Administration CFR 333 requirements)
- Iodine prep pads (if not allergic to iodine, use after soap and water wash for bloodborne exposure)
- Ice pack or cold pack
- Gauze roller bandages: two 2" x 6 yards and one 4" x 6 yards
- Tweezers (one use, disposable)
- Temperature strips
- Triangular bandage: 40" x 40" x 56"
- Sterile normal saline eye wash, 4-ounce bottle
- Eye covering, at least 2
- Antibiotic - individual use packages only, at least 6
- Insect sting relief wipes or spray
- Aspirin, individually wrapped: at least 2 doses
- Tourniquet with windlass, combat-style: (when power tools in use)

- Spill control/absorption supplies
- Soap or waterless hand cleaner and towels
- Technu or alternative poison ivy wash or wipes
- Fire extinguishers placed in the following locations:
  - In each motor vehicle (10B:C)

- On site (2A:20B:C)

SECTION ELEVEN: GENERAL PLAN

11.1 GENERAL SITE RULES

- All site personnel will wear PPE as required by the task.
- The buddy system will be observed at all times.
- Entry into exclusion zones not permitted without Health and Safety Officer approval and sign-in.
- All site personnel who wear corrective lenses will provide their own prescription safety glasses.
- Horseplay will not be tolerated.
- Smoking is allowed only in area designated by the Health and Safety Officer.
- Proper site housekeeping (including removal of trash and orderly stacking and removal of materials to reduce slipping, tripping, and fire hazards) will be the responsibility of all site personnel on a daily basis.
- If any unusual site conditions are noted (odors, presence of unknown liquids, suspect biohazards) or any symptoms are experienced, work will be stopped until site hazards can be evaluated.

11.2 SANITATION

Sanitation issues for this site will include the following:

- Drinking/potable water
- Toilets

Employees will not be required to perform work under unsanitary conditions. AECOM will establish and maintain hygienic sanitation provisions at Camp Blauvelt including the following:

- Drinking/potable water (bottled water) will be kept onsite during field activities. This will be replenished, as necessary, to provide adequate supplies of potable water. Soap and water will also be available at the jobsite for washing body parts.
- Containers used for drinking water will be clearly marked and not used for any other purpose.
- Cups must not be shared by employees.
- Outlets for non-potable water (i.e., firefighting purposes) are not to be used by employees for drinking, washing, or cooking purposes.
- Toilet facilities will be available at Pine Ridge Armory adjacent to the MRS, which are accessible between 0730 and 1600 hours.

- Disposable PPE will eliminate the need for a Personnel Decontamination Station. Used PPE and refuse generated during field activities will be collected in trash bags and disposed of at an approved location.

11.3 CONTAMINATION PREVENTION

One of the most important aspects of decontamination is the prevention of contamination. Good contamination prevention should minimize worker exposure. During the use of hazardous chemicals or when potentially contaminated materials (e.g., soil) are encountered, contamination prevention protocols will be implemented. Procedures for contamination prevention for personnel include:

- Do not walk through areas of obvious or known contamination.
- Do not handle or touch contaminated materials directly.
- Make sure all PPE is free of cuts or tears prior to donning.
- Fasten all closures on suits, covering with tape if necessary.
- Particular care should be taken to protect any skin injuries. If open wounds exist on hands or forearms, handling contaminated materials or samples should be restricted or eliminated.
- Stay upwind of airborne contaminants.
- Do not carry cigarettes, gum, chewing tobacco, cosmetics, etc. into potentially contaminated areas.

Procedures for contamination prevention for equipment include:

- Take care to limit the amount of contamination that comes in contact with heavy equipment.
- If contaminated tools are to be placed on non-contaminated equipment for transport, use plastic to keep non-contaminated surfaces clean.

11.4 SITE ZONES

Although not anticipated in the scope of this project, should site conditions require the establishment of site zones to control the potential spread of contamination, a three-zone system will be implemented. Prior to the start of any activities involving the contaminants of concern, a Support Zone (SZ), a Transition Zone (TZ), and an EZ will be identified.

- *Support Zone* - A non-contaminated area that will be separated from the EZ by the TZ. It contains a center for team communications and emergency response. Appropriate sanitary, safety, and support equipment are also located in this zone. Site operations will be controlled from this location. A log will be kept in the SZ of all personnel entering and exiting the site.

- *Transition Zone* - Established between the EZ and the SZ, the TZ provides for personnel and equipment decontamination. The TZ will be used for EZ entry and exit and for donning and removing PPE.
- *Exclusion Zone* - The areas that contain, or are suspected to contain physical hazards or contaminants of concern are the EZs. Prior to the start of each task, the EZ "hot line," or boundary, will be clearly identified using physical marking systems, which may include stanchions, warning tape, jersey barriers, fencing, or other methods. The Health and Safety Officer will determine the appropriate type of physical marking system at the time of zone establishment. Selection will depend on the activity being conducted within the EZ, as well as the potential for the presence of visitors in the area. All areas that contain, or are suspected to contain, contaminants of concern will be marked as an EZ. Personnel are not allowed in the EZ without:
    - A "buddy"
    - Appropriate PPE
    - Current OSHA medical authorization
    - Current OSHA training certification

Work areas will be clearly marked to alert visitors to the hazards associated with the area. This shall include the placement of appropriate signage and, where necessary, the erection of physical barriers (e.g., barricades). At a minimum, caution tape will be used to mark EZs.

11.5 PERSONNEL DECONTAMINATION

All personnel handling hazardous chemicals will pass through a decontamination station, where conditions necessitate. To reduce the volume of water generated through decontamination, protective clothing will be discarded instead of cleaned and reused. The generation of decontamination water should be minimized whenever possible. The steps outlined in **Table 11-1** will be taken for personnel decontamination when exiting the chemical handling area. The decontamination setup is subject to modification by the Health and Safety Officer.

Equipment and supplies needed for the personnel decontamination station include:

- Plastic buckets and scrub brushes for glove wash and rinse
- Plastic sheeting
- Wash tubs for boot wash and rinse
- Detergent/water solution (non-phosphate detergent)
- Long-handled soft bristle scrub brushes for boot wash

Table 11-1: Personnel Decontamination Procedure

Step	Description
1	Deposit all equipment and tools used in the EZ onto plastic sheeting or into plastic-lined containers.
2	Scrub boots and any soiled PPE thoroughly with a soapy wash solution and a scrub brush. Rinse off boots and PPE.
3	Remove tape from around boots and sleeves and dispose of into a plastic-lined drum.
4	Remove gloves (inside out) and dispose of into a plastic-lined drum.
5	Thoroughly wash prior to eating, drinking, smoking, or using the rest room.

11.6 EQUIPMENT DECONTAMINATION

Hand tools will be decontaminated using phosphate free detergent and distilled water. Wash water is anticipated to be minor in volume and discharged directly at the site of generation. All tools will be cleaned prior to site entry to remove grease, oil, dirt, or any other off-site materials. The Health and Safety Officer will inspect the equipment prior to approving the items for use on site. The Health and Safety Officer will also be responsible for inspecting all items for adequacy of decontamination prior to removal off site. The inspection will be noted in the Health and Safety Officer's logbook. Other site materials will be disposed of as normal trash.

The steps in **Table 11-2** will be taken when decontaminating small equipment:

Table 11-2: Small Equipment Decontamination Procedure

Step	Description
1	Wrap small equipment such as soil probe and hand auger in plastic sheeting.
2	Transport the small equipment from the EZ to the decontamination location.
3	Rinse small equipment with a spray bottle filled with distilled water.
4	Scrub small equipment with soapy water using brushes and a phosphate-free soap.
5	Rinse small equipment with distilled water until free from suds.
6	Place small equipment on clean plastic sheeting and allow it to dry.

11.7 DISPOSAL OF DECONTAMINATION WASTE

PPE that may have come in contact with contaminated media will be decontaminated with phosphate free detergent and rinsed with potable water. The used and decontaminated PPE will be collected in plastic trash bags and disposed of as regular trash. The small volumes of decontamination water will be allowed to infiltrate into the soil.

SECTION TWELVE: REQUIRED DOCUMENTATION

The following documentation must be kept on site or readily accessible:

- Current Hazardous Waste Operation and Emergency Response (HAZWOPER) training certificates (including 8-hour refresher and site supervisor training);
- Current First Aid/CPR certification;
- SDSs for all hazardous chemicals brought on site by AECOM and its subcontractors;
- OSHA-required medical surveillance examination clearance records;
- Field logbook;
- Copies of any Incident Reports such as:
  - AECOM Incident Report; and
- Signed copies of the SSHP Compliance Agreement;
- Site Safety Briefing Form;
- Deficiency Tracking Log
- Completed AHA forms
- Medical Data Sheets for all site personnel;
- Any other permits, training records, or documentation.

12.1 TRAINING LOGS

Training logs will include initial site-specific safety training, daily safety briefings, weekly "toolbox" topic training, and visitor training. A record of the training will be documented on a training log, which will include the following information:

- The date;
- Employee's name;
- Time allocation in training session;
- Training topic(s); and
- Trainer(s) signature.

12.2 FIELD LOG BOOKS

The Health and Safety Officer will maintain a logbook on site in accordance with standard AECOM procedures. Complete and detailed documentation of site activities will be very important. The following information will be recorded on a daily basis:

- Site conditions (e.g., weather);
- Activities being performed;
- Log of photographs taken;
- Personnel on site;
- Site visitors;
- Incidents, accident, and near misses;
- Violations of health and safety procedures; and
- Other significant events.

SECTION THIRTEEN: REFERENCES

"Around Your World." New York's Global Environmental Collge, SUNY College of Environmental Science and Forestry, Aug. 2003, www.esf.edu/pubprog/brochure/snakes/snakes.htm.

Minnesota Departments of Natural Resources. http://files.dnr.state.mn.us/natural_resources/animals/reptiles_amphibians/snakebites.pdf, accessed January 2018.

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U.S. Department of Agriculture, Office of Homeland Security & Emergency Coordination Radiation Safety Division. Portable X-Ray Fluorescence Analyzer https://www.dm.usda.gov/ohsec/rsd/xfa.htm. Accessed January 2017.

USACE, 2014. Safety and Health Requirements Manual, EM 385-1-1. 30 November.

Attachment A

AECOM Safety, Health and Environment Policy and Management System

Safety, Health and Environment Policy Statement

Purpose

This policy establishes the framework to attain best-in-class Safety, Health and Environmental (SH&E) performance for AECOM's employees in the global marketplace.

Commitment

AECOM is committed to exceptional levels of performance in safeguarding our people and the environment as one of our Core Values. Keeping our people safe is our most important measure of success. We strive to be the beacon of safety excellence in the industries and global communities in which we work.

To advance our SH&E program, we are committed to:

- Zero work-related injuries to AECOM employees and protection of the environment as a result of our activities.
- Providing a highly effective SH&E management system that drives continual review and improvement.
- Meeting client requirements and properly incorporating all safety, health and environmental rules and regulations at the local, state, provincial and national levels.
- Developing an exceptional safety culture where our people embrace ownership for the safety of themselves and others.
- Advancing our goals of pollution prevention, resource conservation and environmental sustainability.
- Setting and meeting aggressive SH&E performance goals and Core Value Metrics to promote continuous improvement.
- Working with employees and business partners in order to continuously improve SH&E performance.
- Recognizing and celebrating those who contribute to excellent SH&E performance.
- Striving to make AECOM the provider of choice for the safe execution of design, build, finance, operate and maintenance work globally.

The commitment to this policy by the leadership, management and employees of AECOM provides the foundation for a safe workplace, operational excellence and long-term business success.

Expectations

Safety is a core value and a key to our success. We demand continuous improvement in our journey toward a zero incident culture, where everyone is committed to safety, health and environmental excellence.

To that end, we demand:

- Our leaders, managers, supervisors and employees demonstrate their commitment in their actions and decisions to assure that every person goes home safe every day.
- Our employees embrace safety as a core value both on and off the job.
- Each employee is committed to his/her own safety and that of his/her fellow employees.
- We will incorporate AECOM's Life-Preserving Principles into our work planning and execution.
- We proactively and aggressively identify, manage and eliminate hazards in the workplace.
- We train and prepare our people to have the knowledge, skills, competency and equipment required to work safely.
- We stop our employees from working if the work cannot be executed safely or if conditions or behaviors on the work activity are unsafe.
- All employees immediately report safety, health and/or environmental incidents, near-misses, unsafe conditions, and at-risk behaviors to their supervisor; and that we diligently work to correct the problem.

Our SH&E expectations will be accomplished by the demonstrated leadership of management, compliance with regulatory requirements and participation of AECOM personnel.

Communication

This Policy will be reviewed annually to ensure it meets the needs of the company, and will be made available to all persons under the control of the company.

Sincerely:

M. Burke

Michael S. Burke
Chairman and Chief Executive Officer

04 March 2017
Date

Safety for life

Attachment B

Safety Data Sheets

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), 29CFR1910/1200 and GHS Rev. 3

Effective date: 12.08.2015 **Revision** : 12.10.2015

Trade Name: Alconox

1 Identification of the substance/mixture and of the supplier

1.1 Product identifier

Trade Name: Alconox
Synonyms:
Product number: Alconox

1.2 Application of the substance / the mixture : Cleaning material/Detergent

1.3 Details of the supplier of the Safety Data Sheet

Manufacturer
Alconox, Inc.
30 Glenn Street
White Plains, NY 10603
1-914-948-4040

Supplier
Not Applicable

Emergency telephone number:
ChemTel Inc
North America: 1-800-255-3924
International: 01-813-248-0585

2 Hazards identification

2.1 Classification of the substance or mixture:

In compliance with EC regulation No. 1272/2008, 29CFR1910/1200 and GHS Rev. 3 and amendments.

Hazard-determining components of labeling:
Tetrasodium Pyrophosphate
Sodium tripolyphosphate
Sodium Alkylbenzene Sulfonate

2.2 Label elements:

Skin irritation, category 2.
Eye irritation, category 2A.

Hazard pictograms:

Signal word: Warning

Hazard statements:
H315 Causes skin irritation.
H319 Causes serious eye irritation.

Precautionary statements:
P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P321 Specific treatment (see supplemental first aid instructions on this label).
P332+P313 If skin irritation occurs: Get medical advice/attention.
P362 Take off contaminated clothing and wash before reuse.
P501 Dispose of contents and container as instructed in Section 13.

Safety Data Sheet

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Effective date: 12.08.2015 **Revision** : 12.10.2015

Trade Name: Alconox

Additional information: None.

Hazard description

Hazards Not Otherwise Classified (HNOC): None

Information concerning particular hazards for humans and environment:

The product has to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.

Classification system:

The classification is according to EC regulation No. 1272/2008, 29CFR1910/1200 and GHS Rev. 3 and amendments, and extended by company and literature data. The classification is in accordance with the latest editions of international substances lists, and is supplemented by information from technical literature and by information provided by the company.

3 Composition/information on ingredients

3.1 Chemical characterization : None

3.2 Description : None

3.3 Hazardous components (percentages by weight)

Identification	Chemical Name	Classification	Wt. %
CAS number: 7758-29-4	Sodium tripolyphosphate	Skin Irrit. 2 ; H315 Eye Irrit. 2; H319	12-28
CAS number: 68081-81-2	Sodium Alkylbenzene Sulfonate	Acute Tox. 4; H303 Skin Irrit. 2 ; H315 Eye Irrit. 2; H319	8-22
CAS number: 7722-88-5	Tetrasodium Pyrophosphate	Skin Irrit. 2 ; H315 Eye Irrit. 2; H319	2-16

3.4 Additional Information : None.

4 First aid measures

4.1 Description of first aid measures

General information: None.

After inhalation:

Maintain an unobstructed airway.
Loosen clothing as necessary and position individual in a comfortable position.

After skin contact:

Wash affected area with soap and water.
Seek medical attention if symptoms develop or persist.

After eye contact:

Rinse/flush exposed eye(s) gently using water for 15-20 minutes.
Remove contact lens(es) if able to do so during rinsing.
Seek medical attention if irritation persists or if concerned.

After swallowing:

Rinse mouth thoroughly.
Seek medical attention if irritation, discomfort, or vomiting persists.

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Effective date: 12.08.2015 **Revision** : 12.10.2015

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4.2 Most important symptoms and effects, both acute and delayed

None

4.3 Indication of any immediate medical attention and special treatment needed:

No additional information.

5 Firefighting measures

5.1 Extinguishing media

Suitable extinguishing agents:

Use appropriate fire suppression agents for adjacent combustible materials or sources of ignition.

For safety reasons unsuitable extinguishing agents : None

5.2 Special hazards arising from the substance or mixture :

Thermal decomposition can lead to release of irritating gases and vapors.

5.3 Advice for firefighters

Protective equipment:

Wear protective eye wear, gloves and clothing.
Refer to Section 8.

5.4 Additional information :

Avoid inhaling gases, fumes, dust, mist, vapor and aerosols.
Avoid contact with skin, eyes and clothing.

6 Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures :

Ensure adequate ventilation.
Ensure air handling systems are operational.

6.2 Environmental precautions :

Should not be released into the environment.
Prevent from reaching drains, sewer or waterway.

6.3 Methods and material for containment and cleaning up :

Wear protective eye wear, gloves and clothing.

6.4 Reference to other sections : None

7 Handling and storage

7.1 Precautions for safe handling :

Avoid breathing mist or vapor.
Do not eat, drink, smoke or use personal products when handling chemical substances.

7.2 Conditions for safe storage, including any incompatibilities :

Store in a cool, well-ventilated area.

7.3 Specific end use(s):

No additional information.

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Effective date: 12.08.2015 **Revision** : 12.10.2015

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8 Exposure controls/personal protection

8.1 Control parameters :

7722-88-5, Tetrasodium Pyrophosphate, OSHA TWA 5 mg/m3.

8.2 Exposure controls

Appropriate engineering controls:

Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use or handling.

Respiratory protection:

Not needed under normal conditions.

Protection of skin:

Select glove material impermeable and resistant to the substance.

Eye protection:

Safety goggles or glasses, or appropriate eye protection.

General hygienic measures:

Wash hands before breaks and at the end of work.
Avoid contact with skin, eyes and clothing.

9 Physical and chemical properties

Appearance (physical state, color):	White and cream colored flakes - powder	**Explosion limit lower**: **Explosion limit upper**:	Not determined or not available. Not determined or not available.
Odor:	Not determined or not available.	**Vapor pressure at 20°C**:	Not determined or not available.
Odor threshold:	Not determined or not available.	**Vapor density**:	Not determined or not available.
pH-value:	9.5 (aqueous solution)	**Relative density**:	Not determined or not available.
Melting/Freezing point:	Not determined or not available.	**Solubilities**:	Not determined or not available.
Boiling point/Boiling range:	Not determined or not available.	**Partition coefficient (n-octanol/water)**:	Not determined or not available.
Flash point (closed cup):	Not determined or not available.	**Auto/Self-ignition temperature**:	Not determined or not available.
Evaporation rate:	Not determined or not available.	**Decomposition temperature**:	Not determined or not available.

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Flammability (solid, gaseous):	Not determined or not available.	**Viscosity**:	a. Kinematic: Not determined or not available. b. Dynamic: Not determined or not available.
Density at 20°C:	Not determined or not available.		

10 Stability and reactivity

10.1 Reactivity : None

10.2 Chemical stability : None

10.3 Possibility hazardous reactions : None

10.4 Conditions to avoid : None

10.5 Incompatible materials : None

10.6 Hazardous decomposition products : None

11 Toxicological information

11.1 Information on toxicological effects :

Acute Toxicity:

Oral:

: LD50 > 5000 mg/kg oral rat - Product .

Chronic Toxicity: No additional information.

Skin corrosion/irritation:

Sodium Alkylbenzene Sulfonate: Causes skin irritation. .

Serious eye damage/irritation:

Sodium Alkylbenzene Sulfonate: Causes serious eye irritation .

Tetrasodium Pyrophosphate: Rabbit - Risk of serious damage to eyes .

Respiratory or skin sensitization: No additional information.

Carcinogenicity: No additional information.

IARC (International Agency for Research on Cancer): None of the ingredients are listed.

NTP (National Toxicology Program): None of the ingredients are listed.

Germ cell mutagenicity: No additional information.

Reproductive toxicity: No additional information.

STOT-single and repeated exposure: No additional information.

Additional toxicological information: No additional information.

12 Ecological information

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12.1 Toxicity:

Sodium Alkylbenzene Sulfonate: Fish, LC50 1.67 mg/l, 96 hours.
Sodium Alkylbenzene Sulfonate: Aquatic invertebrates, EC50 Daphnia 2.4 mg/l, 48 hours.
Sodium Alkylbenzene Sulfonate: Aquatic Plants, EC50 Algae 29 mg/l, 96 hours.
Tetrasodium Pyrophosphate: Fish, LC50 - other fish - 1,380 mg/l - 96 h.
Tetrasodium Pyrophosphate: Aquatic invertebrates, EC50 - Daphnia magna (Water flea) - 391 mg/l - 48 h.

12.2 Persistence and degradability: No additional information.

12.3 Bioaccumulative potential: No additional information.

12.4 Mobility in soil: No additional information.

General notes: No additional information.

12.5 Results of PBT and vPvB assessment:

PBT: No additional information.

vPvB: No additional information.

12.6 Other adverse effects: No additional information.

13 Disposal considerations

13.1 Waste treatment methods (consult local, regional and national authorities for proper disposal)

Relevant Information:

It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities. (US 40CFR262.11).

14 Transport information

14.1 UN Number: None
ADR, ADN, DOT, IMDG, IATA

14.2 UN Proper shipping name: None
ADR, ADN, DOT, IMDG, IATA

14.3 Transport hazard classes:
ADR, ADN, DOT, IMDG, IATA

Class: None
Label: None
LTD. QTY: None

US DOT
Limited Quantity Exception: None

Bulk:
RQ (if applicable): None
Proper shipping Name: None
Hazard Class: None
Packing Group: None
Marine Pollutant (if applicable): No additional information.

Non Bulk:
RQ (if applicable): None
Proper shipping Name: None
Hazard Class: None
Packing Group: None
Marine Pollutant (if applicable): No additional information.

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Effective date: 12.08.2015 **Revision** : 12.10.2015

Trade Name: Alconox

	Comments: None	**Comments:** None
14.4	**Packing group:** ADR, ADN, DOT, IMDG, IATA	None
14.5	**Environmental hazards** :	None
14.6	**Special precautions for user:**	None
	Danger code (Kemler):	None
	EMS number:	None
	Segregation groups:	None
14.7	**Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code:**	Not applicable.
14.8	**Transport/Additional information:**	
	Transport category:	None
	Tunnel restriction code:	None
	UN "Model Regulation":	None

15 Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture.

North American

SARA

Section 313 (specific toxic chemical listings): None of the ingredients are listed.
Section 302 (extremely hazardous substances): None of the ingredients are listed.

CERCLA (Comprehensive Environmental Response, Clean up and Liability Act) Reportable

Spill Quantity: None of the ingredients are listed.

TSCA (Toxic Substances Control Act):

Inventory: All ingredients are listed.
Rules and Orders: Not applicable.

Proposition 65 (California):

Chemicals known to cause cancer: None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for females: None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for males: None of the ingredients are listed.

Chemicals known to cause developmental toxicity: None of the ingredients are listed.

Canadian

Canadian Domestic Substances List (DSL):
All ingredients are listed.

EU

REACH Article 57 (SVHC): None of the ingredients are listed.

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Trade Name: Alconox

Germany MAK: Not classified.

Asia Pacific

Australia

Australian Inventory of Chemical Substances (AICS): All ingredients are listed.

China

Inventory of Existing Chemical Substances in China (IECSC): All ingredients are listed.

Japan

Inventory of Existing and New Chemical Substances (ENCS): All ingredients are listed.

Korea

Existing Chemicals List (ECL): All ingredients are listed.

New Zealand

New Zealand Inventory of Chemicals (NZOIC): All ingredients are listed.

Philippines

Philippine Inventory of Chemicals and Chemical Substances (PICCS): All ingredients are listed.

Taiwan

Taiwan Chemical Substance Inventory (TSCI): All ingredients are listed.

16 Other information

Abbreviations and Acronyms: None

Summary of Phrases

Hazard statements:

H315 Causes skin irritation.
H319 Causes serious eye irritation.

Precautionary statements:

P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P321 Specific treatment (see supplemental first aid instructions on this label).
P332+P313 If skin irritation occurs: Get medical advice/attention.
P362 Take off contaminated clothing and wash before reuse.
P501 Dispose of contents and container as instructed in Section 13.

Manufacturer Statement:

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

NFPA: 1-0-0

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), 29CFR1910/1200 and GHS Rev. 3

Effective date: 12.08.2015 **Revision** : 12.10.2015

Trade Name: Alconox

HMIS: 1-0-0

Safety Data Sheet

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND COMPANY/UNDERTAKING

Material Name	:	**Gasoline**
Other Names / Synonyms	:	MOGAS, ULG 95, 88 RON, 90 RON, 91 RON, 92 RON, 93 RON, 95 RON, 97 UNLD, 91 UNLD
Recommended Use / Restrictions of Use	:	Fuel for spark ignition engines designed to run on unleaded fuel.
Supplier	:	**Shell Eastern Trading (PTE) Ltd** 9 North Buona Vista Drive, #07-01, Tower 1, The Metropolis Singapore 138588 Singapore
Telephone	:	+65-6384 8000
Emergency Telephone Number	:	+44 (0) 151 350 4595

2. HAZARDS IDENTIFICATION

GHS Classification	:	Flammable liquids, Category 1 Skin corrosion/irritation, Category 2 Aspiration hazard, Category 1 Toxic to reproduction, Category 2 Germ cell mutagenicity, Category 1B Carcinogenicity, Category 1B Specific target organ toxicity - single exposure, Category 3, Inhalation, Narcotic effects. Acute hazards to the aquatic environment, Category 2 Hazardous to the aquatic environment - Long-term Hazard, Category 2
GHS Label Elements **Symbol(s)**	:	
Signal Words	:	Danger
Hazard Statement	:	PHYSICAL HAZARDS:

H224: Extremely flammable liquid and vapour.

HEALTH HAZARDS:
H304: May be fatal if swallowed and enters airways.
H315: Causes skin irritation.
H336: May cause drowsiness or dizziness.
H340: May cause genetic defects.
H350: May cause cancer.
H361: Suspected of damaging fertility or the unborn child.

ENVIRONMENTAL HAZARDS:
H401: Toxic to aquatic life.
H411: Toxic to aquatic life with long lasting effects.

GHS Precautionary Statements

Prevention : P201: Obtain special instructions before use.
P210: Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P280: Wear protective gloves/protective clothing/eye protection/face protection.

Response : P301+P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.

Storage : P403+P233: Store in a well-ventilated place. Keep container tightly closed.

Disposal: : P501: Dispose of contents and container to appropriate waste site or reclaimer in accordance with local and national regulations.

Other Hazards which do not result in classification : Liquid evaporates quickly and can ignite leading to a flash fire, or an explosion in a confined space. This material is a static accumulator. Even with proper grounding and bonding, this material can still accumulate an electrostatic charge. If sufficient charge is allowed to accumulate, electrostatic discharge and ignition of flammable air-vapour mixtures can occur.
Slightly irritating to respiratory system. This product contains benzene which may cause leukaemia (AML - acute myelogenous leukaemia). May cause MDS (Myelodysplastic Syndrome).

Additional Information : This product is intended for use in closed systems only.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Mixture Description : Complex mixture of hydrocarbons consisting of paraffins, cycloparaffins, aromatic and olefinic hydrocarbons with carbon numbers predominantly in the C4 to C12 range. Includes benzene at 0.1 - 5% v/v. Contains oxygenated hydrocarbons which may include methyl tertiary butyl ether (MTBE) and other ethers. May also contain several additives at <0.1% v/v each.

Synonyms : MOGAS, ULG 95, 88 RON, 90 RON, 91 RON, 92 RON, 93 RON, 95 RON, 97 UNLD, 91 UNLD

Classification of components according to GHS

Chemical Identity	Synonyms	CAS	Hazard Class (category)	Hazard Statement	Conc.
Gasoline, low boiling point naphtha	Gasoline, low boiling point naphtha	86290-81-5	Flam. Liq., 1; Skin Corr., 2; Asp. Tox., 1; Muta., 1B; Carc., 1B; STOT SE, 3; Aquatic Chronic, 2; Aquatic Acute, 2; Repr., 2;	H224; H315; H304; H340; H350; H336; H411; H401; H361;	85.00 - 100.00 %
Ethyl tertiary butyl ether	Ethyl tertiary butyl ether	637-92-3	Flam. Liq., 2; STOT SE, 3; Asp. Tox., 2; Aquatic Acute, 3;	H225; H336; H305; H402;	0.00 - 15.00 %
Methyl tertiary butyl ether	Methyl tertiary butyl ether	1634-04-4	Flam. Liq., 2; Skin Corr., 3; Acute Tox., 5; Asp. Tox., 2;	H225; H316; H303; H305;	0.00 - 15.00 %
Tertiary amyl methyl ether	Tertiary amyl methyl ether	994-05-8	Flam. Liq., 2; Acute Tox., 4; STOT SE, 3;	H225; H302; H336;	0.00 - 15.00 %

Additional Information : Contains Benzene, CAS # 71-43-2. Contains Toluene, CAS # 108-88-3. Contains Ethylbenzene, CAS # 100-41-4. Contains n-Hexane, CAS # 110-54-3. Contains Xylene (Mixed Isomers), CAS # 1330-20-7. Contains Cyclohexane, CAS# 110-82-7. Contains Cumene, CAS# 98-82-8 Contains Tri-methyl-benzene (all isomers), CAS# 25551-13-7.

Contains Naphthalene, CAS # 91-20-3.

The amount of oxygenated components is limited at 2.7 % m/m calculated as oxygen. Alcohols may be present at <0.1%v. Dyes and markers can be used to indicate tax status and prevent fraud. Refer to Ch 16 for full text of H phrases.

Refer to chapter 16 for full text of EC R-phrases.

4. FIRST-AID MEASURES

Inhalation	:	Remove to fresh air. If rapid recovery does not occur, transport to nearest medical facility for additional treatment.
Skin Contact	:	Remove contaminated clothing. Immediately flush skin with large amounts of water for at least 15 minutes, and follow by washing with soap and water if available. If redness, swelling, pain and/or blisters occur, transport to the nearest medical facility for additional treatment. When using high pressure equipment, injection of product under the skin can occur. If high pressure injuries occur, the casualty should be sent immediately to a hospital. Do not wait for symptoms to develop.
Eye Contact	:	Flush eyes with water while holding eyelids open. Rest eyes for 30 minutes. If redness, burning, blurred vision, or swelling persist transport to the nearest medical facility for additional treatment.
Ingestion	:	If swallowed, do not induce vomiting: transport to nearest medical facility for additional treatment. If vomiting occurs spontaneously, keep head below hips to prevent aspiration. If any of the following delayed signs and symptoms appear within the next 6 hours, transport to the nearest medical facility: fever greater than 101° F (38.3°C), shortness of breath, chest congestion or continued coughing or wheezing.
Most Important Symptoms/Effects, Acute & Delayed	:	Skin irritation signs and symptoms may include a burning sensation, redness, or swelling. Eye irritation signs and symptoms may include a burning sensation and a temporary redness of the eye. If material enters lungs, signs and symptoms may include coughing, choking, wheezing, difficulty in breathing, chest congestion, shortness of breath, and/or fever. The onset of respiratory symptoms may be delayed for several hours after exposure. Breathing of high vapour concentrations may cause central nervous system (CNS) depression resulting in dizziness, light-headedness, headache, nausea and loss of coordination. Continued inhalation may result in unconsciousness and death. Auditory system effects may include temporary hearing loss and/or ringing in the ears.

Immediate medical attention, special treatment	:	Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Clear fire area of all non-emergency personnel.

Specific hazards arising from Chemicals	:	Hazardous combustion products may include: A complex mixture of airborne solid and liquid particulates and gases (smoke). Carbon monoxide may be evolved if incomplete combustion occurs. Unidentified organic and inorganic compounds. The vapour is heavier than air, spreads along the ground and distant ignition is possible. Will float and can be reignited on surface water.
Suitable Extinguishing Media	:	Foam, water spray or fog. Dry chemical powder, carbon dioxide, sand or earth may be used for small fires only.
Unsuitable Extinguishing Media	:	Do not use direct water jets on the burning product as they could cause a steam explosion and spread of the fire. Simultaneous use of foam and water on the same surface is to be avoided as water destroys the foam.
Protective Equipment & Precautions for Fire Fighters	:	Proper protective equipment including chemical resistant gloves are to be worn; chemical resistant suit is indicated if large contact with spilled product is expected. Self-Contained Breathing Apparatus must be worn when approaching a fire in a confined space. Select fire fighter's clothing approved to relevant Standards (e.g. Europe: EN469).
Additional Advice	:	Keep adjacent containers cool by spraying with water. If possible remove containers from the danger zone. If the fire cannot be extinguished the only course of action is to evacuate immediately. Contain residual material at affected sites to prevent material from entering drains (sewers), ditches, and waterways.

6. ACCIDENTAL RELEASE MEASURES

Avoid contact with skin, eyes and clothing. Evacuate the area of all non-essential personnel. Ventilate contaminated area thoroughly. If contamination of sites occurs remediation may require specialist advice. Avoid contact with spilled or released material. Immediately remove all contaminated clothing. For guidance on selection of personal protective equipment see Chapter 8 of this Material Safety Data Sheet. For guidance on disposal of spilled material see Chapter 13 of this Material Safety Data Sheet. Ensure electrical continuity by bonding and grounding (earthing) all equipment. Observe the relevant local and international regulations. Take precautionary measures against static discharges.

Personal Precautions, Protective Equipment and Emergency Procedures	:	Do not breathe fumes, vapour. Do not operate electrical equipment. Shut off leaks, if possible without personal risks. Remove all possible sources of ignition in the surrounding area. Vapour can travel for considerable distances both above and below the ground surface. Underground services (drains, pipelines, cable ducts) can provide preferential flow paths. Evacuate all personnel. Attempt to disperse vapour or to direct its flow to a safe location for example using fog sprays.
Environmental Precautions	:	Take measures to minimise the effects on groundwater. Contain residual material at affected sites to prevent material from entering drains (sewers), ditches, and waterways. Prevent from spreading or entering into drains, ditches or rivers by using sand, earth, or other appropriate barriers.
Methods and Material for Containment and Cleaning Up	:	Take precautionary measures against static discharges. For large liquid spills (> 1 drum), transfer by mechanical means such as vacuum truck to a salvage tank for recovery or safe disposal. Do not flush away residues with water. Retain as contaminated waste. Allow residues to evaporate or soak up with an appropriate absorbent material and dispose of safely. Remove contaminated soil and dispose of safely. For small liquid spills (< 1 drum), transfer by mechanical means to a labelled, sealable container for product recovery or safe disposal. Allow residues to evaporate or soak up with an appropriate absorbent material and dispose of safely. Remove contaminated soil and dispose of safely.
Additional Advice	:	Notify authorities if any exposure to the general public or the environment occurs or is likely to occur. Local authorities should be advised if significant spillages cannot be contained. Maritime spillages should be dealt with using a Shipboard Oil Pollution Emergency Plan (SOPEP), as required by MARPOL Annex 1 Regulation 26. To the extent that this product, including its chemical components (e.g. methyl tertiary butyl ether) may impact surface or groundwater, appropriate assessment and remediation (if necessary) should be implemented.

7. HANDLING AND STORAGE

General Precautions	:	Avoid breathing vapours or contact with material. Only use in well ventilated areas. Wash thoroughly after handling. For guidance on selection of personal protective equipment see Chapter 8 of this Material Safety Data Sheet. Use the information in this data sheet as input to a risk assessment of local circumstances to help determine appropriate controls for

		safe handling, storage and disposal of this material. Air-dry contaminated clothing in a well-ventilated area before laundering. Prevent spillages. Turn off all battery operated portable electronic devices (examples include: cellular phones, pagers and CD players) before operating gasoline pump. Contaminated leather articles including shoes cannot be decontaminated and should be destroyed to prevent reuse. Do not use as a cleaning solvent or other non-motor fuel uses. Vehicle fueling and vehicle workshop areas - Avoid inhalation of vapours and contact with skin, when filling or emptying a vehicle.
Precautions for Safe Handling	:	When using do not eat or drink. Extinguish any naked flames. Do not smoke. Remove ignition sources. Avoid sparks. Never siphon by mouth. The vapour is heavier than air, spreads along the ground and distant ignition is possible. Avoid exposure. Use local exhaust ventilation if there is risk of inhalation of vapours, mists or aerosols. Properly dispose of any contaminated rags or cleaning materials in order to prevent fires.
Conditions for Safe Storage	:	Drum and small container storage: Keep containers closed when not in use. Drums should be stacked to a maximum of 3 high. Use properly labelled and closeable containers. Packaged product must be kept tightly closed and stored in a diked (bunded) well-ventilated area, away from, ignition sources and other sources of heat. Take suitable precautions when opening sealed containers, as pressure can build up during storage. Tank storage: Tanks must be specifically designed for use with this product. Bulk storage tanks should be diked (bunded). Locate tanks away from heat and other sources of ignition. Cleaning, inspection and maintenance of storage tanks is a specialist operation, which requires the implementation of strict procedures and precautions. Keep in a cool place. Electrostatic charges will be generated during pumping. Electrostatic discharge may cause fire. Ensure electrical continuity by bonding and grounding (earthing) all equipment to reduce the risk. The vapours in the head space of the storage vessel may lie in the flammable/explosive range and hence may be flammable. Refer to section 15 for any additional specific legislation covering the packaging and storage of this product.
Product Transfer	:	Wait 2 minutes after tank filling (for tanks such as those on road tanker vehicles) before opening hatches or manholes. Wait 30 minutes after tank filling (for large storage tanks) before opening hatches or manholes. Even with proper grounding and bonding, this material can still accumulate an electrostatic charge. If sufficient charge is allowed to

		accumulate, electrostatic discharge and ignition of flammable air-vapour mixtures can occur. Be aware of handling operations that may give rise to additional hazards that result from the accumulation of static charges. These include but are not limited to pumping (especially turbulent flow), mixing, filtering, splash filling, cleaning and filling of tanks and containers, sampling, switch loading, gauging, vacuum truck operations, and mechanical movements. These activities may lead to static discharge e.g. spark formation. Restrict line velocity during pumping in order to avoid generation of electrostatic discharge (<= 1 m/s until fill pipe submerged to twice its diameter, then <= 7 m/s). Avoid splash filling. Do NOT use compressed air for filling, discharging, or handling operations.
Recommended Materials	:	For containers, or container linings use mild steel, stainless steel. Aluminium may also be used for applications where it does not present an unnecessary fire hazard. Examples of suitable materials are: high density polyethylene (HDPE), polypropylene (PP), and Viton (FKM), which have been specifically tested for compatibility with this product. For container linings, use amine-adduct cured epoxy paint. For seals and gaskets use: graphite, PTFE, Viton A, Viton B.
Unsuitable Materials	:	Some synthetic materials may be unsuitable for containers or container linings depending on the material specification and intended use. Examples of materials to avoid are: natural rubber (NR), nitrile rubber (NBR), ethylene propylene rubber (EPDM), polymethyl methacrylate (PMMA), polystyrene, polyvinyl chloride (PVC), polyisobutylene. However, some may be suitable for glove materials.
Container Advice	:	Containers, even those that have been emptied, can contain explosive vapours. Do not cut, drill, grind, weld or perform similar operations on or near containers. Gasoline containers must not be used for storage of other products.
Other Advice	:	Ensure that all local regulations regarding handling and storage facilities are followed. See additional references that provide safe handling practices for liquids that are determined to be static accumulators: American Petroleum Institute 2003 (Protection Against Ignitions Arising out of Static, Lightning and Stray Currents) or National Fire Protection Agency 77 (Recommended Practices on Static Electricity). CENELEC CLC/TR 50404 (Electrostatics – Code of practice for the avoidance of hazards due to static electricity).

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

If the American Conference of Governmental Industrial Hygienists (ACGIH) value is provided on this document, it is provided for information only.

Occupational Exposure Limits

Material	Source	Type	ppm	mg/m3	Notation
Gasoline, low boiling point naphtha	ACGIH	TWA	300 ppm		
	ACGIH	STEL	500 ppm		
	SG OEL	TWA	300 ppm	890 mg/m3	
	SG OEL	STEL	500 ppm	1,480 mg/m3	
Trimethylbenzene, all isomers	ACGIH	TWA	25 ppm		
	SG OEL	TWA	25 ppm	123 mg/m3	
Ethylbenzene	ACGIH	TWA	20 ppm		
	SG OEL	TWA	100 ppm	434 mg/m3	
	SG OEL	STEL	125 ppm	543 mg/m3	
n-hexane	ACGIH	TWA	50 ppm		
	ACGIH	SKIN_DES			Can be absorbed through the skin.
	SG OEL	TWA	50 ppm	176 mg/m3	
Benzene	ACGIH	TWA	0.5 ppm		
	ACGIH	STEL	2.5 ppm		
	ACGIH	SKIN_DES			Can be absorbed through the skin.
	SG OEL	TWA	1 ppm	3.18 mg/m3	

	SHELL IS	TWA	0.5 ppm	1.6 mg/m3	
	SHELL IS	STEL	2.5 ppm	8 mg/m3	
Toluene	ACGIH	TWA	20 ppm		
	SG OEL	TWA	50 ppm	188 mg/m3	
Xylene	ACGIH	TWA	100 ppm		
	ACGIH	STEL	150 ppm		
	SG OEL	TWA	100 ppm	434 mg/m3	
	SG OEL	STEL	150 ppm	651 mg/m3	
Cyclohexane	ACGIH	TWA	100 ppm		
	SG OEL	TWA	300 ppm	1,030 mg/m3	
Naphthalene	ACGIH	TWA	10 ppm		
	ACGIH	STEL	15 ppm		
	ACGIH	SKIN_DES			Can be absorbed through the skin.
	SG OEL	TWA	10 ppm	52 mg/m3	
	SG OEL	STEL	15 ppm	79 mg/m3	
Ethyl tertiary butyl ether	ACGIH	TWA	25 ppm		
Methyl tertiary butyl ether	ACGIH	TWA	50 ppm		
	SG OEL	TWA	40 ppm	144 mg/m3	
Tertiary amyl methyl ether	ACGIH	TWA	20 ppm		
Cumene	ACGIH	TWA	50 ppm		
	SG OEL	TWA	50 ppm	246 mg/m3	

Additional Information : SHELL IS is the Shell Internal Standard. Skin notation means that significant exposure can also occur by absorption of liquid through the skin and of vapour through the eyes or mucous membranes.

Biological Exposure Index (BEI)

Material	Determinant	Sampling Time	BEI	Reference
Benzene	t,t-Muconic acid in Creatinine in urine	Sampling time: End of shift.	500 µg/g	ACGIH BEL (2011)
	S-Phenylmercapturic acid in Creatinine in urine	Sampling time: End of shift.	25 µg/g	ACGIH BEL (2011)
n-hexane	2,5-Hexanedion, without hydrolysis in Urine	Sampling time: End of shift at end of work week.	0.4 mg/l	ACGIH BEL (2011)
Toluene	o-Cresol, with hydrolysis in Creatinine in urine	Sampling time: End of shift.	0.3 mg/g	ACGIH BEL (2011)
	toluene in Blood	Sampling time: Prior to last shift of work week.	0.02 mg/l	ACGIH BEL (2011)
	toluene in Urine	Sampling time: End of shift.	0.03 mg/l	ACGIH BEL (2011)

Ethylbenzene	Sum of mandelic acid and phenylglyoxylic acid in Creatinine in urine	Sampling time: End of shift at end of work week.	0.7 g/g	ACGIH BEL (2011)
	Ethyl benzene in End-exhaled air	Sampling time: Not critical.		ACGIH BEL (2011)
Xylene	Methylhippuric acids in Creatinine in urine	Sampling time: End of shift.	1.5 g/g	ACGIH BEL (2011)
Naphthalene	1-Naphthol, with hydrolysis + 2-Naphthol, with hydrolysis	Sampling time: End of shift.		ACGIH BEL (02 2013)

Appropriate Engineering Controls : The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Select controls based on a risk assessment of local circumstances. Appropriate measures include: Use sealed systems as far as possible. Adequate explosion-proof ventilation to control airborne concentrations below the exposure guidelines/limits. Local exhaust ventilation is recommended. Eye washes and showers for emergency use. Always observe good personal hygiene measures, such as washing hands after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practice good housekeeping. Define procedures for safe handling and maintenance of controls. Educate and train workers in the hazards and control measures relevant to normal activities associated with this product. Ensure appropriate selection, testing and maintenance of equipment used to control exposure, e.g. personal protective equipment, local exhaust ventilation. Firewater monitors and deluge systems are recommended. Drain down system prior to equipment break-in or maintenance. Retain drain downs in sealed storage pending disposal or for subsequent recycle.

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Individual Protection Measures	:	Personal protective equipment (PPE) should meet recommended national standards. Check with PPE suppliers.
Respiratory Protection	:	If engineering controls do not maintain airborne concentrations to a level which is adequate to protect worker health, select respiratory protection equipment suitable for the specific conditions of use and meeting relevant legislation. Check with respiratory protective equipment suppliers. Where air-filtering respirators are suitable, select an appropriate combination of mask and filter. Where air-filtering respirators are unsuitable (e.g. airborne concentrations are high, risk of oxygen deficiency, confined space) use appropriate positive pressure breathing apparatus. All respiratory protection equipment and use must be in accordance with local regulations. Select a filter suitable for combined particulate/organic gases and vapours [boiling point >65°C(149 °F)].
Hand Protection	:	Personal hygiene is a key element of effective hand care. Gloves must only be worn on clean hands. After using gloves, hands should be washed and dried thoroughly. Application of a non-perfumed moisturizer is recommended. Suitability and durability of a glove is dependent on usage, e.g. frequency and duration of contact, chemical resistance of glove material, dexterity. Always seek advice from glove suppliers. Contaminated gloves should be replaced. For continuous contact we recommend gloves with breakthrough time of more than 240 minutes with preference for > 480 minutes where suitable gloves can be identified. For short-term/splash protection we recommend the same, but recognise that suitable gloves offering this level of protection may not be available and in this case a lower breakthrough time may be acceptable so long as appropriate maintenance and replacement regimes are followed. Glove thickness is not a good predictor of glove resistance to a chemical as it is dependent on the exact composition of the glove material. Select gloves tested to a relevant standard (e.g. Europe EN374, US F739). When prolonged or frequent repeated contact occurs, Nitrile gloves may be suitable. (Breakthrough time of > 240 minutes.) For incidental contact/splash protection Neoprene, PVC gloves may be suitable.
Eye Protection	:	Chemical splash goggles (chemical monogoggles). If a local risk assessment deems it so, then chemical splash goggles may not be required and safety glasses may provide adequate eye protection.
Protective Clothing	:	Chemical resistant gloves/gauntlets, boots, and apron (where risk of splashing).
Thermal Hazards	:	Not applicable.

Monitoring Methods	:	Monitoring of the concentration of substances in the breathing zone of workers or in the general workplace may be required to confirm compliance with an OEL and adequacy of exposure controls. For some substances biological monitoring may also be appropriate. Validated exposure measurement methods should be applied by a competent person and samples analysed by an accredited laboratory. Examples of sources of recommended exposure measurement methods are given below or contact the supplier. Further national methods may be available. National Institute of Occupational Safety and Health (NIOSH), USA: Manual of Analytical Methods http://www.cdc.gov/niosh/ Occupational Safety and Health Administration (OSHA), USA: Sampling and Analytical Methods http://www.osha.gov/
Environmental Exposure Controls	:	Local guidelines on emission limits for volatile substances must be observed for the discharge of exhaust air containing vapour. Take appropriate measures to fulfil the requirements of relevant environmental protection legislation. Avoid contamination of the environment by following advice given in Chapter 6. If necessary, prevent undissolved material from being discharged to waste water. Waste water should be treated in a municipal or industrial waste water treatment plant before discharge to surface water.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Yellow. Clear, bright liquid.
Odour	:	Hydrocarbon
Odour threshold	:	Data not available
pH	:	Data not available
Initial Boiling Point and Boiling Range	:	25 - 220 °C / 77 - 428 °F
Freezing Point	:	Data not available
Flash point	:	-40 °C / -40 °F (Tagliabue Closed Cup)
Upper / lower Flammability or Explosion limits	:	1 - 8 %(V)
Auto-ignition temperature	:	> 250 °C / 482 °F
Vapour pressure	:	Typical 570 hPa at 37.8 °C / 100.0 °F
Relative Density	:	Data not available
Density	:	Typical 0.740 g/cm3 at 15 °C / 59 °F
Water solubility	:	Negligible.
Solubility in other solvents	:	Data not available
n-octanol/water partition	:	2 - 7

coefficient (log Pow)		
Dynamic viscosity	:	Data not available
Kinematic viscosity	:	0.5 - 0.75 mm2/s at 40 °C / 104 °F
Vapour density (air=1)	:	Data not available
Electrical conductivity	:	Low conductivity: < 100 pS/m, The conductivity of this material makes it a static accumulator., A liquid is typically considered nonconductive if its conductivity is below 100 pS/m and is considered semi-conductive if its conductivity is below 10 000 pS/m., Whether a liquid is nonconductive or semi-conductive, the precautions are the same., A number of factors, for example liquid temperature, presence of contaminants, and anti-static additives can greatly influence the conductivity of a liquid.
Evaporation rate (nBuAc=1)	:	Data not available
Decomposition Temperature	:	Data not available
Flammability	:	Extremely flammable.

10. STABILITY AND REACTIVITY

Chemical stability	:	Stable under normal conditions of use.
Possibility of Hazardous Reactions	:	No hazardous reaction is expected when handled and stored according to provisions.
Conditions to Avoid	:	Avoid heat, sparks, open flames and other ignition sources.
Incompatible Materials	:	Strong oxidising agents.
Hazardous Decomposition Products	:	Hazardous decomposition products are not expected to form during normal storage. Thermal decomposition is highly dependent on conditions. A complex mixture of airborne solids, liquids and gases, including carbon monoxide, carbon dioxide and other organic compounds will be evolved when this material undergoes combustion or thermal or oxidative degradation.
Hazardous Polymerisation	:	No
Sensitivity to Mechanical Impact	:	No
Sensitivity to Static Discharge	:	Yes, in certain circumstances product can ignite due to static electricity.

11. TOXICOLOGICAL INFORMATION

Information on Toxicological effects

Basis for Assessment	:	Information given is based on product data, a knowledge of the components and the toxicology of similar products. Unless indicated otherwise, the data presented is representative of the

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product as a whole, rather than for individual component(s).

Likely Routes of Exposure	:	Exposure may occur via inhalation, ingestion, skin absorption, skin or eye contact, and accidental ingestion.
Acute Oral Toxicity	:	Low toxicity: LD50 > 5000 mg/kg
Acute Dermal Toxicity	:	Low toxicity: LD50 >2000 mg/kg , Rabbit
Acute Inhalation Toxicity	:	Low toxicity: LC50 >5 mg/l , 4 h, Rat
Skin corrosion/irritation	:	Irritating to skin.
Serious eye damage/irritation	:	Expected to be slightly irritating.
Respiratory Irritation	:	Based on human experience, breathing of vapours or mists may cause a temporary burning sensation to nose, throat and lungs.
Respiratory or skin sensitisation	:	Not expected to be a sensitiser.
Aspiration Hazard	:	Aspiration into the lungs when swallowed or vomited may cause chemical pneumonitis which can be fatal.
Germ cell mutagenicity	:	May cause heritable genetic damage. (Benzene) Mutagenicity studies on gasoline and gasoline blending streams have shown predominantly negative results.
Carcinogenicity	:	Known human carcinogen. (Benzene) May cause leukaemia (AML - acute myelogenous leukemia). (Benzene) Inhalation exposure to mice causes liver tumours, which are not considered relevant to humans.

Material	:	**Carcinogenicity Classification**
Gasoline, low boiling point naphtha	:	ACGIH Group A3: Confirmed animal carcinogen with unknown relevance to humans.
Gasoline, low boiling point naphtha	:	IARC 2B: Possibly carcinogenic to humans.
Gasoline, low boiling point naphtha	:	GHS / CLP: Carcinogenicity Category 1B
Trimethylbenzene, all isomers	:	GHS / CLP: No carcinogenicity classification
Ethylbenzene	:	IARC 2B: Possibly carcinogenic to humans.
Ethylbenzene	:	GHS / CLP: No carcinogenicity classification
n-hexane	:	GHS / CLP: No carcinogenicity classification

Benzene	:	ACGIH Group A1: Confirmed human carcinogen.
Benzene	:	NTP: Known To Be Human Carcinogen.
Benzene	:	IARC 1: Carcinogenic to humans.
Benzene	:	GHS / CLP: Carcinogenicity Category 1A
Toluene	:	ACGIH Group A4: Not classifiable as a human carcinogen.
Toluene	:	IARC 3: Not classifiable as to carcinogenicity to humans.
Toluene	:	GHS / CLP: No carcinogenicity classification
Xylene	:	ACGIH Group A4: Not classifiable as a human carcinogen.
Xylene	:	IARC 3: Not classifiable as to carcinogenicity to humans.
Xylene	:	GHS / CLP: No carcinogenicity classification
Cyclohexane	:	GHS / CLP: No carcinogenicity classification
Naphthalene	:	ACGIH Group A4: Not classifiable as a human carcinogen.
Naphthalene	:	NTP: Reasonably Anticipated to be a Human Carcinogen.
Naphthalene	:	IARC 2B: Possibly carcinogenic to humans.
Naphthalene	:	GHS / CLP: Carcinogenicity Category 2
Ethyl tertiary butyl ether	:	ACGIH Group A4: Not classifiable as a human carcinogen.
Ethyl tertiary butyl ether	:	GHS / CLP: No carcinogenicity classification
Methyl tertiary butyl ether	:	IARC 3: Not classifiable as to carcinogenicity to humans.
Methyl tertiary butyl ether	:	GHS / CLP: No carcinogenicity classification
Tertiary amyl methyl ether	:	GHS / CLP: No carcinogenicity classification
Cumene	:	IARC 2B: Possibly carcinogenic to humans.
Cumene	:	GHS / CLP: No carcinogenicity classification

Reproductive and Developmental Toxicity : Causes foetotoxicity at doses which are maternally toxic. (Toluene)
May impair fertility at doses which produce other toxic effects. (n-hexane)
Many case studies involving abuse during pregnancy indicate that toluene can cause birth defects, growth retardation and learning difficulties. (Toluene)
Inhalation of high concentrations of gasoline vapour containing Methyl tertiary butyl ether produced a very low incidence of rare birth defects (ventral midline closure failure) in mice.

Specific target organ toxicity - single exposure : High concentrations may cause central nervous system depression resulting in headaches, dizziness and nausea; continued inhalation may result in unconsciousness and/or death.

Specific target organ toxicity - repeated exposure : Kidney: caused kidney effects in male rats which are not considered relevant to humans

Blood-forming organs: repeated exposure affects the bone

marrow.

Additional Information : Prolonged and repeated exposures to high concentrations have resulted in hearing loss in rats. Solvent abuse and noise interaction in the work environment may cause hearing loss. (Toluene)

Abuse of vapours has been associated with organ damage and death. (Toluene)

Exposure to very high concentrations of similar materials has been associated with irregular heart rhythms and cardiac arrest.

May cause MDS (Myelodysplastic Syndrome). (Benzene)

Classifications by other authorities under varying regulatory frameworks may exist.

12. ECOLOGICAL INFORMATION

Basis for Assessment : Fuels are typically made from blending several refinery streams. Ecotoxicological studies have been carried out on a variety of hydrocarbon blends and streams but not those containing additives. Information given is based on a knowledge of the components and the ecotoxicology of similar products. Unless indicated otherwise, the data presented is representative of the product as a whole, rather than for individual component(s).

Acute Toxicity : Expected to be toxic: LL/EL/IL50 > 1 <= 10 mg/l (to aquatic organisms) LL/EL50 expressed as the nominal amount of product required to prepare aqueous test extract.

Fish : Expected to be toxic: LL/EL/IL50 > 1 <= 10 mg/l

Aquatic crustacea : Expected to be toxic: LL/EL/IL50 > 1 <= 10 mg/l

Algae/aquatic plants : Expected to be toxic: LL/EL/IL50 > 1 <= 10 mg/l

Microorganisms : Expected to be harmful: LL/EL/IL50 >10 <= 100 mg/l

Chronic Toxicity

Fish : NOEC/NOEL expected to be > 1.0 - <= 10 mg/l

Aquatic crustacea : NOEC/NOEL expected to be > 1.0 - <= 10 mg/l

Mobility : Evaporates within a day from water or soil surfaces. Large volumes may penetrate soil and could contaminate groundwater. Toxic to aquatic organisms; may cause long-term adverse effects in the aquatic environment. Ether oxygenates are significantly more water soluble and less biodegradable

		than benzene, toluene, ethyl benzene and xylenes (BTEX). Consequently ether oxygenates have the potential to migrate relatively longer distances than BTEX in groundwater. Contains volatile components. Floats on water. Methyl tertiary butyl ether degradation may result in the formation of tert-butyl alcohol (TBA).
Persistence/degradability	:	Major constituents are expected to be inherently biodegradable, but the product contains components that may persist in the environment. The volatile constituents will oxidize rapidly by photochemical reactions in air. While biodegradation of Methyl tertiary butyl ether has been documented, it is generally less biodegradable than many petroleum hydrocarbons and has a potential to migrate relatively longer distances in groundwater.
Bioaccumulative Potential	:	Contains constituents with the potential to bioaccumulate. Log Kow > =4
Other Adverse Effects	:	Films formed on water may affect oxygen transfer and damage organisms.

13. DISPOSAL CONSIDERATIONS

Material Disposal	:	Recover or recycle if possible. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste classification and disposal methods in compliance with applicable regulations. Waste arising from a spillage or tank cleaning should be disposed of in accordance with prevailing regulations, preferably to a recognised collector or contractor. The competence of the collector or contractor should be established beforehand. Do not dispose into the environment, in drains or in water courses. Do not dispose of tank water bottoms by allowing them to drain into the ground. This will result in soil and groundwater contamination.
Container Disposal	:	Drain container thoroughly. After draining, vent in a safe place away from sparks and fire. Residues may cause an explosion hazard. Do not puncture, cut, or weld uncleaned drums. Send to drum recoverer or metal reclaimer. Do not pollute the soil, water or environment with the waste container.
Local Legislation	:	Disposal should be in accordance with applicable regional, national, and local laws and regulations. Local regulations may be more stringent than regional or national requirements and must be in compliance.

14. TRANSPORT INFORMATION

Land (as per ADR classification): Regulated

Class	:	3
Packing group	:	II
Hazard indentification no.	:	33
UN number	:	1203
Danger label (primary risk)	:	3
Proper shipping name	:	GASOLINE (UNLEADED)
Environmentally Hazardous	:	Yes

IMDG

Identification number	UN 1203
Proper shipping name	GASOLINE
Technical name	(UNLEADED)
Class / Division	3
Packing group	II
Environmental hazards:	Yes

IATA (Country variations may apply)

UN number	:	1203
Proper shipping name	:	Gasoline
Technical name	:	(UNLEADED)
Class / Division	:	3
Packing group	:	II

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Pollution Category	**:**	Not applicable.
Ship Type	**:**	Not applicable.
Product Name	**:**	Not applicable.
Special Precaution	**:**	Not applicable.
Additional Information	**:**	MARPOL Annex 1 rules apply for bulk shipments by sea.

15. REGULATORY INFORMATION

The regulatory information is not intended to be comprehensive. Other regulations may apply to this material.

Local Regulations

Workplace Safety and Health Act & Workplace	:	This product is subject to the requirement in the Act/ Regulations.

Safety and Health (General Provision) Regulations		
Environmental Protection and Management Act and Environmental Protection and Management (Hazardous Substances) Regulations	:	This product is subject to the requirement in the Act/ Regulations.
Maritime and Port Authority of Singapore (Dangerous Goods, Petroleum and Explosives) Regulations	:	This product is subject to the requirement in the Act/ Regulations.
Fire Safety Act and Fire Safety (Petroleum & Flammable Materials) Regulations	:	This product is subject to the requirement in the Act/ Regulations.
Classification triggering components	:	Contains gasoline, low boiling point naphtha, unspecified.

16. OTHER INFORMATION

Hazard Statement

H224	Extremely flammable liquid and vapour.
H225	Highly flammable liquid and vapour.
H302	Harmful if swallowed.
H303	May be harmful if swallowed.
H304	May be fatal if swallowed and enters airways.
H305	May be harmful if swallowed and enters airways.
H315	Causes skin irritation.
H316	Causes mild skin irritation.
H336	May cause drowsiness or dizziness.
H340	May cause genetic defects.
H350	May cause cancer.
H361	Suspected of damaging fertility or the unborn child.
H401	Toxic to aquatic life.
H402	Harmful to aquatic life.
H411	Toxic to aquatic life with long lasting effects.

Additional Information	:	This document contains important information to ensure the safe storage, handling and use of this product. The information in this document should be brought to the attention of the person in your organisation responsible for advising on safety matters.
SDS Version Number	:	1.0
SDS Effective Date	:	10.03.2014

Safety Data Sheet

SDS Revisions	:	A vertical bar (|) in the left margin indicates an amendment from the previous version.
Uses and Restrictions	:	This product must not be used in applications other than those recommended in Section 1, without first seeking the advice of the supplier. This product is not to be used as a solvent or cleaning agent; for lighting or brightening fires; as a skin cleanser. This product is designed only to suit automotive applications and no provision is made for the requirements of aviation applications.
SDS Distribution	:	The information in this document should be made available to all who may handle the product.
Key/Legend to Abbrevations used in this SDS	:	The standard abbreviations and acronyms used in this document can be looked up in reference literature (e.g. scientific dictionaries) and/or websites.

Flam. Liq.	Flammable liquids
Asp. Tox.	Aspiration hazard
Muta.	Germ cell mutagenicity
Carc.	Carcinogenicity
Skin Corr.	Skin corrosion/irritation
STOT SE	Specific target organ toxicity - single exposure
	Toxic for Reproduction

Key Literature References	:	The quoted data are from, but not limited to, one or more sources of information (e.g. toxicological data from Shell Health Services, material suppliers' data, CONCAWE, EU IUCLID date base, EC 1272 regulation, etc).
Disclaimer	:	This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.

SAFETY DATA SHEET

1. Identification

Product identifier	**Insect Repellent**
Other means of identification	
Product code	14011
Registration number	EPA: 51147-13-55809
Recommended use	Insect repellent
Recommended restrictions	None known.

Manufacturer/Importer/Supplier/Distributor information

Manufactured or sold by:

Company name	CRC Industries, Inc.
Address	885 Louis Dr. Warminster, PA 18974 US
Telephone	
General Information	215-674-4300
Technical Assistance	800-521-3168
Customer Service	800-272-4620
24-Hour Emergency (CHEMTREC)	800-424-9300 (US) 703-527-3887 (International)
Website	www.crcindustries.com

2. Hazard(s) identification

Physical hazards	Flammable aerosols	Category 1
	Gases under pressure	Liquefied gas
Health hazards	Acute toxicity, oral	Category 4
	Acute toxicity, dermal	Category 4
	Skin corrosion/irritation	Category 2
	Serious eye damage/eye irritation	Category 2
	Sensitization, skin	Category 1
	Specific target organ toxicity, single exposure	Category 3 narcotic effects
Environmental hazards	Hazardous to the aquatic environment, acute hazard	Category 2
	Hazardous to the aquatic environment, long-term hazard	Category 3

OSHA defined hazards Not classified.

Label elements

Signal word	Danger
Hazard statement	Extremely flammable aerosol. Contains gas under pressure; may explode if heated. Harmful if swallowed. Harmful in contact with skin. Causes skin irritation. May cause an allergic skin reaction. Causes serious eye irritation. May cause drowsiness or dizziness. Toxic to aquatic life. Harmful to aquatic life with long lasting effects.

Precautionary statement

Prevention	Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Do not spray on an open flame or other ignition source. Pressurized container: Do not pierce or burn, even after use. Do not apply while equipment is energized. Extinguish all flames, pilot lights and heaters. Vapors will accumulate readily and may ignite. Use only with adequate ventilation; maintain ventilation during use and until all vapors are gone. Open doors and windows or use other means to ensure a fresh air supply during use and while product is drying. If you experience any symptoms listed on this label, increase ventilation or leave the area. Avoid breathing mist or vapor. Do not eat, drink or smoke when using this product. Contaminated work clothing must not be allowed out of the workplace. Wear eye/face protection. Wear protective gloves/protective clothing. Wash thoroughly after handling. Avoid release to the environment.
Response	If swallowed: Call a poison center/doctor if you feel unwell. Rinse mouth. If on skin: Wash with plenty of water. If skin irritation or rash occurs: Get medical attention. Take off contaminated clothing and wash before reuse. If inhaled: Remove person to fresh air and keep comfortable for breathing. Call a poison center/doctor if you feel unwell. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical attention.
Storage	Store in a well-ventilated place. Store locked up. Protect from sunlight. Do not expose to temperatures exceeding 50°C/122°F. Exposure to high temperature may cause can to burst.
Disposal	Dispose of contents/container in accordance with local/regional/national regulations.
Hazard(s) not otherwise classified (HNOC)	Static accumulating flammable liquid can become electrostatically charged even in bonded and grounded equipment. Sparks may ignite liquid and vapor. May cause flash fire or explosion.

3. Composition/information on ingredients

Mixtures

Chemical name	Common name and synonyms	CAS number	%
isopropyl alcohol		67-63-0	30 - 40
liquefied petroleum gas		68476-86-8	20 - 30
N,N-diethyl-m-toluamide (DEET)		134-62-3	25
N-octyl bicycloheptene dicarboximide		113-48-4	5
di-n-propyl isocinchomeronate		136-45-8	2.5
acetone		67-64-1	1 - 3
propylene glycol		57-55-6	1 - 3

Specific chemical identity and/or percentage of composition has been withheld as a trade secret.

4. First-aid measures

Inhalation	Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or doctor/physician if you feel unwell.
Skin contact	Remove contaminated clothing immediately and wash skin with soap and water. In case of eczema or other skin disorders: Seek medical attention and take along these instructions. Wash contaminated clothing before reuse.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention if irritation develops and persists.
Ingestion	Rinse mouth. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Get medical advice/attention if you feel unwell.
Most important symptoms/effects, acute and delayed	May cause drowsiness and dizziness. Headache. Nausea, vomiting. Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Skin irritation. May cause redness and pain. May cause an allergic skin reaction. Dermatitis. Rash.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically. Keep victim warm. Keep victim under observation. Symptoms may be delayed.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before reuse.

5. Fire-fighting measures

Suitable extinguishing media	Alcohol resistant foam. Water fog. Carbon dioxide (CO2). Dry chemical powder, carbon dioxide, sand or earth may be used for small fires only.

Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	Contents under pressure. Pressurized container may rupture when exposed to heat or flame. This product is a poor conductor of electricity and can become electrostatically charged. If sufficient charge is accumulated, ignition of flammable mixtures can occur. Static electricity accumulation may be significantly increased by the presence of small quantities of water or other contaminants. Material will float and may ignite on surface of water. During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for firefighters	Firefighters must use standard protective equipment including flame retardant coat, helmet with face shield, gloves, rubber boots, and in enclosed spaces, SCBA.
Fire-fighting equipment/instructions	In case of fire: Stop leak if safe to do so. Move containers from fire area if you can do so without risk. Containers should be cooled with water to prevent vapor pressure build up.
General fire hazards	Extremely flammable aerosol. Contents under pressure. Pressurized container may rupture when exposed to heat or flame.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Keep out of low areas. Remove all possible sources of ignition in the surrounding area. Many vapors are heavier than air and will spread along ground and collect in low or confined areas (sewers, basements, tanks). Wear appropriate protective equipment and clothing during clean-up. Avoid breathing mist or vapor. Emergency personnel need self-contained breathing equipment. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ventilate closed spaces before entering them. Use appropriate containment to avoid environmental contamination. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Keep combustibles (wood, paper, oil, etc.) away from spilled material. The product is immiscible with water and will spread on the water surface. Stop the flow of material, if this is without risk. Prevent product from entering drains. Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid release to the environment. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground. Inform appropriate managerial or supervisory personnel of all environmental releases. Use appropriate containment to avoid environmental contamination.

7. Handling and storage

Precautions for safe handling	Minimize fire risks from flammable and combustible materials (including combustible dust and static accumulating liquids) or dangerous reactions with incompatible materials. Pressurized container: Do not pierce or burn, even after use. Do not use if spray button is missing or defective. Do not spray on a naked flame or any other incandescent material. Do not smoke while using or until sprayed surface is thoroughly dry. Do not cut, weld, solder, drill, grind, or expose containers to heat, flame, sparks, or other sources of ignition. Use caution around energized equipment. The metal container will conduct electricity if it contacts a live source. This may result in injury to the user from electrical shock and/or flash fire. Avoid breathing mist or vapor. Avoid contact with eyes, skin, and clothing. Do not taste or swallow. When using, do not eat, drink or smoke. Use only in well-ventilated areas. Wear appropriate personal protective equipment. Wash hands thoroughly after handling. Observe good industrial hygiene practices. Avoid release to the environment. Wash contaminated clothing before reuse. For product usage instructions, please see the product label.
Conditions for safe storage, including any incompatibilities	Level 3 Aerosol. Pressurized container. Protect from sunlight and do not expose to temperatures exceeding 50°C/122 °F. Do not puncture, incinerate or crush. Do not handle or store near an open flame, heat or other sources of ignition. This material can accumulate static charge which may cause spark and become an ignition source. Avoid spark promoters. These alone may be insufficient to remove static electricity. Store in a well-ventilated place. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value
acetone (CAS 67-64-1)	PEL	2400 mg/m3 1000 ppm

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value
isopropyl alcohol (CAS 67-63-0)	PEL	980 mg/m3
		400 ppm

US. ACGIH Threshold Limit Values

Components	Type	Value
acetone (CAS 67-64-1)	STEL	500 ppm
	TWA	250 ppm
isopropyl alcohol (CAS 67-63-0)	STEL	400 ppm
	TWA	200 ppm

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
acetone (CAS 67-64-1)	TWA	590 mg/m3
		250 ppm
isopropyl alcohol (CAS 67-63-0)	STEL	1225 mg/m3
		500 ppm
	TWA	980 mg/m3
		400 ppm

US. AIHA Workplace Environmental Exposure Level (WEEL) Guides

Components	Type	Value	Form
propylene glycol (CAS 57-55-6)	TWA	10 mg/m3	Aerosol.

Biological limit values

ACGIH Biological Exposure Indices

Components	Value	Determinant	Specimen	Sampling Time
acetone (CAS 67-64-1)	25 mg/l	Acetone	Urine	*
isopropyl alcohol (CAS 67-63-0)	40 mg/l	Acetone	Urine	*

* - For sampling details, please see the source document.

Appropriate engineering controls

Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower should be available when handling this product.

Individual protection measures, such as personal protective equipment

Eye/face protection

Wear safety glasses with side shields (or goggles).

Skin protection

Hand protection

Wear protective gloves such as: Nitrile. Viton®.

Other

Wear appropriate chemical resistant clothing. Use of an impervious apron is recommended.

Respiratory protection

If engineering controls are not feasible or if exposure exceeds the applicable exposure limits, use a NIOSH-approved cartridge respirator with an organic vapor cartridge. Use a self-contained breathing apparatus in confined spaces and for emergencies. Air monitoring is needed to determine actual employee exposure levels.

Thermal hazards

Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations

When using do not smoke. Keep away from food and drink. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Contaminated work clothing should not be allowed out of the workplace.

9. Physical and chemical properties

Appearance

Physical state	Liquid.
Form	Aerosol.
Color	Clear. Colorless.
Odor	Mild. Alcoholic.
Odor threshold	Not available.
pH	Not available.
Melting point/freezing point	-138.5 °F (-94.7 °C) estimated
Initial boiling point and boiling range	132.9 °F (56.1 °C) estimated
Flash point	75 °F (23.9 °C) Tag Closed Cup
Evaporation rate	Moderate.
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	2 % estimated
Flammability limit - upper (%)	12.8 % estimated
Vapor pressure	1255.3 hPa estimated
Vapor density	> 1 (air = 1)
Relative density	0.8 estimated
Solubility (water)	Immiscible.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	700 °F (371.1 °C) estimated
Decomposition temperature	Not available.
Viscosity (kinematic)	Not available.
Percent volatile	67.5 % estimated

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Heat, flames and sparks. Contact with incompatible materials.
Incompatible materials	Acids. Strong oxidizing agents. Isocyanates. Chlorine.
Hazardous decomposition products	Carbon oxides. Nitrogen oxides (NOx).

11. Toxicological information

Information on likely routes of exposure

Inhalation	May cause drowsiness and dizziness. Headache. Nausea, vomiting.
Skin contact	Harmful in contact with skin. Causes skin irritation. May cause an allergic skin reaction.
Eye contact	Causes serious eye irritation.
Ingestion	Harmful if swallowed.
Symptoms related to the physical, chemical and toxicological characteristics	Headache. May cause drowsiness and dizziness. Nausea, vomiting. Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Skin irritation. May cause redness and pain. May cause an allergic skin reaction. Dermatitis. Rash.

Information on toxicological effects

Acute toxicity	In high concentrations, vapors are anesthetic and may cause headache, fatigue, dizziness and central nervous system effects. Harmful in contact with skin. Harmful if swallowed. Narcotic effects. May cause an allergic skin reaction.

Product	Species	Test Results
Insect Repellent		
Acute		
Dermal		
LD50	Rabbit	1388 mg/kg estimated
Inhalation		
LC50	Rat	41224 ppm, 4 hours estimated
Oral		
LD50	Rat	1747 mg/kg estimated
TDL0	Human	117 g/kg estimated

* Estimates for product may be based on additional component data not shown.

Skin corrosion/irritation Causes skin irritation.

Serious eye damage/eye irritation Causes serious eye irritation.

Respiratory sensitization Not a respiratory sensitizer.

Skin sensitization May cause an allergic skin reaction.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

IARC Monographs. Overall Evaluation of Carcinogenicity

Not listed.

US. National Toxicology Program (NTP) Report on Carcinogens

Not listed.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure May cause drowsiness and dizziness.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

12. Ecological information

Ecotoxicity Toxic to aquatic life. Harmful to aquatic life with long lasting effects.

Components		Species	Test Results
acetone (CAS 67-64-1)			
Aquatic			
Crustacea	EC50	Water flea (Daphnia magna)	10294 - 17704 mg/l, 48 hours
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	4740 - 6330 mg/l, 96 hours
isopropyl alcohol (CAS 67-63-0)			
Aquatic			
Acute			
Crustacea	EC50	Water flea (Daphnia magna)	7550 - 13299 mg/l, 48 hours
Fish	LC50	Fathead minnow (Pimephales promelas)	9640 mg/l, 96 hours
N,N-diethyl-m-toluamide (DEET) (CAS 134-62-3)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	106 - 114 mg/l, 96 hours
propylene glycol (CAS 57-55-6)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	710 mg/l, 96 hours

Components		Species	Test Results
Acute			
Crustacea	EC50	Water flea (Daphnia magna)	4850 - 34000 mg/l, 48 hours

* Estimates for product may be based on additional component data not shown.

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential

Partition coefficient n-octanol / water (log Kow)

acetone	-0.24
isopropyl alcohol	0.05
N,N-diethyl-m-toluamide (DEET)	2.02
propylene glycol	-0.92

Bioconcentration factor (BCF)

isopropyl alcohol	3.16

Mobility in soil No data available.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal of waste from residues / unused products If discarded, this product is considered a RCRA ignitable waste, D001. Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Contents under pressure. Do not puncture, incinerate or crush. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose in accordance with all applicable regulations.

Hazardous waste code D001: Waste Flammable material with a flash point <140 F

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

DOT

UN number	UN1950
UN proper shipping name	Aerosols, flammable, Limited Quantity
Transport hazard class(es)	
Class	2.1
Subsidiary risk	-
Label(s)	2.1
Packing group	Not applicable.
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	N82
Packaging exceptions	306
Packaging non bulk	None
Packaging bulk	None

IATA

UN number	UN1950
UN proper shipping name	Aerosols, flammable, Limited Quantity
Transport hazard class(es)	
Class	2.1
Subsidiary risk	-
Packing group	Not applicable.
ERG Code	10L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Other information	
Passenger and cargo aircraft	Allowed with restrictions.
Cargo aircraft only	Allowed with restrictions.

IMDG

UN number	UN1950
UN proper shipping name	AEROSOLS, LIMITED QUANTITY

Transport hazard class(es)

Class	2
Subsidiary risk	-
Packing group	Not applicable.
Environmental hazards	
Marine pollutant	No.
EmS	Not available.
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

SARA 304 Emergency release notification

Not regulated.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

US EPCRA (SARA Title III) Section 313 - Toxic Chemical: Listed substance

di-n-propyl isocinchomeronate (CAS 136-45-8)

CERCLA Hazardous Substance List (40 CFR 302.4)

acetone (CAS 67-64-1) Listed.

CERCLA Hazardous Substances: Reportable quantity

acetone (CAS 67-64-1) 5000 LBS

Spills or releases resulting in the loss of any ingredient at or above its RQ require immediate notification to the National Response Center (800-424-8802) and to your Local Emergency Planning Committee.

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

Drug Enforcement Administration (DEA). List 2, Essential Chemicals (21 CFR 1310.02(b) and 1310.04(f)(2) and Chemical Code Number

acetone (CAS 67-64-1) 6532

Drug Enforcement Administration (DEA). List 1 & 2 Exempt Chemical Mixtures (21 CFR 1310.12(c))

acetone (CAS 67-64-1) 35 %WV

DEA Exempt Chemical Mixtures Code Number

acetone (CAS 67-64-1) 6532

FEMA Priority Substances Respiratory Health and Safety in the Flavor Manufacturing Workplace

acetone (CAS 67-64-1) Low priority
isopropyl alcohol (CAS 67-63-0) Low priority

Food and Drug Administration (FDA) Not regulated.

US EPA Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

FIFRA Information	This chemical is a pesticide product registered by the United States Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets (SDS), and for workplace labels of non-pesticide chemicals. The hazard information required on the pesticide label is reproduced below. The pesticide label also includes other important information, including directions for use.
Signal word	Warning.
Hazard statement	Harmful if swallowed. Causes substantial but temporary eye injury. This product is registered in all 50 United States and Puerto Rico. This product is not registered outside of the United States and Puerto Rico.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Section 311/312 Hazard categories	Immediate Hazard - Yes Delayed Hazard - No Fire Hazard - Yes Pressure Hazard - Yes Reactivity Hazard - No
SARA 302 Extremely hazardous substance	No

US state regulations

US. California. Candidate Chemicals List. Safer Consumer Products Regulations (Cal. Code Regs, tit. 22, 69502.3, subd. (a))

acetone (CAS 67-64-1)
di-n-propyl isocinchomeronate (CAS 136-45-8)
isopropyl alcohol (CAS 67-63-0)
liquefied petroleum gas (CAS 68476-86-8)

US. California Controlled Substances. CA Department of Justice (California Health and Safety Code Section 11100)

Not listed.

US. New Jersey Worker and Community Right-to-Know Act

acetone (CAS 67-64-1)
propylene glycol (CAS 57-55-6)
di-n-propyl isocinchomeronate (CAS 136-45-8)
isopropyl alcohol (CAS 67-63-0)

US. Massachusetts RTK - Substance List

acetone (CAS 67-64-1)
isopropyl alcohol (CAS 67-63-0)

US. Pennsylvania Worker and Community Right-to-Know Law

acetone (CAS 67-64-1)
isopropyl alcohol (CAS 67-63-0)
propylene glycol (CAS 57-55-6)

US. Rhode Island RTK

acetone (CAS 67-64-1)
di-n-propyl isocinchomeronate (CAS 136-45-8)

US. California Proposition 65

WARNING: This product contains a chemical known to the State of California to cause cancer and birth defects or other reproductive harm.

US - California Proposition 65 - CRT: Listed date/Carcinogenic substance

benzene (CAS 71-43-2)	Listed: February 27, 1987
cumene (CAS 98-82-8)	Listed: April 6, 2010
di-n-propyl isocinchomeronate (CAS 136-45-8)	Listed: May 1, 1996
ethanal (CAS 75-07-0)	Listed: April 1, 1988

US - California Proposition 65 - CRT: Listed date/Developmental toxin

benzene (CAS 71-43-2)	Listed: December 26, 1997
toluene (CAS 108-88-3)	Listed: January 1, 1991

US - California Proposition 65 - CRT: Listed date/Male reproductive toxin

benzene (CAS 71-43-2)	Listed: December 26, 1997

Volatile organic compounds (VOC) regulations

EPA

VOC content (40 CFR 51.100(s))	64.9 %
Consumer products (40 CFR 59, Subpt. C)	Not regulated

State

Consumer products	This product is regulated as an Insect Repellent. This product is compliant for use in all 50 states.
VOC content (CA)	64.9 %
VOC content (OTC)	64.9 %

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes

Country(s) or region	Inventory name	On inventory (yes/no)*
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	No
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	No
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	No
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 05-21-2015

Revision date 06-29-2016

Prepared by Allison Cho

Version # 02

Further information CRC # 926

HMIS® ratings
Health: 1
Flammability: 3
Physical hazard: 0
Personal protection: B

NFPA ratings
Health: 1
Flammability: 3
Instability: 0

NFPA ratings

Disclaimer
The information contained in this document applies to this specific material as supplied. It may not be valid for this material if it is used in combination with any other materials. This information is accurate to the best of CRC Industries' knowledge or obtained from sources believed by CRC to be accurate. Before using any product, read all warnings and directions on the label. For further clarification of any information contained on this (M)SDS consult your supervisor, a health & safety professional, or CRC Industries.

Revision Information
Hazard(s) identification: Supplemental label information
Composition / Information on Ingredients: Ingredients
Fire-fighting measures: Suitable extinguishing media
Exposure controls/personal protection: Appropriate engineering controls
Physical & Chemical Properties: Multiple Properties
Toxicological Information: Toxicological Data
Ecological Information: Ecotoxicity
Disposal considerations: Hazardous waste code
Transport Information: Agency Name, Packaging Type, and Transport Mode Selection
Regulatory Information: United States
GHS: Classification

Attachment C

Resumes

Curriculum Vitae

Alberto Munuera
alberto.munuera@aecom.com

Alberto Munuera

DC Metro+ Area SH&E Manager

I am specialized in Occupational Safety and Health, currently responsible for managing DC Metro+ Area at AECOM.

From 2012 I also managed SH&E management systems for international clients at an International Level, developing, implementing, monitoring and improving the systems.

I worked in the soil and groundwater department as hydrogeologist for over 8 years (2003-2012), where I was involved in many environmental projects and civil works, including investigation and remediation of contaminated sites and decommissioning and demolition of old industrial plants.

From 2006 I worked as SH&E manager in AECOM Spain, OHSAS 18001 certified.

Proffessional history

DC Metro+ Area SH&E Manager
AECOM (June 2016 to present)

Spain SH&E Manager
AECOM (2006 to June 2016)

Int. Client EMAAP SH&E Manager
AECOM-URS (2009 to present)

Hydrogeologist - Environmental Consultant
Legacy URS (2003 to 2012)

Education and Training

Master's Degree in Occupational Health and Safety. 2015 (Universidad San Pablo CEU, Madrid, Spain). Project (Hons): Development and implementation of SH&E Management system according to OHSAS 18001

Graduated in Geological Sciences. 1998-2004 (Universidad Complutense de Madrid, Spain)

Nebosh International General Certificate in Occupational Health and Safety (Workplacelaw, 2013)

OHSAS 18001 Auditor and OHS Systems Auditor (2015)

OSHA Outreach Training for General Industry and Construction Works. 30h+30h courses (University of South Florida – OTIEC, 2014-15)

High Technician Certificate in Occupational Health and safety – Specialities of Ergonomy and applied psicosociology, Safety in the workplace and industrial hygiene 2007 (IMF) – 1200h

Certified Health & Safety trainer for HAZWOPER training, OSHA 29 CFR 1910.120 (URS, 2009)

Essential Navigation & Seamanship Training (Avante, 2014) – Including Safety and Emergency Response on powerboats

Emergency and fire extinguishing and first Aids training (Fremap, 2013).

Hazardous Waste Materials Management Expert (Ambientum, 2010)

Preventive driving training. (Prevensis, 2006 and refreshers up to date)

Management of SH&E System

I manage the implementation of the AECOM SH&E management system both in the office and field with the objective of reducing accidents, illnesses and property damage rate by having a safe environment and promoting safety culture and healthy habits within employees. This includes worksites risk assessments and implementation of control measures, ergonomics, industrial hygiene, social psychology and environment protection.

As part of my daily work I manage, among others, the following elements:

- SH&E annual action plan development, management, follow up and continuous improvement
- Training plan development, management and follow up (>2000 employees)
- Trainer in OSHA Hazardous waste operations and emergency response (Hazwoper 24h) and Limnology courses.
- Management of internal (Management and all other employees) and external communications (subcontractors, clients and third parties) on SH&E matters
- Key Performance Indicators definition and control (leading and lagging indicators)
- Safe Work and Emegercy Plans preparation and review
- Office and Field audits and follow up of non conformities (all types of industrial sites, demolition works, landfills, work over water, airport activities, etc)
- Accidents and Incidents investigation and implementation of appropriate control measures. Sharing Lessos Learned.
- Providing support in the development, coordination and implementation of industrial hygiene programs
- OHSAS 18001 implementation and continuous safety improvement
- Encouraging leaders to commit to safety and employees to participate in SH&E and to include safety in their daily activity, projects design, work and life.
- SH&E advising for national and international projects
- Business impact evaluation of SH&E events and measures
- Maintaining adequate records of pertinent data

Affiliations and proffessional associations

International Ambassador in IOSH Education Committee

Graduate IOSH (International Occupational Safety and Health)

ASSE (American Society of Safety Engineers)
Young Professionals Group in ASSE

BCSP (Board of Certified Safety Professionals)

Awards

2016 CE Excellenece Awards: Safety for Life Winner

2016 AECOM Coins Awards: implementation of Wellness Program in Spain

2014 Finalist in the AECOM-URS EMI Safety For Life Annual Awards

OHSAS 18001 certification implementation in URS Spain. April 2014.

2012 through 2015: URS Spain #1 Ranked in unified H&S system of top 6 Oil and Gas companies (Retail) in Spain

2011 BP HSSE Award in recognition of 5 consecutive years of incident-free work in Europe (URS-BP Iberia SH&E Manager)

URS quarterly award 1stQ 2010 (Work over water Training development)

BP Excellence award 2006

Languages

English and Spanish (spoken and written):
Bilingual – Spanish native

Portuguese (spoken and written): medium-high.

French (spoken and written): medium

Other Information

Member of the Innovation and Collaboration Excellence Committee in Safety, Health and Environment within AECOM (2015-2016)

Management of SH&E for International Clients

I have been involved in the development and follow up of several SH&E management systems within AECOM for International Clients with strong safety culture.

Especially I have developed and implemented a client specific SH&E Management system at an EMAAP Region level. This system focuses, among others, on the following elements:

- Having a consistent culture evolution work plan (Key Performance Indicators to follow up)
- Internal and external communication plan development and implementation, especially client fluid communication plan.
- Leadership commitment, including site audits and visits plan
- Training sessions and specific training requirements set up
- Incidents management and investigation
- Establishing joined safety expectations
- Recognition program
- Ensure sites Safe Work Plans consistency across the region
- Subcontractors management
- Site specific safety management programs development and implementation.

Management of SH&E in Field Operations

I have managed SH&E in field projects from 2003, developing worksites risk assessments, implementing preventive and control measures and supervising the compliance of legislation and client and AECOM specific procedures. Some of the field projects I have worked on are:

- SH&E management and environmental investigation of the subsoil in several petrol stations and industrial plants.
- SH&E management during installation and monitoring of several remediation systems at sites contaminated with many different chemical compounds.
- Monitoring, control and management of SH&E in large excavations and refineries.
- Developing, implementing and management of SH&E program in an old lindane landfill
- SH&E audits in several industrial plants and petrol stations.
- Supervisor and SH&E manager of dismantling and demolition works of an oil and gas storage terminal.
- Environmental audit, SH&E management and site assessment during works in a cruise motors factory.
- Management of health and safety, decommissioning, demolition and soil remediation of an industrial complex to be developed as a residential area
- Several derelict industrial buildings SH&E studies
- Environmental audit and risks assessment of a demotlition project of a fertilizers distributor industrial site.
- Development of a detailed Dam Emergency Plan.
- SH&E Management of construction works in airports.

Joseph Witte
Environmental Scientist

Professional History

09/2013 - Present, AECOM
Environmental Scientist

Education

BS, Environmental Science & Policy, University of Maryland, 2013

Years of Experience

With AECOM: 3.5
With Other Firms: 0
With URS: 1

Training

OSHA 8-Hour Site Supervisor Training
OSHA 40-Hour HAZWOPER Training
American Heart Association – First Aid, CPR, and AED Certification
Shell Life Saving Rules
Smith System Defensive Driving Training
SHA MD DOT Temporary Traffic Control Manager's Training
DOT HAZMAT Shipping for Environmental Professionals Training

Mr. Witte is an environmental scientist with remediation team in the Germantown office working both in office and in the field. He has direct project experience across multiple disciplines as the project Health and Safety Officer, field coordinator, field technician, data manager and analyst, and office task leader. Mr. Witte has lead and participated in numerous projects with both state and federal government agencies as well as private clients such as Motiva, Shell Oil, WMATA, Dover AFB, the Army National Guard, and the US Army Corps of Engineers (USACE). Mr. Witte is trained by the SHA MD DOT as a Temporary Traffic Control Manager. Mr. Witte assists in preparing work plans, quality assurance project plans, health and safety plans, and remedial investigation reports for a variety of private and federal clients.

Experience

Army National Guard (ARNG), Remedial Investigation through Decision Document for Five and Six Army National Guard Munitions Response Sites, Multiple U.S. Locations, Deputy Project Manager/Field Task Leader, September 2016 – Ongoing. Manage project activities related to conducting Remedial Investigation of multiple former small arms ranges at Non-Department of Defense, Non-Operational Defense Sites (NDNODS) located with CONUS. Technical lead on implementation of incremental sampling methodology (ISM) technologies to assess the risks of metals contamination in target berm soils. Act as team lead and health and safety officer for field operations. Author RI Work Plans and UFP-QAPPs and assess the fate and transport of site related contaminants.

Army National Guard (ARNG), Preliminary Assessments and Site Inspections for Perfluoroctane-Sulfonic Acid and Perfluoroctanoic Acid Impacted Sites, ARNG Installations-Nationwide, Field Task Leader, August 2017 – Ongoing. Manage project activities related to conducting Preliminary Assessment site visits of ARNG installations nationwide. Project site lead on drafting Preliminary Assessments to assess the presence or absence of perfluorinated compound release areas at ARNG installations. Act as team lead and health and safety officer for field operations. Author Preliminary Assessments and assess the fate and transport of site related contaminants.

US National Guard Bureau - US Property and Fiscal Office, Ravenna Army Ammunition Plant Solid Waste Disposal Sites, Ravenna, Ohio. Act as team lead and health and safety officer for field operations including intrusive investigations of solid waste sites. Author Solid Waste Management Plan to be used as a tool by the OHARNG. Contributed as an integral team member in composing the former Ravenna Army Ammunition Plant/Camp Ravenna Joint Military

Training Center visual assessment survey report for the evaluation, identification, and management of potential solid waste disposal sites.

US Naval Facilities Engineering Command Pacific, Multiple Award Environmental Services - Small Business Remediation Action Contra, Baltimore, Maryland. Performed incremental groundwater and sediment sampling using ISCO equipment, escorted by UXO technicians, on an active army base. Field work included in-stream sampling of surface water and sediment, maneuvering through Florida forest and swamp land.

Washington Metropolitan Area Transit Authority, Bladensburg Heavy Overhaul Maintenance Terminal Industrial Hygiene Assessment, Washington, District of Columbia. Performed industrial hygiene assessment consisting of indoor area sampling for diesel particulate matter, mercaptans, NO, NO2, SO2, formaldehyde, acrolein, methane, VOCs, compressed natural gases and fungal spores using a variety of equipment including SKC air pumps, passive sampling badges, SUMMA canister 1-liter minicans, and Landtec landfill gas meters. Co-wrote deliverable report on findings to client.

Washington Metropolitan Area Transit Authority, TO 15-03 QRT [1], Washington, District of Columbia. Obtains DDOT construction and occupancy permits to perform drilling and installation of monitoring wells onsite, as well as trimesterly groundwater sampling in active roadways. Acted as a traffic control manager onsite during well installation on active roadways. Performed groundwater sampling onsite and groundwater monitoring well redevelopment, while acting as traffic control manager during thru-way tasks.

Shell Oil Company, Site Assessment, Various Locations. Assisted in numerous office and field work tasks and worked in the field at over 25 unique sites and performed office work associated with many more. Field work tasks include groundwater gauging and sampling, product bailing and absorbent sock administering, soil sampling soil vapor sampling, operations and maintenance with a senior field technician, subcontractor oversight of drum pickups, field screening various indoor areas using a photoionization detector, excavation oversight, and system demo oversight across states including Maryland, Massachusetts, New Jersey, Pennsylvania, South Carolina and Washington DC. Acted as a direct contact for laboratories in arranging for appropriate equipment and laboratory glassware for scheduled field work. Also acted as a liaison with previous consultant in the transferal of field notes, data, work orders, and site safety information. Prepared numerous health and safety plans for the newly acquired sites using information disseminated by previous firm and independent research.

Shell Oil Company, Pennzoil-Quaker State - Active Third-Party Owned Terminal Time and Materials Contract, Charleston, South Carolina. Coordinated groundwater sampling events onsite, participated in surfactant extractions and injections, composed biannual site reports, and ordered lab bottleware and equipment. Spearheaded a group of three as the only current Shell-trained technician to ensure all Shell safety standards were met. Created the field operations manual prior to this work for use in the field by all field staff. The former PQS site is a 20-year remediation project

and the current and past site activities include periodic monitoring and sampling of site monitoring wells; LNAPL removal activities consisting of periodic aggressive fluid vapor recovery (AFVR) events and passive recovery methods such as manual bailing and absorbent socks; and aggressive LNAPL recovery program that includes targeted excavations and surfactant injections and extractions.

Shell Chemical Holdings Inc, 2015 Groundwater Investigation and Soil Delineation, East Hanover, New Jersey. Performed groundwater sampling as a field team lead in March 2015 and composed following groundwater sampling report. Participated as a field team member in soil sampling as part of the offsite PCB delineation in November and December 2016 under client and third party consultant supervision. Performed various office tasks associated with facilitating field work operations.

Motiva Enterprises, LLC, Site #137675 - 15541 New Hampshire Avenue, Silver Spring, Maryland. Performed site manager and field work duties including quarterly groundwater sampling, weekly coordination of operation and maintenance events, placing field equipment and lab bottleware requests, and report writing. Additionally, developed and maintained a trusted relationship with residents in the surrounding neighborhood to perform potable well sampling in their homes and manage bottled water deliveries to their homes in lieu of municipally supplied water.

Petroleum Marketing Group, Site #2007-317 (VDEQ), Woodbridge, Virginia. Site manager performing duties including monthly groundwater gauging, quarterly groundwater sampling, quarterly soil vapor point sampling using SUMMA 1-liter canisters, coordination of field events, ordering lab bottleware and equipment, performing Mann-Kendall statistical analysis to present a case for no further action to Virginia Department of Environmental Quality, and writing quarterly status reports to be submitted to VDEQ.

Travel Centers of America, Stormwater Management, Richmond, Virginia and Ashland, Virginia. Performed managerial site duties including report writing, field event coordinating, and permit application updating.

Shell Oil Company, Service Station #136431, Washington, District of Columbia. Site manager performing duties including quarterly groundwater sampling, coordinating field events, ordering lab bottleware and equipment, and writing quarterly status reports to be submitted to the District Department of the Environment.

Shell Oil Products US, Site #58141 - Fairfax Terminal, Fairfax, Virginia. Performed monthly groundwater gauging, biannual groundwater sampling, pond outfall sampling to meet VPDES permit requirements, coordination of field events, equipment ordering, and composition of biannual status reports. Acted as team lead during field events associated with the site.

Shell Oil Company, Service Station #136440, Washington, District of Columbia. Site manager performing duties including groundwater sampling, coordinating field events, ordering lab bottleware and equipment, and writing status reports.

Chahel 252 Inc., Service Station #10 (VDEQ), Vienna, Virginia. Site manager performing duties including coordination of operations and maintenance activities onsite, ordering bottleware and equipment, and writing quarterly status reports to be submitted to Virginia Department of Environmental Quality.

Baltimore County Game & Fish Protective Association, Small Arms Range Environmental Stewardship Plan, Portland, Oregon. Aided in a site visit at the Baltimore County Game & Fish Protective Association Small Arms Range to assess bullet containment, vegetative ground cover and erosion, soil pH, and volume control. Created an environmental stewardship plan following site visit on behalf of the BCGF.

Wood Group Mustang, Inc., Sunrise Gas Development, Various Locations, Pennsylvania. Participated in a geophysical seismic refraction survey to delineate the Sunrise Pipeline route across rural landscapes in Lancaster, PA.

Confidential Client, 2013 Long Term Monitoring, Dover AFB, Delaware. Assisted in field activities performing injection events onsite to stimulate the growth of microbes to promote bioremediation.

Shell Oil Company, Rouseville Parcel 07-019-001, Rouseville, Pennsylvania. Participated in completing a site investigation of the large, wooded property. During inspection, the team took photographs, detailed descriptions, and GPS locations of any items relating to the prior storage of crude oil including steel vessels, tank pads, wooden barrels, piping, steel drums, and Pennzoil-branded items. Contaminants of concern included, volatile organic compounds, semi-volatile organic compounds, and RCRA metals. Contributed to a report containing a summary of investigation results and recommendations for future remedial activities.

Shell Oil Company, Former Rouseville Refinery Plant I AST Farm, Rouseville, Pennsylvania. Participated in a lmited Phase II ESA, which included over 160 soil borings advanced via hand-auger excavation at items discovered during the November investigation. Also contributed to the field operations manual used during the Phase II ESA and a report containing a summary of soil sampling results and recommendations for future remedial activities.

Shell Oil Company, Former Rouseville Refinery Plant II AST Farm, Rouseville, Pennsylvania. Participated in oversight of the excavation of a suspected drum pit estimated to extend to 285 feet by 130 feet. Contaminants of concern included volatile organic compounds, semi-volatile organic compounds, and RCRA metals. Present for tree clearing, grading, temporary road construction, onsite job trailer establishment, soil staging area construction, and soil logging associated with the excavation. Also conducted product bailing onsite and oversaw repairs to a sump associated with the site.

Certificate of Completion

This is to certify that

Joe Witte

Has completed the

Radiation Safety for X-ray Tube Based Instruments

Online training course

On

10/13/2017

Supervisor signature

Erin Poitras, RSO Thermo Fisher Scientific
Portable Analytical Instruments

Attachment D

AECOM Safety Forms

SAFETY COMPLIANCE AGREEMENT AND
DOCUMENTATION OF SITE SAFETY BRIEFING
Bangor Range, ME
Contract/Delivery Order: W9133L-14-D-0001/ 0006

DATE AND TIME: _____ PROJECT NAME AND NUMBER: _____

SITE LOCATION: _____ SITE SAFETY OFFICER: _____

NAME AND EFFECTIVE DATE OF SITE HEALTH AND SAFETY PLAN: _____

TOPICS COVERED DURING BRIEFING:

___ Extent and Concentration of Chemical Hazards on Site
___ Monitoring Procedures
___ Health Effects of Chemical Hazards
___ Action Levels
___ Physical Hazards on Site
___ Decontamination Procedures
___ Levels of Protection Required
___ Location of Emergency Numbers
___ Route to the Hospital
___ Location of Emergency Equipment (e.g., first-aid kit, fire extinguishers)
___ Verification That Health and Safety Plan Has Been Received and Read
___ Other:_____

I, the undersigned, have received a copy of the safety plan for the referenced project. I have read the plan, understand it, and agree to comply with all of the health and safety requirements. I understand that I may be prohibited from working on the project for violating any of the requirements. In addition, I have been verbally briefed on the topics noted above.

Name (print): _____

(Signature):_____

Company:_____

AECOM

Americas

Daily Tailgate Meeting

S3AM-209-FM5

Job Location:		Date:	
AECOM Site Supervisor:		Person Conducting Tailgate Meeting:	
AECOM Site Supervisor Phone:		AECOM Safety Officer Name & Phone:	

List activities to be performed today:	

Muster Point:		Spill Kit Location:	
First Aid Kit Location:		Fire Extinguisher Location:	

Have all personnel reviewed and understand the site-specific safety plan?	☐ Yes ☐ No*
Are current Pre-Job Hazard Assessments in place for each of the tasks to be performed today and understood by all?	☐ Yes ☐ No*
Does each subcontractor have hazard assessments (e.g., THA, JSA, JHA) for their activities?	☐ Yes ☐ No* ☐ N/A
Are any required permits in place for the applicable tasks to be performed today and understood by all? Identify required permits and permit #s:	☐ Yes ☐ No* ☐ N/A
Have all members of the work team confirmed understanding of the work, hazards, and controls/ mitigation?	☐ Yes ☐ No*
Have work areas been properly cordoned-off to protect workers, site staff, and the public?	☐ Yes ☐ No* ☐ N/A
Have equipment checks been completed, documented, and reviewed?	☐ Yes ☐ No* ☐ N/A
Do all site workers understand injury/ intervention reporting requirements including immediately notifying the AECOM Site Supervisor of any injury near miss, unsafe condition or hazard observation?	☐ Yes ☐ No*

** if No, then work cannot be performed until corrective action is completed and documented.*

Topics covered in today's tailgate meeting:	

Other Items Discussed Today:	**Stop Work Authority & Obligation**
	* All employees will stop the job any time anyone is concerned or uncertain about safety. * All employees will stop the job if anyone identifies a hazard or additional mitigation not recorded on the THA. * All employees will be alerted to any changes in personnel or conditions at the worksite. * All employees will stop the job and reassess a task, hazards, and mitigations, and then amend the THA as needed.

SITE WORKERS (including AECOM Contractors and Subcontractors): By signing here, you are stating the following:

* You have been involved in reviewing the THAs and understand the hazards and control measures associated with each task you are about to perform.
* You understand the permit to work requirements applicable to the work you are about to perform (if it includes permitted activities).
* You are aware that no tasks or work (that is not risk-assessed) is to be performed.
* You are aware of your authority and obligation to 'Stop Work'.

I arrived and departed fit for duty:

* You are physically and mentally fit for duty.
* You are not under the influence of any type of medication, drugs, or alcohol that could affect your ability to work safely.
* You are aware of your responsibility to immediately report any illness, injury (regardless of where or when it occurred), or fatigue issue you may have to the AECOM Supervisor.
* You signed-out uninjured unless you have otherwise informed the AECOM Supervisor.

Print Name & Company	Signature	Initials & Sign In Time	Initials & Sign Out Time
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit
		In & Fit	Out & Fit

(Attach additional Site Worker sign-in/out sheets if needed)

SITE VISITOR / SITE REPRESENTATIVE

Name	Company Name	Arrival Time	Departure Time	Signature

To be completed once activities for the day have been concluded:

Were there any Incidents, Near Misses or Observations?	☐ Yes ☐ No	If yes, details:
Were there any 'Stop Work' interventions?	☐ Yes ☐ No	If yes, details:
Were there any areas for improvement noted?	☐ Yes ☐ No	If yes, details:
At the conclusion of the day, the job site is being left in a safe condition and there were no reports of injury or first aid.	☐ Yes ☐ No	AECOM Supervisor Signature:

AECOM

Americas

Task Hazard Assessment

S3AM-209-FM6

Customer	**Permit No.**
Location	**Job No.**
Description of Task	**Date**

Basic Task Steps (explain how the task will be carried out)	**Hazards** (identify all hazards and potential hazards)	**Risk** (initial)	**Precautions** (describe how that hazard will be controlled)	**Risk** (final)	**Initials**
			Highest Risk Index		

Review and attach to Tailgate Meeting as required. Number and attach additional pages if necessary.

Worker/Visitor acknowledgement and review of this content on back of this document.

Risk Matrix on Reverse

Originator _____ (Print Name) _____ (Signature)

Supervisor _____ (Print Name) _____ (Signature)

THIS FORM IS TO BE KEPT ON JOB SITE.

AECOM

WORKER SIGN ON

NAME (Please Print) SIGNATURE

I participated in the development and understand the content of this Task Hazard Assessment.

VISITOR SIGN ON

NAME (Please Print) SIGNATURE TIME

Risk Rating Matrix

Probability	Severity				
	5 - Catastrophic	4 – Critical	3 – Major	2 – Moderate	1 - Minor
5 – Frequent	25	20	15	10	5
4 – Probable	20	16	12	8	4
3 – Occasional	15	12	9	6	3
2 – Remote	10	8	6	4	2
1 - Improbable	5	4	3	2	1

Risk Rating (Probability x Severity)	Risk Acceptance Authority
1 to 4 (Low)	Risk is tolerable, manage at local level
5 to 9 (Medium)	Risk requires approval by Operations Lead/Supervisor & Safety Manager
10 to 25 (High)	Risk requires the approval of the Operations Manager & Safety Director

Severity – Potential Consequences				
	People	Property Damage	Environmental Impact	Public Image/Reputation
Catastrophic	Fatality, Multiple Major Incidents	>$1M USD, Structural collapse	Offsite impact requiring remediation	Government intervention
Critical	Permanent impairment, Long term injury/illness	>$250K to $1M USD	Onsite impact requiring remediation	Media intervention
Major	Lost/Restricted Work	> $10K to $250K USD	Release at/above reportable limit	Owner intervention
Moderate	Medical Treatment	> $1K to $10K USD	Release below reportable limit	Community or local attention
Minor	First Aid	</=$1K USD	Small chemical release contained onsite	Individual complaint

Probability		
Frequent	Expected to occur during task/activity	9/10
Probable	Likely to occur during task/activity	1/10
Occasional	May occur during the task/activity	1/100
Remote	Unlikely to occur during task/activity	1/1,000
Improbable	Highly unlikely to occur, but possible during task/activity	1/10,000

Task Hazard Assessment Follow-Up/Review.

First Break **Initial**

Lunch Break **Initial**

Second Break **Initial**

Emergency Meeting / Assembly Area

Emergency Contact #

Emergency Radio Channel

Area is safe and housekeeping completed at the end of task/shift.

Supervisor (print name)

Signature

Americas

Driving

S3NA-005-PR1

1.0 Purpose and Scope

1.1 The purpose of this document is to establish policies and procedures for operation of AECOM-owned, rented, or leased vehicles, client or customer-owned vehicles, and personal vehicles used by AECOM employees.

1.2 This procedure applies to all AECOM Americas-based employees and operations. Policies and procedures related to the operation of commercial motor vehicles are in addition to this procedure; refer to *S3NA-320-PR1 Commercial Motor Vehicles.*

2.0 Terms and Definitions

2.1 **AECOM Business** – Any activity that is performed in the name of AECOM. This includes, but is not limited to, vehicle travel between work locations, client sites, meeting locations as well as driving performed as a part of work-related travel (e.g., driving to and from airports, hotels, train stations). AECOM business does not include driving that is a part of a daily routine commute from home to an AECOM location.

2.2 **Authorized Driver** – AECOM employees who receive manager approval following evaluation of driver criteria to drive and maintain an AECOM-owned, leased or rented vehicle, a client or customer-owned vehicle, or a personal vehicle operated in the course of conducing AECOM business. Authorized Drivers shall maintain a current driver's license with full privileges applicable to the vehicle to be operated. There are three categories of Authorized Drivers;

- Professional (AECOM employee who operates a commercial motor vehicle. Please refer to *S3NA-320-PR1 Commercial Motor Vehicles*).
- Hired (Employee's specific AECOM role is to drive employees in a normal street vehicle, which may or may not require commercial licensing by the applicable authorities. This category does not include busses or vans with a capacity of more than 12 people.).
- General (Driving is required as a part of the employee's job duties. This includes driving AECOM-owned, leased, or rented vehicles, client or customer-owned vehicles, or personal vehicles on AECOM business).

2.3 **Collision** – Any incident in which a motor vehicle that (whether in motion, temporarily stopped, or parked) makes contact with another vehicle or pedestrian, or results in property damage and/or bodily injury, regardless of who was injured, what property was damaged, or who was responsible.

2.4 **Commercial Motor Vehicle (CMV)** – Any self-propelled or towed motor vehicle used for AECOM business (e.g., to transport passengers or property) when the vehicle is one of the following:

- Has a gross vehicle weight rating (GVWR) or gross combination weight rating, of ≥ 10,001 pounds (4,536 kilograms); or
- Is designed or used to transport more than eight passengers, including the driver, for compensation; or
- Is designed or used to transport more than 15 passengers, including the driver, and is not used to transport passengers for compensation; or
- Is used in transporting hazardous material in quantities ≥ 1,001 pounds (454 kilograms) combined total weight at any time.
- Refer to *S3NA-320-PR1 Commercial Motor Vehicles* for additional information.

2.5 **Distracted Driving** – An activity that takes the driver's attention away from the primary task of driving.

2.6 **Driving Under the Influence (DUI)/Driving While Intoxicated (DWI)** – The operation of a vehicle while under the influence of alcohol, drugs, medications, or other substances capable of inducing an altered mental state and/or impairing physical and mental judgments, such that the influence of the substances produces impairment in violation of the applicable governmental laws.

2.7 **Fatigue** – A general term used to describe the experience of being "sleepy", "tired" or "exhausted". The effect of fatigue is both physiological and psychological and can severely impair a driver's judgement. Fatigue can cause lapses in concentration which could prove fatal. Fatigue is not just a problem for drivers on long trips, as drivers can also suffer from fatigue on short trips.

2.8 **Incident** – For the purposes of this procedure, a vehicle collision or other event where personal injury or property damage occurs, or where a citation is issued while the employee is on AECOM business. This may also include acts of theft, vandalism, and criminal mischief.

2.9 **Journey Management** – A process for planning and executing necessary journeys safely.

2.10 **Local Laws** – Signs, postings, laws, regulations, ordinances and codes applicable for the jurisdiction in which the motor vehicle is being operated.

2.11 **Motor Vehicle Report (MVR) / Driver's Abstract** – A listing of the tickets (violations), incidents collision for an individual driver over a period of time (e.g., 3 years, 5 years) provided by a state or provincial authority such as the Department of Motor Vehicles.

2.12 **Personal Vehicle** – A motorized vehicle owned or leased by an employee.

2.13 **Portable Electronic Device** – A mobile electronic device that is used to receive or communicate voice, email, internet, and/or public media. The device requires user interaction (typing, dialing, reading, keying, etc.) that distracts the motor vehicle operator. Example devices include, but are not limited to:

- Mobile Communication Devices (MCD)
  - Mobile/Cellular phones
  - Two-way Radios
- Personal Data Assistant (PDA)
- iPads, iPods, or other tablet models
- Computers
- Global Positioning System (GPS) receivers

2.14 **Spotters –** Extra personnel that may provide guidance when maneuvering in close and/or complex situations in order to avoid the occurrence of an incident.

2.15 **Task Hazard Analysis (THA)** – A tool for evaluating work activities for the purpose of:

- Identifying the SH&E hazards and risks associated with the activity being performed;
- Identifying and implementing control measures to eliminate or reduce hazards and risks; and,
- Evaluating the effectiveness of control measures and making modifications as needed.

3.0 References

3.1 AECOM Global Travel Policy

3.2 RS2-001-PR Firearms Standard

3.3 S3NA-003-PR1 SH&E Training

3.4 S3NA-004-PR1 Incident Reporting, Notifications & Investigation

3.5 S3NA-009-PR1 Fatigue Management

3.6 S3NA-010-PR1 Emergency Response Planning

3.7 S3NA-209-PR1 Risk Assessment & Management

3.8 S3NA-314-PR1 Working Alone

3.9 S3NA-319-PR1 All-Terrain Vehicles

3.10 S3NA-320-PR1 Commercial Motor Vehicles

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Manager / Supervisor**

- Confirming employees are informed of the provisions of this procedure and related vehicle procedures.
- Providing a copy of this procedure to an employee who will be driving an AECOM-owned, leased or personal vehicle for AECOM business.
- Allowing employees to designate time to complete required driving safety training, vehicle inspections and related activities.
- Assigning driving tasks to authorized employees only.
- Selecting and providing vehicles for use by authorized employees that are appropriate for the planned working conditions and environment.
- Supporting employees in the reporting of vehicle incidents per *S3NA-004-PR1 Incident Reporting, Notifications & Investigations,* including the entry of the incident into the on-line incident management system (e.g., IndustrySafe).
- Confirm notification of AECOM Human Resources and Counsel upon receipt by an employee of a legal summons associated with a moving violation related to the use of a company vehicle.

4.1.2 **Employee**

- Follow this procedure and applicable laws while operating a vehicle.
- Complete assigned driver safety training based on the training matrix and any additional training assessments developed at the business group. Refer to *S3NA-003-PR1 SH&E Training, including S3NA-003-FM1 SH&E Training Matrix.*
- Report to the Manager / Supervisor if the vehicle selected is not appropriate for the working conditions and environment.
- Report to the Manager / Supervisor if the employee is inexperienced in operating the type of vehicle assigned.
- Report to the Manager / Supervisor if the employee is inexperienced in driving in the type of working conditions and environment assigned.
- Review the completed Task Hazard Assessment and complete journey management. If required, document the Journey Management Plan using *S3NA-005-FM1 Journey Management Plan* or equivalent.
- Immediately report vehicle incidents per *S3NA-004-PR1 Incident Reporting, Notifications & Investigations*, including the entry of the incident into the on-line incident management system (e.g., IndustrySafe).
- Notify the appropriate Manager / Supervisor and SH&E Manager upon receipt of a legal summons associated with a moving violation related to the use of a company vehicle.
- Immediately report a change or limitation(s) to his/her Driver's License to the appropriate AECOM Human Resources representative or his/her Manager / Supervisor.

- Conducting a pre-operational inspection of the vehicle for damage or deficiencies and reporting discovered deficiencies affecting the safe operation of the motor vehicle to the appropriate authority (e.g., supervisor, rental car agency, etc.).

4.1.3 **SH&E Manager**

- Maintaining and updating training resources for vehicle and driver safety.
- Providing guidance.
- Assisting operational leaders with determining the risk incurred by the use of motor vehicles.
- Assist in the incident investigation and review process.

4.2 General Procedures and Practices

4.2.1 Only Authorized Drivers are to operate a motor vehicle (rental, personal, client or customer-owned, or AECOM-owned/leased) while on AECOM business.

4.2.2 Drivers must comply with *AECOM's Global Travel Policy* and applicable laws, and employ safe driving practices. (NOTE: *Individual state, provincial, and local laws vary*.) Refer to *S3NA-005-ATT1 Authorized Driver Safety Practices*.

4.2.3 Authorized Drivers shall confirm their operating license is on their person, and valid registration and insurance is maintained with the respective vehicle prior to operation.

4.2.4 All local laws including, signs, postings, regulations, ordinances, and codes applicable for the jurisdiction in which the motor vehicle is being operated shall be adhered to.

4.2.5 At-risk driving behavior by AECOM employees shall be identified and managed accordingly.

4.2.6 Authorized Drivers must be at least 18 years of age (noncommercial license) or 21 years of age (commercial license) and have a current driver's license for the appropriate class of vehicle (unless more stringent requirements are established by the leasing/renting agency). Employees with conditional licenses are prohibited from operating vehicles on AECOM business.

4.2.7 If an Authorized Driver receives a citation resulting in their license being suspended, has his/her driver's license revoked, or is otherwise unauthorized to drive, he/she shall notify the appropriate AECOM Human Resources representative or his/her Manager prior to start of the following work day. Failure to do this may result in disciplinary action up to and including termination.

4.2.8 The office to which the vehicles are registered is liable for any damages to the vehicle being operated by an Authorized Driver.

4.2.9 Seat belts are to be worn by the occupants. The number of passengers shall not exceed the manufacturer's specifications for the vehicle.

4.2.10 The vehicle may not move until all passengers have fastened their restraints in the proper manner (e.g., lap belt secured and shoulder harness placed over the shoulder). Vehicles are not to be operated or used by AECOM employees if seatbelts are not included as part of the vehicle's safety equipment.

4.2.11 The vehicle's engine is to be turned off during refueling. Smoking or cellular phone use is not allowed while refueling.

4.2.12 Motorcycles may not be operated on AECOM business unless:

- Specific approval is provided by the Supervisor with concurrence from the SH&E Manager.
- A hazard analysis is completed.
- Required training and license is in place.
- Headlights or daytime running lights will be used when the vehicle is in operation.
- A Class 2 or 3 safety vest and appropriate helmet shall be worn while operating a motorcycle.

4.2.13 When practical, drivers should travel during daylight hours and avoid driving during adverse weather conditions. Drivers should also inform colleagues of their travel itinerary including destination and anticipated departure and arrival times.

4.2.14 Fire arms and weapons are not permitted in AECOM-owned, leased or rented vehicles insured by AECOM. Firearms and weapons in personal vehicles are subject to the laws and regulations of the respective local, provincial, state, territory, federal and region and/or country. Refer to the *RS2-001-PR1 Firearms Standard*.

- Exceptions to this standard may exist where there is a credible and demonstrated risk to AECOM employees or assets, or when knives or weapons are required as part of the work activity. Under such circumstances, the exception must be approved by the Chief Resilience Officer, and must strictly adhere to the procedures set forth by the Global Resilience Group.

4.2.15 Vehicles are to be selected based on the nature of planned use. In some working conditions, specialized vehicles, such as four-wheel drive and higher clearance vehicle, may be required to confirm safe travel. These specialized vehicle requirements/specifications shall be identified in the project specific SH&E Plan and/or THA.

4.2.16 Vehicles are to be maintained according to manufacturer's specifications and the applicable environmental and operating factors (e.g. winterized with appropriate fluids, winter tires installed, appropriate coolant for hot climates, etc.).

4.2.17 Vehicles are to be outfitted with the appropriate support equipment based on the THA or client vehicle specifications. Support equipment may include, but is not limited to, cones, rotating warning lights, warning flags, vehicle identification (magnetic door signs or similar), wheel chocks, cargo nets, and rollover protection.

4.2.18 Drivers are to operate vehicles in a manner that avoids situations where backing is necessary. Whenever possible and as permitted, reverse parking of all vehicles while on business is required. A spotter shall be used when backing of trucks and heavy equipment presents a risk of collision.

4.2.19 Non-AECOM drivers (subcontractors, joint venture partners, clients) are prohibited from operating an AECOM company owned, leased or rented vehicle unless the activity is specifically agreed to in the applicable contract and only if the use of the vehicle is consistent with the terms of the contract.

4.2.20 Authorized drivers required to operate vehicles with special hazards (e.g., trucks carrying fuel cells, vehicles used to tow trailers, vehicles with limited visibility, etc.) will be thoroughly briefed on the hazards and control measures necessary for safe operation of the vehicle. The local AECOM operation will maintain documentation of the briefing.

4.2.21 Define specific vehicle travel routes and parking areas at field sites through the use of fencing, cones, or other markings.

4.3 Distracted Driving

4.3.1 Distractions while driving are a major cause of incidents. Distractions include the use of cellular phones (including texting), eating, drinking, smoking, and engaging in intense conversations. AECOM Authorized Drivers must exercise proper control of the vehicle at all times, including the management of possibly distracting actions and behaviors.

4.3.2 The use of portable electronic devices that may distract the driver while driving is prohibited. This includes cell phones, two-way radios and other items whether hand-held or hands-free. Electronic devices include, but are not limited to, all mobile phones pagers, iPods, MP3s, GPS DVD players, tablets laptops and other portable electronic devices that can cause driver distraction.

- Employees shall not use a personal or company mobile communication devices (MCD) while driving any vehicle on AECOM business.
- Employees shall not use a company MCD while driving a personal vehicle.
- Driving includes the time spent in traffic or while stopped at red lights or stop signs.

4.3.3 GPS units and devices (e.g., smart phones, tablets) used for navigation may only be used if factory installed or secured to the vehicle with a bracket that allows the driver to view the image without having to take their eyes off the road.

4.3.4 Electronic devices shall be setup for operation prior to commencing driving activities and shall not be changed by the driver while driving.

4.4 Impairment

4.4.1 Impairment can take many forms ranging from fatigue, to the use of prescription medication or alcohol (even small amounts), to the abuse use of illegal and legal drugs and alcohol. AECOM employees shall not drive in an impaired condition.

4.4.2 AECOM employees are prohibited from being under the influence of alcohol or drugs or improperly using medication in a way that could diminish, or raise questions concerning, an employee's ability to perform at his or her best while performing services for or on behalf of AECOM. Operation of vehicles while under the influence may void insurance coverage.

4.4.3 Drivers/operators will not drive or operate vehicles while under the influence of medications when told by a physician, another healthcare provider, or the manufacturer (e.g., instructions on the label) the medication could render the activity unsafe.

4.4.4 AECOM employees are prohibited from operating a vehicle if they are experiencing signs and symptoms of fatigue. Employees should stop work and rest before driving. No employee should operate a vehicle if they have worked 14 consecutive hours within a 24 hour period. Refer to *S3NA-009-PR1 Fatigue Management*.

4.5 Journey Management

4.5.1 When practical, alternatives to road travel should be evaluated including teleconferencing/video conferencing, the use of public transportation or carpooling.

4.5.2 Journey management is a process for planning and executing necessary journeys safely and may or may not be documented. Review the completed THA and complete the journey management process. If required, document a Journey Management Plan (JMP) using *S3NA-005-FM1 Journey Management Plan* or equivalent. The journey management process includes the following steps:

- Determining if the trip is necessary.
- Evaluating alternative safer modes of transport.
- Evaluating the potential to combine journeys with others.
- Planning the trip.
- Select the safest and most efficient route. Confirm compliance with any site specific specified routes, route rules, or restrictions.
- Confirm route planning factors in fatigue management. Refer to *S3NA-009-PR1 Fatigue Management*.
- Review road conditions and potential hazards associated with the route.
- Review weather conditions and forecast.
- If applicable, review *S3NA-314-PR1 Working Alone*.
- Confirm Emergency Response Plan includes procedures to be taken in the event of a collision or vehicle incident.
- Allow for adequate travel time.
- Inform others of destination, estimated time of arrival and routing.

4.5.3 Drivers who are to undertake trips in excess of 250 miles (400 km) each way, drive in remote or hazardous areas, or when otherwise deemed necessary, shall develop and document a JMP. This plan typically includes the route, location of route hazards, timing, rest periods and locations, communications, emergency response and security arrangements.

4.5.4 Drivers are responsible for developing the JMP and coordinating with the applicable parties identified in the plan.

4.6 Driver Safety Training

Authorized drivers shall have a current driver's license for the appropriate class of vehicle (unless more stringent requirements are established by the leasing/renting agency).

Driver safety training is to be assigned based on the risks posed with the work environment, driver type and vehicle type, using the training matrix and any additional training assessments developed at the business group level. Refer to *S3NA-003-PR1 SH&E Training, including S3NA-003-FM1 SH&E Training Matrix*. A determination of training type is at the discretion of the Manager / Supervisor, with the following guidance applied.

4.6.1 All Authorized Drivers (Professional, Hired, and General Drivers) shall be trained in this procedure; *S3NA-005-PR1 Driving*.

4.6.2 All Authorized Professional Drivers shall be trained in *S3NA-320-PR1 Commercial Motor Vehicles.*

4.6.3 Vehicle Safety (online) Training

- Recommended for all employees who drive on behalf of AECOM (Professional, Hired and General Drivers).
- Shall be completed within 1 month of the Authorized Driver's hire date.

4.6.4 Defensive Driver (online) Training

- Recommended for all Authorized Drivers (Professional, Hired, and General Drivers) who are assigned an AECOM company owned, leased or rented vehicle for a significant period of time with the expectation that the employee utilizes the vehicle on a regular basis for AECOM business.
- It is recommended that authorized drivers who have completed web-based defensive driver training or equivalent also complete a refresher every three years.
- Defensive Driver training is provided online through AECOM University or one of the following AECOM-approved training resources:
  - The National Safety Council
  - Alert Driving

4.6.5 Defensive Driver (hands-on) Training

- Recommended for all Authorized Professional Drivers and Authorized Hired Drivers.
- Recommended for Authorized General Drivers who drive in remote locations, hazardous environments (such as refineries, ports, terminals etc.), at-risk drivers, and when required by clients.
- Defensive Driver hands-on training is provided through an AECOM-approved training resource, such as Smith Systems.
- Hands on defensive driver training may be required as a result of an incident or negative Motor Vehicle Report.

4.6.6 Driver Retraining

- Drivers involved in repeated motor vehicle incidents, incidents of sufficient severity or concern, or drivers identified as at-risk through review of their Motor Vehicle Report/Driver Abstract may be retrained or, as applicable, subject to disciplinary action and refused the right to drive on behalf of AECOM.
- Retraining programs will be implemented at the discretion of the Supervisor and SH&E Manager.

- Employees eligible to continue driving shall be subject to a driver retraining program that may include any of the above programs or other training programs appropriate for the type of driving the employees performs.

4.6.7 Special Vehicles and Driving Conditions

- Vehicles such as All-Terrain Vehicles (ATVs), four wheel drive vehicles, motorized carts, snowmobiles, box vans and trailers (towing) require specialized training and supervision. For ATVs, Refer to *S3NA-319-PR1 All-Terrain Vehicles* for additional information.
- Use of these types of vehicles is limited to AECOM projects, therefore training and qualification programs for drivers will be project specific. The Manager shall work with the SH&E Manager to tailor training to the specific needs of the project.

4.7 Personal Vehicles (additional requirements)

4.7.1 The requirements of this procedure apply to the use of a personal vehicle for AECOM business. Additional requirements are set forth in the *AECOM Global Travel Policy*.

4.7.2 Personal vehicles driven by Authorized Drivers for business use must satisfy the jurisdiction's registration and inspection requirements and may not be modified beyond manufacturer's specifications.

4.8 Rental Vehicles (additional requirements)

4.8.1 The requirements of this procedure apply to the use of a rental vehicle for AECOM business. Additional requirements are set forth in the *AECOM Global Travel Policy*.

4.9 Requirements for Authorized Drivers

4.9.1 Review the *S3NA-005-ATT1 Authorized Driver Safety Practices* for specifics.

4.9.2 Drivers are not to permit unauthorized persons to operate an AECOM-owned/leased/rented vehicle.

4.9.3 All Authorized Drivers shall perform a walk-around inspection of the vehicle prior to operation.

4.9.4 Pre-operation vehicle inspections shall be performed and documented by all Authorized Professional Drivers and all Authorized Hired Drivers. A sample vehicle inspection checklist is provided in *S3NA-005-FM2 Vehicle Inspection Checklist*.

4.9.5 Vehicles with deficiencies that affect or could potentially affect the safe operation of the vehicle shall be removed from service and promptly repaired as necessary to permit safe vehicle operation.

4.9.6 As applicable, arrange for and/or coordinate with appropriate AECOM personnel to facilitate preventive maintenance services for the vehicle. Maintain it in sound mechanical condition, as per the manufacturer's recommendations provided in the owner's manual.

4.9.7 Do not operate the vehicle if unsafe maintenance conditions exist that would likely result in vehicle damage or personal injury. This applies to vehicles owned or leased by AECOM and to personally-owned vehicles used for AECOM business. Escalate other maintenance issues for correction to appropriate authority (e.g., manager, rental car agency, supervisor, etc.).

4.9.8 Transport only persons on AECOM related business or those persons receiving transportation as a prescribed service. Only drive vehicles in conditions for which the driver has the appropriate training and experience.

4.9.9 AECOM-owned, rented, or leased vehicles are for official business use only and are not to be used for personal activities. Exceptions to this requirement can be made only with the specific written approval of the Manager of the office or location the vehicle is registered to.

4.9.10 Smoking (including the use of e-cigarettes) and chewing tobacco is not permitted in AECOM-owned, leased or rented vehicles.

4.9.11 Drivers are responsible for damage caused by abuse of the vehicle.

4.9.12 Secure the vehicle when left unattended.

4.9.13 Securing loads in the inside and outside compartments of the vehicle.

- Do not rely on weight/shape of load alone. Always use a cargo net, straps, containers or other mechanical device when necessary to confirm load is secure.
- Mark loads that extend the beyond the end of truck, trailer or similar edge with a red warning flag of at least 16 square inches.
- Red lights will be utilized at night to mark loads that extend the beyond the end of truck, trailer or similar edge.

4.9.14 Do not modify existing equipment (warning sounds, backing alarms etc.) or install aftermarket equipment including toolboxes, truck caps, specialty lights, or towing equipment) without approval from the Manager of the office or location the vehicle is registered to and AECOM Procurement Department.

4.10 Emergency Preparedness

4.10.1 AECOM-owned or leased vehicles are to have a “Safety Kit” that contains a first-aid kit, portable fire extinguisher, safety triangle, and two reflective safety vests. If not available, contact the Manager / Supervisor of SH&E Manager to determine how to obtain a kit.

4.10.2 The following suggested items should be kept in vehicles used for AECOM business in remote project locations:

- First aid kit, appropriate to the work and crew size, or per regulations.
- Fire extinguisher, safety triangle, and safety vest.
- Emergency equipment (e.g., flares, flashlight, blanket, drinking water, etc.) based on conditions.
- Means of communication (cell phone, radio or satellite phone), extra batteries or a charger.

4.10.3 To the extent possible, employees should refrain from changing tires or making repairs to vehicles in the field. A road side assistance service should be identified for vehicles used for AECOM business in advance travel.

4.10.4 Specific emergency procedures are to be identified in the applicable Emergency Response Plan, JMP or the THA. Refer to *S3NA-010-PR1 Emergency Response Planning*.

4.11 Vehicle Incidents

4.11.1 Vehicle incidents are to be managed in accordance with *S3NA-004-PR1 Incident Reporting, Notifications and Investigation* regardless of how minor the incident might be.

4.11.2 The Employee(s) involved in a collision shall follow the below guidelines:

- Assess the situation to confirm everyone is safe, and remove any vehicle occupants from harm’s way. Call, or have someone else call 911 immediately, if necessary.
- As appropriate, remain at the scene of a collision to contact the police. Ask another motorist to call the police if necessary; never leave the scene of a collision.
- As applicable, provide (if requested) to police and the other driver(s) the liability insurance information. Obtain the officer’s jurisdiction, name, and badge number and a copy of the police report.
- As applicable, consider moving the vehicle out of the traffic flow if it is safe to do so, the vehicle is operational, and/or no further damage to the vehicle can occur.
- Do not operate a damaged vehicle if its safety is questionable, its operating condition is illegal by applicable laws or its condition is such that further damage would likely result from its operation.
- Turn on the vehicle’s flashers to warn other motorists.
- Obtain:

- Names, phone numbers, and addresses of owner(s), driver(s), and occupants of the other car(s) involved.
- Other party's insurance company's name, address, phone number, policy number, and insurance agent.
- Names, phone numbers, and addresses of all witnesses.
- Photographs of the accident scene when safe to do so.

- Cooperate with AECOM Counsel if the incident results in unresolved risks or third party claims, or if the employee receives a summons, complaint or other legal documents relating to a traffic incident.
- DO NOT ADMIT LIABILITY, AGREE TO PAY FOR DAMAGE OR SIGN A DOCUMENT RELATED TO AN INCIDENT EXCEPT AS REQUIRED BY LAW.
  - Statements made in haste or anger may be legally damaging.
  - If contacted by a third party, do not answer any questions. Immediately report this contact to the Manager / Supervisor and/or Legal Counsel
- Employees shall report the incident to AECOM's Global Travel Department. If the incident involved a third party, the driver is responsible for obtaining a copy of the police report and providing to global travel

4.11.3 Employees must cooperate with the incident investigation team during any investigation of an incident meeting the investigation protocol.

4.11.4 Vehicle repairs shall be conducted at the authorization of the Manager / Supervisor.

4.12 Drug and Alcohol Testing

4.12.1 Testing for Alcohol and/or Drugs procedures shall be administered in accordance with the applicable policy and procedures.

4.12.2 In the event that a police/regulatory officer responding to a vehicle incident administers field and/or laboratory impairment testing AECOM reserves the right, as permitted, to obtain copies of such testing results for inclusion in the incident report and consideration in a subsequent incident investigation.

4.13 Driving Privileges, Citations and Violations

4.13.1 A violation of this vehicle safety standard is subject review by the appropriate AECOM Human Resources representative and may be subject to disciplinary action, up to and including termination. The applicable Manager / Supervisor will review all incidents involving AECOM-owned, rented, or leased vehicles.

4.13.2 Citations and violations which occur while driving for AECOM business are to be reported as a vehicle incident in accordance with *S3NA-004-PR1 Incident Reporting, Notification & Investigation* within 24-hours.

4.13.3 The AECOM Manager responsible for the employee, in consultation with the appropriate AECOM Human Resources representative, may suspend the privilege to operate vehicles on AECOM business due to noncompliance with the AECOM Vehicle and Driver Safety Program, involvement in a motor vehicle incident, or resulting citations or other legal actions associated with motor vehicle violations.

4.13.4 The employee's driving privileges will be suspended for any of the following:

- Accidents or legal action involving alcohol or drug use (e.g., driving under the influence).
- Driving without a license.
- Hit-and-run driving or leaving the scene of an accident.
- Unauthorized use of AECOM vehicles (e.g., using an AECOM vehicle for moving personal items, carrying passengers who are not associated with work activities, etc.).

4.13.5 The employee's driving privileges may be suspended for any of the following:

- Two or more at-fault accidents involving the same Authorized Driver within a 12-month period.
- Multiple complaints from other employees or members of the public about driving performance.
- Any accident caused by an AECOM Authorized Driver where damages exceed $2,500.
- Failure to comply with the distracted driving requirements.
- Gross misconduct or violation of policy.

4.13.6 An Authorized Driver's driving privileges may be reinstated as follows:

- For any suspension resulting from law enforcement agency legal action involving drugs and alcohol on the part of the former Authorized Driver, driving privileges may be reinstated only by concurrent agreement of the Vice President of SH&E for the applicable Business Group and Human Resources Manager.
- For those Authorized Driver's privilege suspensions that are not related to driving under the influence of drugs or alcohol, privileges may be reinstated with concurrent agreement by the AECOM Manager, the SH&E Manager, and Human Resources Manager upon completion of required remedial training.

4.13.7 Disciplinary action may include the following:

- Loss of AECOM driving privileges.
- Disciplinary warning.
- Termination.

4.13.8 The employee is personally responsible for payment of fines for moving violations and parking citations incurred while driving a vehicle on AECOM business and for reporting such incidents to his/her Manager / Supervisor. The Manager is responsible for notifying Counsel.

4.13.9 If an Authorized Driver receives a citation resulting in the license being suspended from driving or has his/her driver's license revoked, he/she is required to notify his/her Manager / Supervisor prior to start of the following work day. Failure to do so may result in disciplinary action up to and including termination.

5.0 Records

5.1 Documentation of employee training completed shall be retained in accordance with *S3NA-003-PR1 SH&E Training*.

5.2 As applicable, completed *S3NA-005-FM2 Vehicle Inspection Checklists* and/or *S3NA-005-FM1 Journey Management Plans* shall be retained in project files.

6.0 Attachments

6.1 S3NA-005-ATT1 Authorized Driver Safety Practices

6.2 S3NA-005-FM1 Journey Management Plan

6.3 S3NA-005-FM2 Vehicle Inspection Checklist

Americas

Vehicle Inspection Checklist

S3NA-005-FM2

Vehicle Tag No:	Mileage:	Date:	Time:	Driver Name:	Location:

Inspection Checklist: This Pre-Trip Vehicle Inspection Checklist is intended to be completed by the vehicle driver prior to departing on a trip. Checking boxes means that item is present and functioning. Deficiencies that affect or could potentially affect the safe operation of the vehicle shall be repaired or corrected prior to departure. This checklist should only be used in addition to an on-going vehicle maintenance program.

Item	Yes	No	N/A
1. General			
1-1 Proof of insurance and registration available and current?	☐	☐	☐
1-2 Is the date of the last regular maintenance known, or is the mileage/date of next scheduled maintenance known?	☐	☐	☐
1-3 Is the overall condition of the vehicle good (no body damage, unusual sounds, leaks, odors, etc.)?	☐	☐	☐
2. Tires			
2-1 Do all tires have sufficient tread for driving conditions? Legal limit: 2/32” (for rain/snow: > 4/32”)	☐	☐	☐
2-2 Are tires sufficiently inflated for driving conditions?	☐	☐	☐
2-3 Are the lug nuts and stem caps present and tight for each tire?	☐	☐	☐
2-4 Is the spare tire and jack present and in good condition?	☐	☐	☐
3. Vehicle Interior			
3-1 Are the brake and accelerator pedal pads in good condition?	☐	☐	☐
3-2 Are the floor mats in good condition and not interfering with the brake or accelerator pedals?	☐	☐	☐
3-3 Is the seat properly adjusted (including the headrest)?	☐	☐	☐
3-4 Is the seatbelt in good condition?	☐	☐	☐
3-5 Are the mirrors in good condition (not broken, dirty)?	☐	☐	☐
3-6 Are the dashboard/instrument lights working?	☐	☐	☐
3-7 Is the dashboard free of warning lights and do the gauges appear to work when the car is started?	☐	☐	☐
3-8 Does the horn work?	☐	☐	☐
3-9 Are distractions such as cell phones and GPS units secured so they do not encourage use?	☐	☐	☐
4. Lights and Signals			
4-1 Do the headlights and high beams work?	☐	☐	☐
4-2 Do the tail lights function properly?	☐	☐	☐
4-3 Do the turn signals work (front and rear)?	☐	☐	☐
4-4 Do the brake lights work (including high light in the rear window if applicable)?	☐	☐	☐
4-5 Do the hazard lights (emergency flashers) work?	☐	☐	☐
4-6 Do back up / reverse lights work?	☐	☐	☐
4-7 If equipped with a back-up alarm can it be heard clearly?	☐	☐	☐
5. Mechanical			
5-1 Do the brakes work and feel solid (not soft)?	☐	☐	☐
5-2 Does the parking/emergency brake work?	☐	☐	☐
5-3 Is the steering in good working condition (not loose)?	☐	☐	☐
5-4 Is the engine oil level full or in the operating zone?	☐	☐	☐
5-5 Excessive vehicle bounce going over bumps reported (possible sign of worn shock absorbers)?	☐	☐	☐

Item	Yes	No	N/A
6. Windows and Windshield			
6-1 Is the windshield clean and unbroken?	☐	☐	☐
6-2 Are the wiper blades in good condition (front and rear)?	☐	☐	☐
6-3 Are all the windows clean and unbroken and windshield fluid available and operational?	☐	☐	☐
7. Emergency Equipment (as needed per conditions/project requirements)			
7-1 Is there a “Safety Kit” (fire extinguisher, first aid, safety triangle and 2 reflective vests)?	☐	☐	☐
7-2 Is there a first aid kit, has it been inspected recently?	☐	☐	☐
7-3 Is survival gear and equipment available (blanket, water, heat source, flashlight, etc.)?	☐	☐	☐
7-4 Is a means for emergency communication available?	☐	☐	☐
8. Other Equipment (as needed per conditions/project requirements)			
8-1 Is there a means to secured loads (cargo next, container)?	☐	☐	☐
8-2 Are cones or other warning devices available?	☐	☐	☐
8-3 Is weather specific equipment (snow chains, tired etc.)?	☐	☐	☐
8-4 Does the vehicle have a snow brush/ice scraper?	☐	☐	☐
8-5 Does the vehicle have a fire extinguisher?	☐	☐	☐
9. Comments			

Inspector Name:	Signature:	Date:

Americas

Housekeeping

S3NA-013-PR1

1.0 Purpose and Scope

1.1 This procedure provides AECOM's basic housekeeping requirements for offices and work sites, as well as establishes personal hygiene and sanitation standards for housekeeping.

1.2 This procedure applies to all AECOM Americas-based employees and operations.

2.0 Terms and Definitions

2.1 None

3.0 References

3.1 S3NA-208-PR1 Personal Protective Equipment

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Managers / Supervisors**

- Implementation of this procedure at all AECOM sites and offices.
- Confirm inspections are performed at appropriate intervals.
- Confirm the building Property Manager maintains leased facilities effectively.

4.1.2 **SH&E Managers**

- Monitor, assess, and report on housekeeping when visiting AECOM sites.

4.1.3 **Employees**

- Report any areas of concern to their Manager / Supervisor for prompt resolution.
- Maintain office locations that are free from debris, clutter, and slipping or tripping hazards.

4.2 General Housekeeping

4.2.1 All aisles, emergency exits, fire extinguishers, etc., will be kept clear (a minimum of three feet / 0.9 meters of either side) of material storage (temporary and permanent) at all times.

4.2.2 Areas in front of electrical panels will be kept clear and free of debris and materials storage for a minimum distance of 36 inches, or approximately 0.9 meters.

4.2.3 All work areas shall be kept clean to the extent that the nature of the work allows.

4.2.4 Spills shall be promptly cleaned up and resulting waste will be disposed of properly.

4.2.5 Storage areas will be maintained in an orderly manner at all times. When supplies are received, the supplies will be stored properly.

4.2.6 At all times, work areas will be kept free of debris and unused materials, tools and equipment that may affect the safety of employees and visitors.

4.2.7 All sharps, and sharp objects, shall be stored and/or guarded in a manner that prevents injury.

4.2.8 Recyclable material, debris and trash will be collected and stored in appropriate containers (e.g., recycle bins, plastic trash bags, garbage cans, roll-off bins) prior to disposal or recycling.

4.2.9 Containers maintained outdoors shall be provided with lids that are kept closed. Contents shall be removed at appropriate intervals (e.g. garbage weekly, garbage daily in areas with wildlife, monthly recyclable cardboard, etc.).

4.2.10 Take positive control measures for protection against vermin, insects, and rodents.

4.3 Smoking, Eating, and Drinking

4.3.1 Eating and drinking will be permitted in designated areas. These areas shall be located away from the work zone.

4.3.2 Operate and maintain food dispensing facilities established by AECOM in compliance with applicable health and sanitation regulations.

4.3.3 Buildings housing food dispensing facilities shall be floored completely, painted, well lighted, heated, ventilated, fly proof, and sanitary. Equip doors and windows with screens.

4.3.4 Microwave ovens shall be used for food only.

4.3.5 Use refrigerators designated for food storage for food only (i.e., no chemical or samples storage).

4.3.6 Hand washing stations shall be available nearby for employees entering the eating and smoking areas.

4.3.7 Smoking will be permitted only in areas:

- Designated in compliance with applicable local laws, regulations, legislation and ordinances;
- Not in the immediate vicinity of work-related activities or designated eating and drinking areas.
- Free of fire hazard;
- That will not contaminate indoor areas and HVAC systems. Specifically, there shall be no smoking within 5 metres (16 feet) around doorways, windows, air vents, and HVAC intakes and equipment; and
- Supervisors will designate each smoking area giving primary consideration to those employees who do not smoke.

4.3.8 Employees involved in the performance of certain activities will not be permitted to smoke, eat, drink, or use smokeless tobacco, except during breaks (e.g., HAZWOPER-controlled work areas).

4.3.9 Site employees will first wash hands and face after completing work activities which involve potential exposure or contact with hazardous substances and prior to eating or drinking.

4.4 Water Supply

4.4.1 Water will be available for use on all AECOM sites and will comply with the following requirements:

- Potable Water:
  - An adequate supply of drinking water will be available for site staff consumption.
  - Potable water can be provided in the form of approved well or city water, bottled water, or drinking fountains.
  - Water coolers and water dispensers shall be maintained in a sanitary condition and filled only with potable water.
  - Where drinking fountains are not available, individual use cups will be provided as well as adequate disposal containers. Do not use common drinking cups.
  - Potable water containers will be properly identified in order to distinguish them from non-potable water sources.
  - Laboratory-test drinking water obtained from streams, wells, or other temporary sources in accordance with applicable regulations, or often enough to ensure it is suitable for consumption. Maintain records of testing reports and results

- Non-potable Water:
  - Non-potable water will not be used for drinking purposes.
  - Non-potable water may not be used for hand washing or other personal hygiene activities but may be used for other types of cleaning activities.
  - All containers/supplies of non-potable water used will be properly identified and labelled as such.

4.5 Toilet Facilities

4.5.1 Clean and sanitary toilet facilities in good repair will be available for site and office staff and visitors. For locations without flush toilets readily available, one of the following shall be provided:

- Chemical toilets.
- Combustion toilets.
- Recirculation toilets.

4.5.2 A minimum of one toilet will be provided for every 20 site staff, with separate toilets maintained for each sex, except where there are less than five total staff on site or in an office.

4.5.3 Where toilet facilities will not be used by women, urinals may be provided instead of water closets in accordance with jurisdictional regulations.

4.5.4 Provisions for toilet facilities shall be considered as being met when mobile crews or employees working at normally unattended work locations have transportation immediately available (within 4 minutes travel time) to nearby toilet facilities.

4.5.5 Toilets shall be constructed so that the interior is lighted, by artificial or natural light, adequate ventilation is provided, and all windows and vents are screened.

4.5.6 A means for washing hands shall be provided next to or near toilet areas.

4.5.7 Release sanitary sewage into sanitary sewer lines or to other proper disposal channels.

4.6 Washing Facilities

4.6.1 Hand and Face: Site staff will wash hands and face after completing work activities and prior to breaks, lunch, or completion of workday.

4.6.2 Personal Cleaning Supplies: Cleaning supplies at all AECOM sites will consist of soap, water, and disposable paper towels or items of equal use/application (e.g., anti-bacterial gels, wipes, etc.).

4.7 Work Areas

4.7.1 Worksites which store chemical or environmental samples in refrigerators will clearly label the refrigerators that no food or beverages permitted and will locate refrigerators and sample coolers used for temporary sample storage, away from any food areas.

4.7.2 Every work area shall be maintained, so far as practicable, in a dry condition. Where wet processes are used, drainage shall be maintained and platforms, mats, or other dry standing places shall be provided, where practicable, or appropriate waterproof footgear shall be provided.

4.7.3 Protruding objects or placement of materials on paths or foot traffic areas creates the risk of slips, trips, falls, and puncture wounds. Employees shall eliminate slip, trip, and fall hazards where reasonably practicable.

4.7.4 At no time will debris or trash be intermingled with waste PPE or contaminated materials.

4.8 Break Areas and Lunchrooms

Site staff will observe the following requirements when using break areas and lunchrooms at AECOM sites:

4.8.1 All food and drink items will be properly stored when not in use.

4.8.2 Food items will not be stored in personal lockers for extended periods in order to prevent the potential for vermin infestation.

4.8.3 Perishable foods will be refrigerated whenever possible.

4.8.4 All waste food containers will be discarded in trash receptacles.

4.8.5 All tables, chairs, counters, sinks, and similar surfaces will be kept clean and free of dirt, waste food, and food containers at all times.

4.8.6 All ice dispensing machines for beverages shall be hands free/touchless design to prevent bacterial contamination (no ice scoops or ice bins permitted, closed beverage containers can be stored in portable ice coolers but the ice may not be used in the beverage).

4.8.7 Refrigerators used to store food items will be maintained at 40 degrees Fahrenheit (4 degrees Celsius) and emptied of all unclaimed food items weekly. Refrigerators used to store food will be labelled as such so that only food and drinks are stored within the refrigerator.

4.8.8 Routine cleaning of refrigerators will also be performed on a regular basis.

4.9 Change Rooms and Sleeping Facilities

4.9.1 Heated and ventilated change rooms shall be provided for changing, hanging, and/or drying clothing for operations subjecting employees to prolonged wetting or contact with hazardous materials.

4.9.2 Temporary sleeping quarters shall be heated, ventilated, lighted, and clean with all doors and windows screened.

4.9.3 Keep clean and sanitary, and periodically disinfect bunkhouses, bedding, and furniture.

4.10 Office Areas

Office areas are to be kept neat and orderly. The following general rules apply to prevent injuries and to maintain a professional workplace appearance.

4.10.1 All waste receptacles shall be lined with a plastic trash bag to avoid direct contact with waste during disposal. Employees shall use gloves when handling waste and may use a compaction bar to compress waste when necessary.

4.10.2 Keep file and desk drawers closed when not in use to avoid injuries. Open only one file drawer at a time to prevent tipping of file cabinets. Nothing should be stored on top of high filing cabinets without adequate support.

4.10.3 Telephone cords, electrical cords, wastebaskets, open file cabinets, and other ground-level hazards shall be managed in a manner that protects employees from tripping and obstruction hazards.

- Electrical cords and computer/phone cables will be bundled and stored.
- Cord covers should be used to protect temporary extension cords (used for presentations etc.) where they could be a tripping hazard.
- Small electrical appliances shall not be plugged into portable extension cords.
- Multiple appliances amperage should not exceed the circuit load limits.

4.10.4 Electrical appliances shall not be used in wet areas unless the circuit is equipped with ground fault circuit interrupters (GFCI).

4.10.5 File cabinets, desk drawers, safes, and other doors shall be fitted with handles or other hardware to protect employees from pinch points.

4.10.6 All materials shall be stored in a manner that prevents tipping of storage furniture (e.g. book shelves, file cabinets) and inadvertent falling of overhead material.

4.10.7 Do not stack excessive amounts of papers or other material on shelves to reduce possibility of shelf overload or falling items.

4.10.8 Workstations should be tidied, as a minimum, at the end of each day.

- Paperwork that is not currently needed should be filed appropriately
- Refrain from storing items on the floor as they may become falling or tripping hazards.

4.10.9 In public areas of the office:

- Maintain chairs in good repair.
- Keep rugs clean, in good repair, and free of tripping hazards.
- Clean up spills immediately.
- Pick up objects that may have been left on the floor by others.
- Report loose carpeting, damaged flooring, or other obstructions that are present in walkways.

4.10.10 Broken or damaged office furniture and equipment shall be removed from service. Office equipment shall be repaired and serviced by qualified personnel or contractors.

5.0 Records

5.1 None

6.0 Attachments

6.1 S3NA-013-FM1 Housekeeping Inspection

Americas

Housekeeping Inspection

S3NA-013-FM1

Building or Location: _____

Inspection Conducted by: _____ **Date:** _____

Check Yes, No, or NA for Not Applicable.

General Site Housekeeping

1.	Exits, emergency equipment, and electrical panels unblocked?	☐ Yes	☐ No	☐ NA
2.	Equipment, materials, supplies properly stored and, as applicable, secured (e.g. chocked)?	☐ Yes	☐ No	☐ NA
3.	Drawers closed when not in use?	☐ Yes	☐ No	☐ NA
4.	Equipment, including desks and chairs, in good repair?	☐ Yes	☐ No	☐ NA
5.	Storage areas free from the accumulation of materials that constitute trip hazards?	☐ Yes	☐ No	☐ NA
6.	Recyclable material, debris and trash collected and stored in appropriate containers?	☐ Yes	☐ No	☐ NA
7.	Scrap materials and other debris from removed from work area?	☐ Yes	☐ No	☐ NA
8.	Combustible scrap and debris removed by safe means at regular intervals?	☐ Yes	☐ No	☐ NA
9.	Oily rags removed at the end of the day and stored in metal cans with tight fitting lids?	☐ Yes	☐ No	☐ NA

Visibility

10.	Worksite and, as applicable, halls, stairways and walkways are well lit?	☐ Yes	☐ No	☐ NA
11.	Well-designed light switches are present in areas where walkways are not always lighted?	☐ Yes	☐ No	☐ NA
12.	Dust, smoke or steam does not create poor visibility?	☐ Yes	☐ No	☐ NA
13.	Glare from floodlights or windows does not create poor visibility in work areas?	☐ Yes	☐ No	☐ NA

Stairs

14.	Handrails are tight and at the proper level?	☐ Yes	☐ No	☐ NA
15.	Handrails extend past the top and bottom step?	☐ Yes	☐ No	☐ NA
16.	White or yellow strips are painted on the first and last step for better visibility? (recommendation only).	☐ Yes	☐ No	☐ NA
17.	Steps are not rough or defective?	☐ Yes	☐ No	☐ NA
18.	Stair treads are wide enough and risers consistently spaced?	☐ Yes	☐ No	☐ NA
19.	Stairs are free of obstructions?	☐ Yes	☐ No	☐ NA

Floor Conditions

20.	Floors of every workroom are clean, and so far as possible, in a dry condition?	☐ Yes	☐ No	☐ NA
21.	Floors are not oily, overly waxed, or polished.	☐ Yes	☐ No	☐ NA
22.	Where wet floors or processes are present, proper drainage and false floors, mats, or other dry standing places are provided?	☐ Yes	☐ No	☐ NA
23.	Floor surfaces finished with non-slip coatings where spills are likely?	☐ Yes	☐ No	☐ NA
24.	Floors and passageways are free from protruding nails, splinters, holes, or loose boards?	☐ Yes	☐ No	☐ NA
25.	Floors are free of holes and depressions?	☐ Yes	☐ No	☐ NA
26.	Aisles or pathways are wide enough for easy passage and for carrying objects (48 inches is recommended)?	☐ Yes	☐ No	☐ NA
27.	Ramps are covered with non-slip surfaces or matting?	☐ Yes	☐ No	☐ NA

28.	Carpets or rugs free from loose or frayed edges that may catch boots or shoes?	☐ Yes	☐ No	☐ NA
29.	Extension cords, air hoses and cables removed from walkways, or otherwise managed to prevent trip hazards?	☐ Yes	☐ No	☐ NA
30.	Pathways free from boxes, containers, machine parts, or other tripping hazards?	☐ Yes	☐ No	☐ NA
	Ground Conditions			
31.	Trip hazards are not present?	☐ Yes	☐ No	☐ NA
32.	Fall hazards are not present?	☐ Yes	☐ No	☐ NA
33.	Holes or changes in ground elevation are either filled or guarded?	☐ Yes	☐ No	☐ NA
34.	Muddy or icy walkways are provided with traction material (e.g. sand, gravel) to reduce slipping?	☐ Yes	☐ No	☐ NA
	Equipment			
35.	Vehicle steps are free from debris or obstructions and of adequate size, and surface placement for safe dismounting?	☐ Yes	☐ No	☐ NA
36.	Hand grips or ladders are free from debris or obstructions and adequate for getting into and out of equipment?	☐ Yes	☐ No	☐ NA
37.	Ladders have been checked for damage and removed from service if found unsafe?	☐ Yes	☐ No	☐ NA
	Chemicals			
38.	Chemicals are properly stored to minimize a potential spill?	☐ Yes	☐ No	☐ NA
39.	Spill cleanup materials are available and appropriate for the type of potential spill?	☐ Yes	☐ No	☐ NA
	Smoking, Eating and Drinking			
40.	Smoking permitted in designated areas only?	☐ Yes	☐ No	☐ NA
41.	Designated smoking area appropriately placed?	☐ Yes	☐ No	☐ NA
42.	Appropriate and clean eating and drinking areas designated away from work areas?	☐ Yes	☐ No	☐ NA
43.	Food and drink items properly stored?			
44.	Potable water identified and readily available?	☐ Yes	☐ No	☐ NA
	Sanitation			
45.	Appropriate cleaning supplies available and properly stored?	☐ Yes	☐ No	☐ NA
46.	Hand and face washing facilities available and maintained with adequate supplies?	☐ Yes	☐ No	☐ NA
47.	Adequate toilet facilities available and maintained with sufficient supplies?	☐ Yes	☐ No	☐ NA

Identify areas that need attention and describe the corrective actions to be implemented:

_____

_____

_____

_____

_____

I certify that the above inspection was performed to the best of my knowledge and ability, based on the conditions present.

_____ _____

Signature Date

Americas

First Aid

S3NA-012-PR1

1.0 Purpose and Scope

1.1 The purpose of this procedure is to ensure employee accessibility to first aid personnel and supplies commensurate with the hazards of the workplace**.**

1.2 This procedure applies to all AECOM Americas employees and operations, except where legislation is more stringent.

2.0 Terms and Definitions

2.1 **Automated External Defibrillator (AED)** – A portable electronic device that automatically diagnoses the potentially life threatening cardiac arrhythmias of ventricular fibrillation and ventricular tachycardia in a patient, and is able to treat them through defibrillation, the application of electrical therapy which stops the arrhythmia, allowing the heart to re-establish an effective rhythm; are used in the resuscitation of a patient in full cardiac arrest.

2.2 **Cardiopulmonary Resuscitation (CPR) –** An emergency procedure in which the heart and lungs are made to work by:

- Manually compressing the chest overlying the heart, or
- Both manually compressing the chest and performing rescue breaths that force air into the lungs.

CPR is applied to a victim in respiratory distress and/or to maintain circulation when the heart stops pumping (cardiac arrest), which may be due to heart tissue damage (heart attack), disease, electrical shock, drug overdose, drowning, suffocation, stroke or trauma.

2.3 **First Aid Provider –** Is a First Aid, CPR, and AED trained employee who provides emergency first aid or treatment (including performing CPR and applying an AED) to someone who is injured or suddenly ill, before emergency medical services (EMS) arrives. This is a voluntary action and not an occupational duty assigned by AECOM. They may use a limited amount of equipment to perform initial assessment and provide immediate life support and care while awaiting arrival of emergency medical services.

2.4 **High Risk Task(s) –** For the purpose of this procedure, a work related task with the potential to cause traumatic injury/illness or immediate life threatening conditions.

2.5 **Occupational Exposure –** Reasonably anticipated skin, eye mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties. Employees will be considered to be potentially exposed, even though they are using the precautions specified for the project.

3.0 References

3.1 S3NA-003-PR1 SH&E Training

3.2 S3NA-004-PR1 Incident Reporting, Notifications & Investigation

3.3 S3NA-010-PR1 Emergency Response Planning

3.4 S3NA-018-PR1 Injury & Claims Management

3.5 S3NA-111-PR1 Bloodborne Pathogens

3.6 S3NA-208-PR1 Personal Protective Equipment

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 SH&E Manager

- Supporting the assessment of employees in the need for first aid, CPR and/or AED training and making training available to required employees.
- Assisting Managers with the assessment of each office or project site for adequate response time and availability of Emergency Medical Services (EMS).
- Assisting Managers with the development of the location specific emergency response plan. Refer to *S3NA-010-PR1 Emergency Response Planning*.
- Coordinating first aid/adult cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) training with the Manager.

4.1.2 Managers

- Ensure location specific emergency response plans are developed. Refer to *S3NA-010-PR1 Emergency Response Planning*.
- Coordinating weekly / monthly inspections of first aid kits and AEDs.
- Coordinating replacement supplies to re-stock first aid kits and AEDs.
- Ensuring debriefing and availability of counselling for any Employees, including First Aid Providers, who responded to the event, as well as any bystanders and co-workers who witnessed the event.
- Ensuring the appropriate investigations of incidents are conducted.
- Ensuring jurisdictional requirements, such as appropriate notifications, oversight and specific protocols are in place as necessary (e.g., requirements associated with Good Samaritan protection).

4.1.3 Employees

- Notifying supervisors of any injuries.
- Complying with emergency response procedures.
- Reporting all work related injuries in accordance with *S3NA-004-PR1 Incident Reporting, Notifications & Investigation*.

4.1.4 AECOM First Aid Providers

- Maintaining all required First Aid, CPR, and AED training.
- Providing emergency first aid or treatment if they so choose (including performing CPR and applying an AED) in accordance with training.

4.1.5 Designated Individual

- Ensuring First Aid Providers have been trained and maintain valid certificates in First Aid, CPR, and AED.
- Ensuring appropriate maintenance, testing and inspections of emergency equipment and supplies are completed as identified by this procedure and manufacturer requirements.
- Coordinating replacement supplies to re-stock first aid kits and AEDs.
- Ensuring appropriate documentation and reporting is completed as identified by this procedure and manufacturer requirements.

4.2 Requirements

4.2.1 An assessment shall be made by the Manager for each office or work site for first aid and medical requirements. The following factors should be considered:

- Types of incidents that could reasonably occur.
- Location of local clinics and hospitals.
- Response time for external emergency services (EMS).
  - Consult applicable legislation for minimum response time required as determined by hazards and distance to medical facilities.
- Corrosive or hazardous materials that may be used.
- Industry specific requirements.
- Types of training for Employees and First Aid Providers.
- First aid supplies required to be available.

4.2.2 A location specific emergency response plan must be developed and communicated to all affected personnel. Refer to *S3NA-010-PR1 Emergency Response Planning*.

4.2.3 The responsible Manager shall ensure adequate first aid supplies are available and an adequate number of trained First Aid Providers (but not less than one) are available during hours of normal operation or while performing work if either of these conditions cannot be met or relied on:

- High Risk Tasks: In workplaces locations where life-threatening injuries can reasonably be expected, emergency medical services must be available within 3-4 minutes. This generally means that community emergency medical services cannot be relied on since their response time is usually greater than 3 minutes.
- Remote Potential for Serious Injury: If no life-threatening work-related injuries can reasonably be expected, the response time for trained personnel is extended to 15 minutes.

4.2.4 The number of First Aid Providers and the type and quantity of first aid supplies will vary depending upon the number of workers, location of the office or project site, associated site hazards and legislation.

4.2.5 The trained First Aid Providers should be designated so that the other employees know who they are and how to contact them. Location specific emergency response plans shall include emergency contact lists that identify and provide contact information for the designated First Aid Providers. Refer to *S3NA-010-PR1 Emergency Response Planning*.

4.2.6 All on-site personnel must be aware of the First Aid Room (if applicable), First Aid Provider's location and contact information.

4.2.7 For certain long-term, heavily staffed, or high hazard projects, AECOM may opt to establish a first aid station on site. It should be staffed with a person who is a nurse, Emergency Medical Technician (EMT), or Emergency Medical Technician Paramedic (EMT-P) who may practice limited treatment under the direction of a physician.

4.3 First Aid Rooms

4.3.1 Where required by the applicable federal, provincial, or territorial legislation, every first aid room will:

- Be located in an area that is easily accessible to workers at all times;
- Be clearly identified as a first aid room;
- Be used exclusively for the purposes of administering first aid and medical examinations and to provide rest for persons who are ill or injured;

- Have adequate lighting, ventilation, and heating and be covered by a floor made of non-porous material;
- Be of an adequate size to accommodate all supplies;
- Be equipped with
- An appropriately sized First Aid Kit;
- Instructions on how and where to access a first aider,
- A communication system capable of communicating with the medical facility to which an injured worker would be transported,
- A permanently installed sink with hot and cold potable running water,
- A cot or bed with a moisture-protected mattress and two pillows;
- A stretcher.
- During working hours, be supervised by a first aid provider, who is readily available to provide first aid; and
- Be kept clean and sanitary.

4.4 First Aid Supplies

4.4.1 It is required that all AECOM locations maintain an adequate amount of first aid supplies in an easily identifiable and accessible location (this may by a vehicle in vehicle-based operations in remote locations). All locations (including vehicles) must be equipped with a complete first aid kit appropriate to the number of staff, location of work, and site hazards, as dictated by the applicable legislation and regulation.

4.4.2 First aid kits must be inspected to ensure contents meet jurisdictional requirements given the number of staff, work location, and potential hazards prior to being placed in the determined location or sent to site and, as a minimum, monthly thereafter.

- For construction operations, first aid kits shall be checked before being sent out to each job and at least weekly thereafter.
- An inventory (listing required and approved items) and weekly / monthly inspection form shall be included with each first aid kit. Any items not listed on the inventory (listed as required or approved for the kit) will be removed during the weekly / monthly inspection unless specifically approved by a health care professional for inclusion and added to the inventory. Refer to *S3NA-012-FM1 First Aid Kit / AED Inventory and Inspection* form.
- At no time will over-the-counter medications such as antacids, aspirin, cold or cough drops, or other sundry items be stored in the kits without the prior approval of a health care professional (where permitted by local legislation) and inclusion in the kit's listed inventory. Over-the-counter medications may be provided to employees with work-related injuries if recommended by a medical professional and/or a SH&E Manager.
- First aid kit content usage shall periodically be assessed for demand and supply inventory increased accordingly.

4.4.3 The Designated Individual identified on each individual project / location will be responsible for ensuring the weekly / monthly documented inspection of first aid kits for their assigned projects or locations, including all vehicles.

4.4.4 Each item in first aid kits shall be individually sealed to protect the contents from contamination. The first aid equipment and supplies shall be maintained in a clean, dry and serviceable condition, contained in a material that protects the contents from the environment, and clearly identified as first aid equipment and supplies.

4.5 First Aid Response

4.5.1 Any Employee who recognizes a medical emergency immediately initiates an emergency response in accordance with the location-specific Emergency Response Plan. Refer to *S3NA-010-PR1 Emergency Response Planning.*

4.5.2 First Aid Providers assess the emergency scene to determine and initiate the appropriate course of action based on their observations, the victim's condition, their training and according the location-specific Emergency Response Plan.

4.5.3 As is applicable to the victim's condition, First Aid Providers arrange for an escort to a suitable medical provider.

- For work related non-critical injuries and illnesses, Employees must follow procedures outlined in *S3NA-004-PR1 Incident Reporting, Notifications & Investigation*.
- Contact shall be made with their Manager, Supervisor or SH&E Manager prior to seeking any medical treatment for non-critical injuries/illnesses. Refer to *S3NA-018-PR1 Injury & Claims Management.*

4.5.4 As is applicable to the victim's condition, First Aid Providers transfer the victim's care to the EMS agency for appropriate advanced medical treatment and provides a report including: The initial time of the event.

- The initial time of the event.
- Any care given prior to the First Aid Provider's arrival.
- Victim's condition upon the First Aid Provider's arrival.
- Treatment rendered to the victim by the First Aid Provider.
- Available medical information about the victim.

4.5.5 If an AED was used, leave the defibrillator attached to the victim until instructed to remove it by EMS personnel or higher medical authority.

4.5.6 Reporting shall be completed in accordance with *S3NA-004-PR1 Incident Reporting, Notifications & Investigation* and *S3NA-018-PR1 Injury & Claims Management.*

4.6 Automated External Defibrillator (AED)

4.6.1 While locations are not mandated to acquire AEDs, an AED should be considered based on the number of employees, response time of local Emergency Medical Services (EMS), and access to other AED units (e.g., those provided by the office building management).

4.6.2 The selection of AED equipment will be based on the most current listing of approved AED manufacturers as provided by the American Heart Association, Heart and Stroke Foundation of Canada or country equivalent.

4.6.3 Many jurisdictions require Emergency Medical Services (EMS) notification as a requirement for placing an AED.

- This allows the servicing or responding agency to know that an AED is at a particular location. In some instances the 911 dispatcher will have that information and can advise callers as to its location.
- To meet this requirement, each location purchasing an AED will contact the local Emergency Response Services (EMS) or fire department to determine where notification(s) need to be sent.
- Some jurisdictions also require registration of AEDs. The Heart and Stroke Foundation, Department of Health or Office of Emergency Medical Services of the applicable jurisdiction may be helpful in this determination.

- Once it has been determined who must be notified, notification(s) will be made via certified mail, and records of notification will be delivered to the Designated Individual and maintained in the applicable project/ location files.
- Notification requirements shall be provided in AED procedures included in the location specific emergency response plan.

4.6.4 AEDs should be placed in a location that optimizes the fastest response time an individual walking at a rapid pace would incur to reach the victim. A general rule of thumb by the American Heart Association is that it should take no longer than 3 minutes to retrieve an AED and return to the victim. The AED should be in an easily accessible position with the location well-communicated to all staff.

4.6.5 In order to ensure readiness for use and integrity of the device, AEDs shall be inspected after use and on a monthly basis, and maintained, cleaned and tested according to manufacturer's specifications.

- Check equipment, supplies, accessories and spares for quantities, performance, expiration dates and defects. Additional items that should be stored and accessible with the AED:
  - Simplified written directions for CPR and the use of the AED.
  - Non-latex protective gloves (several pairs in various sizes).
  - Breathing barrier (CPR)
  - Disposable razor to shave chest hair if necessary.
  - Biohazard clean-up kit with two biohazard disposal bags.
  - Absorbent towels.
- AEDs shall be serviced according the manufacturer's specifications.
- After-use maintenance shall be performed according to manufacturer's specifications before it is returned to service.
- Inspections, cleaning, maintenance, tests and results shall be documented on *S3NA-012-FM1 First Aid Kit / AED Inventory and Inspection* form.
- All documentation (e.g. inspections, service records, etc.) will be delivered to the Designated Individual and maintained in the applicable project/ location files.

4.6.6 AEDs shall only be used by individuals with current and proper training.

4.6.7 Each location that has an AED will incorporate AED procedures into its location specific emergency response plan. Refer to *S3NA-010-PR1 Emergency Response Planning.*

4.6.8 AEDs shall be used in conjunction with CPR according to training and the equipment's operator directions when a victim is unresponsive and not breathing.

4.6.9 AEDs shall be applied to a victim and operated by a First Aid Provider in accordance with training and the equipment's instructions.

- Once the AED is turned on, it coaches the user through the steps for use. AEDs are completely safe. The device gives its users step-by-step instructions on what to do in an emergency situation and will only deliver a shock if the heart rhythm can be corrected by defibrillation.

4.6.10 Once an AED has been applied to a victim, it shall not be removed or turned off even if the device advises 'No Shock'. The AED will continue background monitoring of the victim's heart rhythm and alert the First Aid Provider(s) if a shock is required. The AED shall only be turned off or removed upon direction of the device itself, EMS personnel or higher medical authority.

4.6.11 When an AED has been used and has been detached from the victim, the First Aid Provider shall deliver the equipment as soon as possible to the Designated Individual who will download the data from its internal memory and, as necessary, subsequently erase the AEDs memory (ensures adequate memory space for future data).

4.6.12 Ensure any additional reporting or notifications required as per jurisdictional or client requirements is completed. Note: Jurisdictional requirements may specify additional actions, reports or notifications necessary in order for Good Samaritan protections to apply.

4.7 Eyewash and Body Flush (Shower) Facilities

4.7.1 If corrosive, irritating or otherwise hazardous materials are used, review applicable safety data sheets to assist in determining whether eyewash and body flush (shower) facilities must be provided.

4.7.2 Employees who may be exposed to corrosive, irritating or otherwise hazardous materials will be instructed in the location and proper use of emergency eyewash units and body flush (shower) facilities.

4.7.3 Eyewash and body flush (shower) facilities will be assembled and installed in accordance with the manufacturer's instructions.

4.7.4 These facilities should highly visible, clearly identified and, if possible, within 10 seconds of the hazard. The water source / flushing fluid must be tepid, pressure controlled, and maintained to prevent freezing and contamination of the fluid.

4.7.5 Eyewash facilities must be capable of flushing both eyes simultaneously and providing at least 15 minutes of potable water flow at a velocity low enough so as not to cause injury to the user (not less than 0.4 gallons per minute (gpm), or 1.5 liters per minute (lpm)).This generally requires between 7 and 15 gallons depending on flow.

4.7.6 Plumbed eyewash and body flush (shower) equipment will be activated weekly to verify operation and ensure that flushing fluid is available. Self-contained eyewash and body flush (shower) equipment will be visually checked regularly to determine whether the flushing fluid needs to be changed or supplemented.

4.7.7 Body flush (shower) facilities will be capable of delivering flushing fluid at a rate of not less than 20 gpm (75.7lpm) for 15 minutes.

4.7.8 Eye/face wash facilities will meet all the criteria outlined for facewash facilities, except the equipment will be capable of delivering flushing fluid at a rate of not less than 3.0 gpm (11.4 lpm) for 15 minutes.

4.7.9 All eyewash and body flush (shower) equipment will be included in site inspections as well as inspected annually for compliance with this procedure.

4.8 Training

4.8.1 First Aid Provider(s) shall possess a valid certificate in First Aid, CPR, and AED training from an approved provider for the applicable jurisdiction (e.g., the U.S. Bureau of Mines, the American Red Cross, St. John Ambulance, etc.), that can be verified by documentary evidence. Refer to *S3NA-003-PR1 Training.*

4.8.2 First Aid, CPR, and AED training will be renewed 30 days before expiration. Specific training may also be considered for such topics including wilderness survival and rescue for employees performing work in remote locations where access by EMT is limited by extreme terrain.

4.8.3 If there is potential for occupational exposure to bloodborne pathogens, requirements of *S3NA-111-PR1 Bloodborne Pathogens* will be followed (where regulatory required).

4.9 Providing Assistance to Injured Employees

4.9.1 In the case of an emergency, the First Aid Provider may provide injured workers with a level of care within the scope of the their training, objectively record observed or reported signs and symptoms of injuries and exposures to contaminants, and refer workers with injuries considered to be serious or beyond the scope of the provider's training to medical personnel.

4.10 Program Review

4.10.1 This program will be evaluated at least annually.

5.0 Records

5.1 Documented inspections shall be maintained in the office / location / project files.

5.2 Records associated with treatment will be filed and maintained with strict confidentiality.

5.3 Downloaded AED data shall be stored in a secure location.

6.0 Attachments

6.1 S3NA-012-FM1 First Aid Kit / AED Inventory and Inspection

Americas

First Aid Kit / AED Inventory and Inspection

S3NA-012-FM1

This form is to be used to record the required contents of the first aid kit as well as document monthly First Aid Kit / AED inspections. The column '**Quantity**' is to be completed according to jurisdictional requirements and/or approval prior to the first aid kit being delivered to its intended location and at the beginning of each calendar year thereafter. Any listed items that are not required by the given jurisdiction or approved to be included in the first aid kit shall have '**N/A**' entered in the corresponding '**Quantity**' box. If an AED is not on location, or inspection is included on another *S3NA-012-FM1 First Aid Kit / AED Inventory and Inspection* form, mark the AED content in this form with 'N/A'.

Project/Location/ Office Name:		**Address:**	
First Aid Kit Type:		**Kit Location:**	
First Aid Kit ID #:		**AED Location:**	
AED ID #:		**Date:**	

Monthly inspections require the inspector to record the actual quantity of required items in the corresponding monthly column. Items deficient in number must be restocked. Unapproved items shall be removed from the First Aid Kit.

Item (Year)	Quantity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
First Aid Manual *(current)*													
Adhesive Bandage													
Elastic Adhesive Bandage													
Gauze Roller Bandage													
Triangular Bandage													
Conforming Bandage													
Tensor Bandage													
Safety Pins													
Adhesive Tape													
Antiseptic *(solution/swabs)*													
Burn Treatment													
Medical Exam Gloves													
Dressing *(Sterile Pad)* Sz/ Type													
Dressing *(Sterile Pad)* Sz/ Type													
Dressing *(Sterile Pad)* Sz/ Type													
Dressing *(Sterile Pad)* Sz/ Type													
Dressing *(self-adherent roller)*													
Eye Pad *(with Shield / Tape)*													
Breathing Barrier *(CPR use)*													
Bandage Scissors													
Soap													

Item (Year)	Quantity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cold Compress													
Splinter Forceps													
Waterless Hand Cleaner													
Waterproof Waste Bag													
Eye Wash													
Tweezers													

AED inspected according to manufacturer specifications. Use '✓' as acceptable condition and 'x' as deficient. Deficiencies, corrective actions taken, and whether inspection was an 'After-Use' inspection recorded in monthly comments below.

AED Condition													
AED Tested													
AED Pads													
AED Battery													
AED Supplies *(razor, manual)*													
AED Other													

Inspector for the given month shall record his/her name, record any comments regarding the inspection (including items replaced) and initial once complete.

MONTH	Inspector Name	Comments	Initials
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			
January			
December			

Americas

Personal Protective Equipment

S3NA-208-PR1

1.0 Purpose and Scope

1.1 Provide an effective Personal Protective Equipment (PPE) Program to protect AECOM employees from potential workplace safety and health hazards.

1.2 This procedure applies to all AECOM Americas-based employees and operations.

1.3 The proper use of appropriate PPE, in combination with effective engineering and administrative controls, can provide AECOM employees with protection against potential workplace hazards and can reduce the potential for workplace injury and illness.

2.0 Terms and Definitions

2.1 **ANSI** – American National Standards Institute

2.2 **CSA** – Canadian Standards Association

2.3 **PPE** – Personal Protective Equipment

2.4 **SDS** – Safety Data Sheets

2.5 **THA –** Task Hazard Assessment

3.0 References

3.1 S3NA-123-PR1 Respiratory Protection

3.2 S3NA-209-PR1 Risk Assessment & Management

3.3 S3NA-301-PR1 Confined Spaces

3.4 S3NA-304-PR1 Fall Protection

3.5 S3NA-315-PR1 Working On & Near Water

3.6 S3NA-317-PR1 Hand Safety

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Managers** or **Supervisors**

- Confirm the location specific SH&E Plan documents required hazard controls.
- Confirm Task Hazard Assessments (THAs) are conducted and hazards identified are eliminated through substitution, engineering, or administrative controls first before assigning PPE for hazard mitigation.
- Confirm appropriate subject matter experts, manufacturer's specifications, and regulatory requirements are consulted as necessary to assist with proper PPE selection.
- Match the appropriate PPE to those hazards that cannot be eliminated; support employees in exercising Stop Work Authority if the task is too hazardous to be mitigated
- Provide and document employee training on use and care of PPE.
- Determine which staff requires employee-issued PPE.

- If applicable, manage medical monitoring of employees using PPE (e.g. respirators, hearing protection, radiation, etc.).
- Approve the purchase of company-issued PPE.
- Confirm that appropriate PPE is utilized by employees when required or necessary. This may periodically be documented using *S3NA-208-FM2 Personal Protective Equipment Inspection*.
- Exercise Stop Work Authority if PPE is inadequate to address hazards

4.1.2 **SH&E Managers**

- Provide guidance to Managers, Supervisors, and staff on the assessment of hazards and the selection of PPE.
- Provide training materials to Managers and Supervisors for employee training

4.1.3 **Employee**

- Review all relevant SH&E Plans, THAs and applicable SDS prior to commencing work.
- Exercise Stop Work Authority if the task is too hazardous.
- In accordance with training and instructions, utilize appropriate PPE that has been issued when required or necessary.
- Inspect PPE prior to and after use to confirm that it is functional, and maintain PPE in a clean and functional condition.
- Follow instructions and manufacturers' guidance on the care, use, and storage of PPE.
- Replace PPE when worn out, expired or damaged.
- Refrain from wearing PPE outside of the work area for which it is required if doing so would constitute a hazard.

4.2 Hazard Assessment

4.2.1 The location specific SH&E plan and THA shall assess the hazards and identify the necessary control measures. Refer to *S3NA-209-PR1Risk Assessment & Management.*

4.2.2 These control measures shall include direction and guidance concerning the appropriate PPE required as the last line of defense to the anticipated hazards of the specific operations and tasks. A PPE specific assessment may assist in identifying PPE requirements. *S3NA-208-FM1 Personal Protective Equipment Assessment* may be completed and included in the SH&E Plan.

4.2.3 Various tasks and operations, including but not limited to, demolition, remediation, spill response, asbestos abatement, and lead removal, may require additional direction concerning selection, use, care, and disposal of PPE from a subject matter expert (e.g. protector manufacturer, industrial hygienist, asbestos professional, etc.).

- Obtained direction shall be included in the SH&E Plan.
- Consultation with subject matters may be limited to the planning phase or they may be retained to provide technical assistance for a portion of or duration of the project.

4.3 Training

4.3.1 All employees shall be informed of their right to Stop Work if the task is too hazardous to mitigate through use of elimination, substitution, engineering controls, administrative controls, and PPE.

4.3.2 Staff will receive adequate instruction on the correct use, limitations, and assigned maintenance duties for the equipment to be used. The following information, at a minimum, will be covered during PPE training:

- What PPE is required.

- When it is required.
- Why it is required.
- How to properly don, doff, adjust, and wear the PPE described.
- The limitations of the PPE, including its expected useful life.
- How to properly care for, maintain, and dispose of the PPE.

4.3.3 Staff are responsible for confirming that they have reviewed the operation manual/instructions for the PPE before work commences.

4.3.4 All staff will receive a location specific orientation to the hazards on the job site as well as appropriate PPE requirements.

4.4 Determining the Need for PPE

4.4.1 Prior to beginning work, the SH&E plan shall be consulted and THAs developed to identify the PPE requirements.

4.4.2 After the hazard assessments have been completed, the manager and/or employee shall select the appropriate PPE for each job category or task, as necessary. PPE will be provided to each employee appropriate for the hazards present. All PPE selected, purchased and used by AECOM will meet or exceed the appropriate ANSI/CSA standards or other standards as determined by federal, provincial, territorial, or state legislation

4.4.3 If the hazard can be mitigated through using appropriate PPE shall:

- Properly fit the employee's body.
- Be selected and used in accordance with recognized standards and provide effective protection.
- Not in itself create a hazard to the wearer (e.g., scratched safety glasses which could cause impaired vision should be replaced with clear safety glasses).
- Be compatible so that one item of PPE does not interfere with other PPE.
- Be maintained in good working order and in a sanitary condition.
- Not be altered in any way.

4.4.4 Prior to entering any controlled or restricted work area, employees shall review the SH&E plan and corresponding THA(s) to confirm that they are equipped with the applicable ANSI/CSA-approved PPE, appropriate to the specific work area's hazards.

4.5 Eye and Face Protection

4.5.1 AECOM employees shall use appropriate eye and face protection when eye or face hazards are present or potential from flying particles, molten metal, liquid chemicals, acid and caustic liquids, chemical gases or vapors, or injurious light radiation.

4.5.2 Safety glasses with side protection is the minimum eye protection requirement. Additional eye protection shall be suitable to the anticipated hazards (e.g. goggles, safety glasses with a face-shield, welder's helmet, etc.). Refer to *SN3NA-208-ATT1 Eye & Face Protection*.

4.6 Head Protection

4.6.1 Appropriate protective hardhats are required when employees are working in areas where there is any potential for injury to the head.

4.6.2 Head protection shall be suitable to the anticipated hazards (e.g. working near exposed electrical conductors requires hardhats designed to reduce electrical shock). Refer to *S3NA-208-ATT2 Head Protection.*

4.7 Foot Protection

4.7.1 AECOM employees shall use appropriate foot protection when hazards to feet are present or potential; including impact, puncture, cut, electrical, thermal or chemical hazards.

4.7.2 Refer to *S3NA-208-ATT3 Foot Protection.*

4.8 Hand Protection

4.8.1 Appropriate hand protection is required when employee's hands are exposed to hazards such as those from skin absorption of harmful substances, cuts and lacerations, abrasions, punctures, chemical burns, thermal burns, electricity, or harmful temperature extremes.

4.8.2 Refer to *S3NA-208-ATT4 Hand Protection* and *S3NA-317-PR1 Hand Safety*.

4.9 Chemically Resistant Clothing

4.9.1 Chemically resistant clothing is required when there is significant potential for the employee to come in direct contact with the chemicals being handled. Tasks that involve chemical handling will be evaluated for potential splashing or spilling. Refer to *S3NA-208-ATT5 Limb & Body Protection*.

4.9.2 The process for selecting chemical resistant clothing will be similar for the selection of chemical resistant gloves (refer to *S3NA-208-ATT4-Hand Protection* and *S3NA-317-PR1 Hand Safety*).

4.10 High-Visibility Apparel

4.10.1 “High visibility safety apparel” means personal protective safety clothing that is intended to provide conspicuity during both daytime and nighttime usage and that meets the Performance Class II or III requirements of ANSI/CSA standards. Refer to *S3NA-208-ATT6 High Visibility Safety Apparel.*

4.10.2 Color of apparel (orange or lime) may be client/project-specific. If there is a specific need to be visible to the passing public, to machine operators, or to other crew members, high visibility vests shall be worn (and retro-reflective striping on arms and legs at night).

4.10.3 Work conducted at night may require that the minimum level of apparel worn be, at minimum, ANSI/CSA Class III, and in accordance with the governing legislation.

4.11 Personal Clothing

4.11.1 Employees on a project site shall wear full length trousers and shirts that cover shoulders.

4.11.2 For personal safety on the job site, do not wear

- Loose or unsecured clothing or loose fitting cuffs;
- Greasy or oily clothing, gloves, or boots; or
- Torn or ragged clothing.
- Jewelry (e.g. rings, bracelets, neck chains) when working with moving parts or there is a risk or entanglement.

4.11.3 Long hair shall be tied back or otherwise confined when working with moving parts or there is a risk of entanglement.

4.11.4 Clothing made of synthetic fibers can be readily ignited and melted by electric flash or extreme heat sources. Cotton or wool fabrics are recommended for general use.

4.11.5 Footwear shall be suitable for the site conditions and task requirements. No athletic shoes, sandals, flip flops, permitted on active job sites.

4.11.6 It is recommended to use clothing with sun protection properties when working in high sun uv exposure

4.12 Specialized PPE

4.12.1 In addition to basic PPE, additional specialized PPE may be required to provide appropriate protection to the employee. Refer to applicable legislation and related SH&E procedures for additional information on PPE requirements.

- Fall Protection – Only full-body harnesses with shock-absorbing lanyards will be used for personal fall arrest. Refer to *S3NA-304-PR1 Fall Protection*.
- Respiratory Protection – Respiratory protection shall be selected based on the contaminant and concentration to which the employee will be exposed. Refer to *S3NA-123 PR1 Respiratory Protection*, the task- or project-specific hazard assessments and the applicable SDSs for specific requirements.
- Fire Resistant Clothing (FRC) – Approved fire-resistant outer clothing may be required at work locations with flammable or explosive materials or environments. Refer to *S3NA-208-ATT5 Limb & Body Protection.*
- Other Head Protection – Operators and passengers (if trained and permitted) of all-terrain vehicles and snowmobiles will wear approved helmets. Refer to *S3NA-208-ATT2 Head Protection.*
- Protection from Drowning – Appropriate personal floatation devices shall be worn when work working over and near water. Refer to *S3NA-315 Working On & Near Water*.
- Temperature Extremes – Work in cold environments may require additional layers and insulated clothing, gloves, boots and accessories such as balaclavas, hardhat liners. Confirm these items are approved and do not introduce additional unacceptable hazards (e.g. insufficient visibility, conductivity, etc.).
- Hearing Protection – Noise levels in the work environment that cannot be eliminated or reduced to acceptable levels requires worker be protected from exposure. Refer to *S3NA-118-PR1 Hearing Conservation.*
- Traction Devices – Traction devices applied to the base of work boots may be necessary if the employee may be walking on icy surfaces. Refer to *S3NA-208-ATT3 Foot Protection*.
- Rescue – Confined spaces hazards may necessitate the use of specific harnesses attached to retrieval lines to facilitate rescue. Refer to *S3NA-301-PR1 Confined Spaces*.

4.13 Maintaining PPE Supplies

4.13.1 Employees shall inspect their required PPE prior to use. Defective equipment shall be removed from service and replaced.

4.13.2 Each AECOM location will maintain a supply of safety equipment of appropriate types and sizes, including hard hats, high visibility vests, safety glasses, gloves, hearing protection and chemically resistant clothing based on the nature of their field activities. The Manager or designee will be responsible for maintaining this inventory.

4.13.3 Use of PPE by employees and adequacy of protection should be evaluated on a routine basis. This may periodically be documented using *S3NA-208-FM2 Personal Protective Equipment Inspection.*

4.13.4 At a minimum, locations will review their PPE program annually.

4.14 Obtaining Personalized Safety Gear

4.14.1 Employees are not expected to provide their own general PPE. Most basic PPE will be provided to the employee at no charge (e.g. safety glasses, hard hat, gloves, hearing protection, etc.) with the exception of the below personalized safety equipment (prescription safety glasses, safety-toed boots, any washable coveralls).

4.14.2 Certain personalized safety gear such as prescription safety glasses, safety-toed (capped) boots, and any washable coveralls will be ordered and sized specifically by the user. A partial cost reimbursement to the employee may be made if their location provides a specialized PPE purchase program.

4.14.3 All specialized PPE (e.g. fall protection equipment, respirators, helmets, etc.) will be provided by AECOM for employee use at no charge to the employee, with the exception of the above personalized safety equipment (prescription safety glasses, safety-toed boots, any washable coveralls).

5.0 Records

5.1 Completed SH&E plans, THAs documenting PPE requirements, and as applicable, PPE assessments and PPE inspections, will be maintained in the location's safety files.

6.0 Attachments

6.1	S3NA-208-ATT1	Eye & Face Protection
6.2	S3NA-208-ATT2	Head Protection
6.3	S3NA-208-ATT3	Foot Protection
6.4	S3NA-208-ATT4	Hand Protection
6.5	S3NA-208-ATT5	Limb & Body Protection
6.6	S3NA-208-ATT6	High Visibility Safety Apparel
6.7	S3NA-208-FM1	Personal Protective Equipment Assessment
6.8	S3NA-208-FM2	Personal Protective Equipment Inspection

Americas

Competent Person Designation

S3NA-202-PR1

1.0 Purpose and Scope

1.1 Outlines the process and minimum requirements necessary for classifying an AECOM employee as a "Competent Person" to oversee and/or self-perform activities involved with tasks listed in this procedure. Employee competency to perform work activities is addressed elsewhere.

1.2 This procedure applies to all AECOM Americas-based employees and operations where AECOM is self-performing the identified activities and where AECOM controls projects performing activities requiring a Competent Person. Client-mandated requirements may apply on a project-specific basis and shall be addressed in supplemental documents (e.g. Task Hazard Assessment, SH&E Plan, etc.).

1.3 It is recognized that local regulations and legislation may contain alternate definitions for Competent Person and it will be the responsibility of the manager responsible for the work (e.g. Manager, Superintendent) in conjunction with the local SH&E Manager to determine if conflicts exist between AECOM and applicable regulatory/legislative definitions and resolve the conflict.

1.4 When a qualified employee within AECOM is not available to be designated as the AECOM Competent Person, the Manager in coordination with their SH&E Manager may designate an appropriately qualified and trained Contractor employee as the Competent Person for the AECOM operations.

2.0 Terms and Definitions

2.1 **Competent Person –** An employee, through education, training and experience who has knowledge of applicable regulatory requirements, is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

3.0 References

3.1 S3-NA-213-PR1 Subcontractor Management

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 M**anager**

- Confirm that all assigned personnel, including personnel utilized from other offices to support their operations, comply with the requirements of this procedure. The manager responsible for the work shall:
  - Identify the need for a designated Competent Person or persons based on anticipated work activities.
  - Communicate competent person training/experience requirements with the employee and documenting completion of these requirements using *S3NA-202-FM-1 Competent Person Designation* or equivalent.
  - Identify supplemental employee training needs based on local/client requirements.
- For projects controlled by AECOM, when these activities are contracted to another party:
  - Confirm and secure the identity of the Contractor's Competent Person(s) for its activities. Refer to *S3NA-213-PR1 Subcontractor Management*.
  - *S3NA-202-FM1 Competent Person Designation* or equivalent may be used for this purpose.

- Provide the Contractor with a copy of this SH&E Procedure to verify the Contractor's capability to comply with the requirements within, and obtain documentation to support the designation of the Contractor employee as a Competent Person for AECOM.

- Verify the designation of the Competent Person for a specific activity is documented and effectively communicated to field personnel on site during daily tailgate safety meetings.

4.1.2 **Safety, Health and Environment (SH&E) Manager**

- Assist the Manager responsible for the work in assessing the competency of all designated persons based on specific requirements outlined in this procedure.
- Assist the Manager in:
  - Establishing competent person training/experience requirements and communicating these requirements to the supervisor.
  - Monitoring the overall implementation of this SH&E Procedure.
  - Monitoring field compliance of this procedure.
  - Providing technical assistance/support as requested.
  - Coordinating internal safety training classes as requested.
- Support the Manager in establishing minimum competent person requirements for regulated job activities based on individual job descriptions, applicable regulatory requirements, operational considerations, and management directives.
- Review as requested by designated operations representatives the Competent Person's qualifications for AECOM employees.

4.1.3 **Competent Person**

- Predict, identify, and control hazards when either AECOM self-performs associated field work or oversees and directs the work of subcontractors.
  - For operations where AECOM is providing oversight of subcontractors (e.g. drilling services), it is the subcontractor's employee who shall be designated as the Competent Person.
- Contractor Competent Persons - Unless AECOM is self-performing, the Contractor shall:
  - Determine the safe means and methods of its work activities.
  - Designate its Competent Person(s) for each category of work the Contractor undertakes and/or controls as required by this procedure.
  - If the contractor is unable to designate a Competent Person, AECOM may designate an appropriate AECOM employee as the contractor's Competent Person only if AECOM is contractually responsible for safety oversight of the contractor's activities.
- The Contractor's Competent Person shall:
  - Technically support the Contractor's site operations for the safe execution of its activities. Identify and remove any field hazards
  - Maintain appropriate knowledge about the work activities, the Contractor's work practices and procedures and compliance with the associated safety and health regulations.

4.2 General Requirements

4.2.1 The AECOM Competent Person project or worksite functions are dependent on the project activities and AECOM's project or worksite function.

4.2.2 Refer to each SH&E Procedure for the activities listed below and the associated legislative standards to determine the details of responsibility.

4.2.3 The following activities require an individual to be designated as a Competent Person:

- Asbestos
- Assured Equipment Grounding Conductor
- Blasting & Explosives
- Concrete & Masonry Construction
- Confined Spaces
- Control of Hazardous Energy (Lockout-Tagout)
- Cranes & Derricks
- Crane Assembly / Disassembly
- Demolition
- Electrical Wiring Design & Protections
- Elevated Work Platforms & Aerial Lifts
- Fall Protection
- Hearing Protection
- Heavy Equipment
- Ionizing Radiation
- Lead
- Material Hoists & Personnel Hoists
- Stairways & Ladders
- Respiratory Protection
- Rigging Equipment
- Scaffolds
- Steel Erection
- Trench & Excavations
- Underground Construction
- Welding & Cutting

4.2.4 Generally, it is the responsibility of the Competent Person(s) to be on site at all times when respective staff (AECOM, subcontractor) are performing work governed by this procedure, make daily inspections of the conditions and work activities, and take actions to control any hazards associated with those activities.

4.2.5 The *S3NA-202-FM1 Competent Person Designation* or equivalent shall be used for all programs or on all projects for documenting Competent Person designations. Documentation shall be filled out completely and updated as necessary.

4.2.6 *S3NA-202-ATT1 Competent Persons in General Industry (29 CFR 1910)* and *S3NA-202-ATT2 Competent Persons in Construction (29 CFR 1926)* include descriptions of various U.S. Occupational Safety and Health Administration requirements for competent persons. The list is not comprehensive and as such 29 CFR 1910 and 1926 shall be consulted for any additional competent person requirements.

5.0 Records

5.1 AECOM Competent Person Designation forms shall be maintained in the program / project file.

5.2 Documentation as to daily inspections and corrective measures by the AECOM Competent Person shall be maintained in the program / project file.

6.0 Attachments

6.1 S3NA-202-FM1 Competent Person Designation

6.2 S3NA-202-ATT1 Competent Persons in General Industry (29 CFR 1910)

6.3 S3NA-202-ATT2 Competent Persons in Construction (29 CFR 1926)

Americas

Medical Screening & Surveillance

S3NA-128-PR1

1.0 Purpose and Scope

1.1 Provides a streamlined process to determine if employees meet the physical requirements to perform assigned duties as defined by applicable regulations.

1.2 Designed to provide a means to collect data relevant to exposure to chemical and physical agents for the protection of the workers and to confirm the effectiveness of health and safety programs.

1.3 Applies to all AECOM Americas employees and operations.

2.0 Terms and Definitions

2.1 **Employee Exposure Record** - A record containing any of the following kinds of information:

- Environmental (workplace) monitoring or measuring of a toxic substance or harmful physical agent, including personal, area, grab, wipe or other form of sampling, as well as related collection and analytical methodologies, calculations and other background data relevant to interpretation of the results obtained.
- Biological monitoring results which directly assess the absorption of a toxic substance or harmful physical agent by body systems (e.g., the level of a chemical in the blood, urine, breath, etc.), but not including results which assess the biological effect of a substance or agent or which assess an employee's use of alcohol or drugs.
- Safety data sheets indicating that the material may pose a hazard to human health.
- In the absence of the above, a chemical inventory or any other record which reveals where and when used and the identity (e.g., chemical, common, or trade name) of a toxic substance of harmful physical agent.

2.2 **Medical Director –** A physician, board-certified in occupational medicine, employed by the Medical Services Provider (MSP). The Medical Director manages the services provided by the MSP and provides to AECOM guidance on medical matters.

2.3 **Medical Services Provider (MSP) –** Manages all occupational medical services, including medical surveillance programs, travel medicine, and injury intervention for first aid support for employees with occupational injuries or illnesses.

2.4 **Participating Employee** – Those employees required to participate in the medical screening and surveillance program will be identified by the Supervisor, Operations and SH&E Manager. Medical surveillance is required for employees who are or may be:

- Exposed to substances at or above the occupational exposure limits.
- Required to participate by regulatory provisions (e.g., asbestos, lead OSHA standards, designated substances).
- Fit-tested for or wearing a respirator in the field.
- Working on sites/projects with specific state, provincial/territorial or federal medical surveillance requirements.
- Driving a commercial motor vehicle.
- Performing safety sensitive tasks.

2.5 **Physical Activity Restriction –** To prevent aggravation of an existing condition, the Medical Doctor recommends a physical activity restriction to limit exposure to a chemical or class of chemicals (e.g., benzene, lead), a physical agent (e.g., noise), or an activity (e.g., heavy lifting).

2.6 **Safety Sensitive –** A task or position is designated as safety sensitive when the task or position is such that an action would endanger the lives of others. Examples, but not a complete list, of positions that have been designated "safety-critical" by regulations include:

- Drivers of Commercial Motor Vehicles (CMV)
- Workers on pipelines carrying fuels or toxic or corrosive substances
- Workers at nuclear power plants
- Employees that operate Nuclear Regulatory Commission -regulated devices (nuclear density gauges)
- Operators of industrial mobile equipment, including: cranes of more than 6,000-pound capacity, forklifts, loaders, etc.
- Laboratory technicians working with hazardous substances

3.0 References

3.1 S3NA-214-PR1 International Travel

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Employees**

- Ensuring that he/she maintains a current work clearance as required for the performance of assigned work duties.
- All employees designated to participate, called Participating Employees, in the medical surveillance program as a condition of employment or participate voluntarily and will be notified in advance if they will be assigned to a location, project or client which requires a Medical Surveillance and Surveillance program.
- If employee knows or suspects that he/she may have an adverse reaction to completing elements of the physical, (such as blood draws, physical limitation, etc.) then the employee should notify the MSP at the time they schedule the physical so that appropriate safeguards may be taken to protect the health of the employee.
- Communicate any change in medical condition (e.g. medications, pregnancy), to MSP to allow for evaluation of the need for additional precautions.

4.1.2 **Supervisors and Operations Managers**

- Evaluates the duties of each employee and prospective employee reporting to him or her for potential participation in the medical screening and surveillance program.
- Responsible for ensuring that the employee is enrolled in the medical screening and surveillance program if the employee's position requires participation. Consult with a SH&E Manager if assistance is needed in determining if an employee is required to participate in the program.
- Assures employees in positions that require medical surveillance in order to meet their job description may not be on site until they have satisfactorily completed the baseline or pre-employment medical examination.

4.1.3 **Safety, Health, & Environment (SH&E) Department**

- Serves as the primary point of contact between the employee, employee's supervisor, the MSP and the SH&E Department.
- Provides information regarding medical surveillance documentation, forms, and scheduling of services.
- Maintains a medical surveillance database and other associated documents.
- Assists employees with scheduling of exams with the MSP.

- Participates in initial SH&E training and subsequent reviews and updates that will provide guidance on exam protocols.

4.1.4 **SH&E Manager**

- Reviews employee assignments with managers to ensure that all employees who should be participating in the medical surveillance program have been enrolled.
- Provides all assistance necessary to ensure all required information is provided to the Medical Director.
- Report any change in requirements, protocols or concerns with the MSP to the Occupational Health Manager.

4.1.5 **Occupational Health Manager**

- Provide the MSP with appropriate references (e.g., a copy of this procedure, regulations).
- Designate other employees to participate in certain parameters of the medical screening and surveillance program after consultation with the Medical Director.

4.1.6 **Medical Director**

- Requires an exposure-specific examination when he/she has reason.
- Determine the frequency of the exposure-specific medical examinations.
- Consults with the Occupational Health Manager.

4.2 General Requirements

4.2.1 All AECOM employees whose work assignments involve potential exposure to harmful chemical and/or physical agents should participate in the medical surveillance program. Guidance as to harmful potential exposures is presented in *S3NA-128-FM1 Medical Surveillance Evaluation (MSE).* The form provides the primary guidance for determining whether medical screening is required for an employee and the frequency of periodic exams. The MSE is to be completed by the employee and his/her supervisor at the time of hire for any employee who may work outside an office environment. At each annual performance review, the MSE is to be reviewed for accuracy. Other reviews are required whenever there is a change in job tasks.

4.2.2 In addition, employees may be requested to participate in the medical surveillance program if they perform a task that requires an assessment for fitness for duty (e.g., lifting, climbing, etc.). The Supervisor, Operations Manager and SH&E Manager will identify activities/tasks that will require fit-for-duty assessments.

4.2.3 Medical screening and surveillance will only be performed were required by regulatory requirements or this procedure. Screening and surveillance provided at no cost to employees.

4.2.4 For medical screening and surveillance related to international travel, refer to *S3NA-214-PR1 International Travel*.

4.3 Types of Medical Examinations

The medical surveillance program consists of the following types of examinations:

4.3.1 **Baseline (initial)**

- The baseline medical examination is used to identify physical capabilities and medical limitations that may have an impact on the candidate's ability to perform in the position for which he/she is being considered and to provide a baseline against which periodic or project-specific monitoring can be compared. The baseline medical examination is used to determine the suitability of an existing employee for a new assignment (pre-placement) or a candidate's suitability to be hired (pre-employment) for a particular position.

4.3.2 **Periodic (annual or biennial)**

- The periodic medical examination is used to evaluate an employee's continued fitness for duty and to assess any impact occupational exposures may have on his/her health status. The periodic examination includes an update to the medical and work history, results of any occupational exposure assessments and a detailed medical examination tailored to the job description.
- The SH&E Manager will assist in determining the frequency of the periodic medical examinations based on regulatory requirements, the position held by the employee, and the level of exposure to physical, chemical, and biological agents.
- Employees performing work activities on HAZWOPER sites will receive exams based on the following schedule:

Annual	Working in an exclusion zone and the regulatory required exposure limit is exceeded for 30 or more days a year.
Biennial	Working in an exclusion zone more than 30 days a year and the regulatory required exposure limit is not exceeded.

4.3.3 **Exposure-specific**

- The exposure-specific examination consists of medical tests to assess the impact of occupational exposures associated with a particular activity or project. The Medical Director or SH&E Manager will require an exposure-specific examination when he/she has reason to believe occupational exposures are impacting or may be impacting the health of an employee.

4.3.4 **Exit/termination**

- Employees currently participating in an examination program will receive exit exams when they leave their work assignment as identified in *S3NA-128-ATT1 Exit Exam Determination.* In the event an employee declines the exit exam, the employee will be requested to sign *S3NA-128-FM2 Waiver of Exit Medical Surveillance Exam*.
- An exit medical examination is offered when an employee leaves the medical surveillance program, either because of termination of employment with AECOM or because of reassignment to a position not designated to participate in the medical surveillance program or if conditions in the workplace no longer constitutes the need for the medical surveillance (e.g., change in product).
- The exit examination assesses any impact occupational exposures may have had on the employee's health status.

4.4 Exam Protocols

4.4.1 *S3NA-128-ATT2 Exam Protocol* identifies the medical exam components of exam.

4.4.2 The evaluation will be confidential and provided during normal business hours. Employees will be offered the opportunity to discuss the results of the evaluation with the MSP. All exam results are considered personal and confidential information, and will not be stored in any unsecured records not transmitted without the employee's permission.

4.5 Participating Employee Guidance and Documentation

4.5.1 When necessary, based on the position being filled, the hiring Supervisor and Human Resources Representative informs the candidate that the offer of employment is contingent on the candidate being physically and medically qualified to perform the duties of the position for which he/she is being hired. The hiring Supervisor and Human Resources Representative may not allow the candidate to begin employment until the conditions of the offer letter have been satisfied.

4.5.2 When designated to participate in the medical surveillance program, the Employee completes and signs the following documents:

- Medical and Work History Questionnaire (provided by the MSP).

- Medical Records Release authorizing MSP to receive the work clearance certificate.

4.5.3 Any Employee that has not completed the required medical evaluation after 30 days of an expiration date will be issued a non-qualified statement. The Employee is not permitted to perform the associated task and/or work until the required medical evaluation is completed and a qualified statement is issued by the Medical Director.

4.5.4 If an exam becomes due during an employee's pregnancy, it is advised to defer the exam until after delivery and the employee returns to work from family/medical leave status.

4.5.5 Human Resources Representative

- Notifies the SH&E Manager or designee to arrange for exit medical examination, upon notification of termination or impending termination from the Supervisor. In the event an employee declines the exit exam, the employee will be requested to sign *S3NA-128-FM2 Waiver of Exit Medical Surveillance Exam*.
- Place the original waiver in the employee's Human Resources personnel file and send a copy the MSP.

4.5.6 Medical Services Provider (MSP)

- Provides notification approximately 30 days before subsequent periodic or exposure-specific medical examination is due.
- Notify employee 30 days before the periodic or exposure-specific medical examination is due.
- Provides notification of delinquent medical examinations.

4.5.7 Operations Manager

- Facilitate the management and exchange of documentation regarding the medical screening and surveillance program between AECOM (typically employee's supervisor) and MSP using the *S3NA-128-FM3 Scheduling Request Form*. If exams for multiple employees is required, the information from page 1 of the Scheduling Request Form and the requested exams can be placed in a spreadsheet and sent to the MSP.
- Schedule the initial exam for newly hired or re-assigned employees as needed. Special requests should be coordinated with the SH&E Manager, prior to contacting MSP to schedule.
- Assist employees with scheduling examinations as necessary.
- Coordinate medical surveillance program information exchange between Human Resources Representative and the MSP as necessary.
- Notify the candidate's manager and Human Resources upon receipt of the work clearance.
- Provide information from previous examinations that may not be readily available.

4.5.8 SH&E Manager

- Provides such assistance as is requested by the hiring Supervisor to ensure the job description for the position being filled adequately describes the physical, chemical, and biological stresses of the position, and the PPE used or which may be used, including respiratory protection.
- Provides all necessary assistance to ensure that required and appropriate information is provided with the request and authorization for medical examination.
- Provides assistance to the hiring Supervisor to interpret physical activity restrictions if such restrictions are noted on the work clearance certificate.
- Confirms that all relevant exposure assessments have been appropriately annotated to show the applicability to the employee and forwarded to the MSP.

- Confirms that employees on the delinquent medical examination list have been removed from designated assignments.
- Provides assistance to ensure that terminating and reassigned employees are offered the opportunity to take an exit medical examination.

4.5.9 Supervisor

- Arranges work assignments so that the employee is available to take the medical examination before the work clearance certificate expires.
- Removes the employee from the work assignment before the work clearance certificate expires until the medical evaluation is completed and a qualified statement is issued by the Medical Director.
- Contacts the Human Resources Representative, upon notification of termination or reassignment and requests they arrange for the MSP to perform an exit medical examination.
- Releases the terminating or reassigned employee from duties as necessary to complete the exit medical examination.

4.6 Reports

4.6.1 Report of Examination

- The MSP provides AECOM and the employee with a copy of the work clearance certificate, which will include any medical restrictions and address the employee's ability to use personal protective equipment. AECOM requires the employee to preserve the work clearance certificate in a safe place and provide copies to AECOM managers and clients as requested.
- The MSP will mail a confidential letter detailing the results of the exam to the employee's home address within 30 days of the exam date.

4.6.2 Examinations Due Report

- The MSP produces a list by organization code of employees due to be examined 30 days before the expiration of their work clearance certificate. This list is provided to SH&E Department, who ensures each Supervisor is notified of the employees in his/her charge who are due examinations so they may be scheduled appropriately.
- The MSP notifies each employee via email or phone to the office of record 30 days before the periodic or exposure-specific medical examination is due.

4.6.3 Delinquent Examinations Report

- The MSP distributes a report of delinquent medical examinations to the SH&E Department.
- When an employee's name appears on the delinquent examination report for two consecutive months, the SH&E Department must notify the SH&E Manager, who will bring this to the attention of the employee's Supervisor for resolution. If the delinquency issue is not resolved, the employee's regional management will be notified for final resolution.

4.6.4 Physical Activity Restriction Report

- The Supervisor maintains a list of employees who have physical activity restrictions.
- The SH&E Manager shall evaluate locations and projects periodically to ensure employees with physical activity restrictions are not exceeding their limitations. Concerns of an employee exceeding his/her physical activity restriction is brought to the attention of the employee's Supervisor for resolution.

4.6.5 Annual Reports

- The MSP provides annual reports of utilization, medical trends, and statistical analyses. These reports are prepared to improve the service, manage trends, and reduce the cost of the medical screening and surveillance program.

5.0 Records

5.1 Employees who participate in a medical surveillance or physical examination program or had exposure monitoring conducted will have access to all employee exposure and medical records maintained for that employee by AECOM and the MSP.

5.2 Upon an employee entering into a medical surveillance or physical examination program, the employee shall be informed of the following:

- The existence, location and availability of any records covered by this procedure
- The MSP responsible for maintaining and providing access to records and
- The employee's right of access to these confidential records.

5.3 Employees in medical monitoring programs are notified initially and annually thereafter, of the existence, location and ability to access medical records maintained by the MSP. Upon request, each employee (or designated representative) will have access to the employee's medical records. Prior to the release of health information to the employee (or designated representative), a specific written consent must be signed by the employee. Records will be provided in a reasonable time and manner at no cost to the employee.

5.4 Medical records must be preserved and protected in accordance with applicable legislative requirements for the duration of employment plus 30 years, verify local, state of federal regulations to confirm time period. Medical records contain information that is protected by the Privacy Act. To meet the obligations of preserving the medical records and protecting the information they contain, AECOM has arranged for the MSP to manage the medical records.

5.5 An employee or designated representative may request to review his/her medical. Such a request must be in writing and be signed and dated. The SH&E Manager or the SH&E Department will forward the request to the MSP, who will provide the employee with a copy of the medical records.

The MSP provides employees with a copy of their results after each physical. If employee would like a copy of their historical records, the MSP will supply the copy within 15 days after the request has been submitted by the employee or designated representative.

MSP performs quality control checks on all medical records to ensure examining physicians appropriately record the findings of the examination and tests. The MSP has access to all medical records to perform quality assurance checks to ensure proper recording and preservation

5.6 Projects that use local clinics or employer/client clinics may store records at that site, but at the termination of the project, all employee medical records must be transferred to long-term record retention.

5.7 If in the event AECOM ceases operations, medical records will be transferred to the successor employer. If no successor employer is available, records will be transferred to the National Institute for Occupational Safety and Health.

6.0 Attachments

6.1	S3NA-128-ATT1	Exit Exam Determination
6.2	S3NA-128-ATT2	Exam Protocols
6.3	S3NA-128-FM1	Medical Surveillance Evaluation
6.4	S3NA-128-FM2	Waiver of Exit Medical Surveillance Exam
6.5	S3NA-128-FM3	Scheduling Request Form
6.6	S3NA-128-FM4	Waiver of Medical Surveillance

Americas

Substance Abuse Prevention

S3NA-019-PR1

1.0 Purpose and Scope

1.1 This policy and procedure applies to all Americas - based employees and operations and is consistent with the U.S. Drug-Free Workplace Act of 1988 and in accordance with federal, state / provincial / territorial, and local laws and regulations. It sets out practices for a drug-free, healthy, productive, safe and secure workplace and provides guidance for employees and supervisors with respect to their responsibilities. Drug and alcohol abuse pose a serious threat to the health and safety of employees, clients, and the general public as well as the security of our job sites, equipment and facilities. The Company is committed to the elimination of illegal drug use and alcohol abuse in its workplace and regards any misuse of drugs or alcohol by employees to be unacceptable.

1.2 AECOM prohibits the use, possession, presence in the body, distribution, manufacture, concealment, transportation, promotion or sale of the following items or substances on company premises:

- Illegal drugs (or their metabolites), designer and synthetic drugs, mood or mind altering substances and drug use related paraphernalia unless authorized for administering currently prescribed medication;
- Controlled substances that are not used in accordance with physician instructions or non-prescribed controlled substances;
- Alcoholic beverages while at work or while on any customer or AECOM controlled property. This prohibition on alcohol applies whenever an employee is on-duty, including during meal or break periods, while on Company premises, or while representing AECOM. AECOM may make exceptions and permit the consumption of alcohol beverages at work-related events, such as Company-sponsored or approved business meals, conferences, or holiday events. Employees who choose to consume alcohol on approved occasions are expected to exercise good judgment and to refrain from becoming intoxicated or impaired. If an employee has consumed alcohol and needs transportation home, the Company will reimburse the cost of a taxicab or other reasonable costs of transportation so that the employee may avoid driving.
- This policy does not prohibit lawful use and possession of current medication prescribed in the employees name or over-the-counter medications. Employees must consult with their health care provider about any prescribed medication's effect on their ability to perform work safely. An employee who has work restrictions due to his or her consumption of a prescribed medication must disclose these restrictions to their supervisor.

1.3 Substance abuse testing procedures shall meet requirements of various U.S. regulatory agencies and / or those of the applicable jurisdiction, with regard to testing employees for the possession and use of illegal drugs (and their metabolites),mood or mind altering substances, synthetic and designer drugs, unauthorized use of prescription drugs and the unauthorized use of alcohol on AECOM or client premises or during working hours. The procedures will also comply with applicable laws and regulations by federal, state and local law. If the law of a particular location differs from the practices expressed in this policy and procedure, AECOM will implement this policy and procedure in accordance with applicable law.

1.4 Although some states may pass laws legalizing medical or recreational marijuana use, the use, sale, distribution and possession of marijuana are violations of federal law. Similarly, the use sale, distribution, presence in the body and possession of marijuana or the presence of marijuana on company premises or while on duty including during lunch and breaks violates the *S3NA-019-ATT1 Substance Abuse Policy Statement* (policy), and will subject an employee to disciplinary action up to and including termination in accordance with controlling law.

1.5 This policy and procedure has been developed to provide employees, managers, supervisors and administrative support personnel with guidelines and procedures for the implementation, administration, and enforcement of this policy and procedure. The company policy statement for substance abuse prevention is included as Attachment 1 of this document and a copy of the included policy statement shall be posted on employee information boards. New employees shall receive and sign *S3NA-019-FM1 Acknowledgement and Consent Form* upon hire or transfer between sites or clients as acknowledgement of the program requirements. A signed or electronic copy of this form should be kept as part of the employee personnel file.

1.6 This policy and procedure does not prohibit employees from the lawful use and possession of current prescribed or over-the-counter medications. Employees must consult with their health care providers about any prescribed medication's effect on their ability to perform work safely. Employees must disclose any relevant work duty restrictions to their supervisor. Employees are required only to provide information necessary for the Company to make an informed decision regarding the ability to perform required work safely, and to evaluate whether the employee may be entitled to a reasonable accommodation. Employees who must bring current prescribed medications to work must carry the medication in the original packaging bearing a current label from a licensed pharmacist for the person in possession of the drugs.

1.7 Compliance with this policy is a condition of initial and continued employment. Failure to comply with these requirements will be grounds for disciplinary action, up to and including termination of employment.

1.8 This procedure will be administered by the Corporate Substance Abuse Program Manager in conjunction with Safety, Health & Environment (SH&E) and Human Resources (HR).

2.0 Terms and Definitions

2.1 **Adulterated Sample** – A urine sample provided by an applicant, employee or contractor that has been intentionally altered to mask the analysis for illegal substance use. Any applicant or employee who knowingly provides a false sample or attempts to adulterate a sample will be terminated or disqualified from employment.

2.2 **Breath test for alcohol (BrAC)** – A method of measuring the breath alcohol concentration (BrAC) of an individual using an approved analyzer performed by a certified analyst using test protocol described in the SAP Procedures.

2.3 **Confidentiality** – The principle in medical ethics that the information a patient reveals to a health care provider is private and has limits on how and when it can be disclosed to a third party.

2.4 **Employees/Applicants** – The SAP program will apply to all individuals who may be: regular full-time, part-time, probationary, temporary, craft (direct hires), casual, contract or leased employees, and applicants of employment as permitted by applicable laws

2.5 **Employee Assistance Program (EAP)** – All salaried employees and their immediate family members are eligible for the EAP assistance limited to five paid counselling sessions per calendar or benefit year. Hourly employees may be eligible on projects, plants and mines or in offices where a substance abuse testing program is implemented. Separate EAP brochures and telephone cards are available through the HR Department. Check with your HR manager for eligibility for EAP.

2.6 **Illegal Drugs, Controlled Substances and Unauthorized Items** – Illegal drugs, designer and synthetic drugs, substances that impair job performance or safety and drug-related paraphernalia: Controlled substances such as medications when usage is abused; Unauthorized alcoholic beverages

2.7 **Medical Review Officer (MRO)** – The MRO is a designated Medical Doctor (MD) with experience and certification in the interpretation of urinalysis test results for drug testing. The MRO examines the positive test results with consideration of whether there is a legitimate medical reason for the result. This is accomplished by telephone interviews with the donor and also with their prescribing physician or pharmacist when prescription or over the counter medications are possibly involved.

2.8 **Negative Drug Test** – A personal sample (urine, blood, hair, breath, swab or other permitted by law) that indicates a concentration(s) of any drug on the panel which is below the cut-off limit and also meets all quality control requirements (e.g., temperature, pH) and no evidence of adulterants.

2.9 **Positive Test Result** – A personal sample (urine, blood, hair, breath, swab or other permitted by law) that indicates a concentration(s) of any drug on the panel which is above the cut-off limit and/or the GCMS confirmation level of that applicable regulation or requirement.

2.10 **Prohibited Substances** – Illegal or unprescribed drugs (or their metabolites), controlled substances and mood or mind-altering substances (i.e. any synthetic derivative/product that produces a marijuana-type high and any herbal products not intended for human consumption); or any prescribed drugs used in a manner inconsistent with the prescription, and alcoholic beverages.

2.11 **Reasonable Suspicion** – Suspicion based upon the observation of objective facts or specific and articulable behavior. May also be warranted based on search or disclosure of evidence obtained on a work site or company controlled property. Supervisor should complete a Reasonable Suspicion training course and document the process and observations.

2.12 **Refusal to Test** – Refusing to provide a sample or refusing to accept and sign the testing consent form, is considered a breach of company policy and subject to disciplinary action up to termination of employment.

2.13 **Safety Sensitive** – A task or position is designated as safety sensitive when the task or position is such that an action would endanger the lives of others. AECOM business groups may further define safety sensitive as it applies to their applicable line of work. Examples, but not a complete list, of positions that may be designated “safety-sensitive” by regulations include:

- Drivers of Commercial Motor Vehicles (CMV)
- Workers on pipelines carrying fuels or toxic or corrosive substances
- Workers at nuclear power plants
- Employees that operate Nuclear Regulatory Commission -regulated devices (nuclear density gauges)
- Operators of industrial mobile equipment, including: cranes of more than 6,000-pound capacity, forklifts, loaders, etc.
- Laboratory technicians working with hazardous substances.

2.14 **Swab Alcohol Test** – A swab test may be required by a client instead of the Breath test for alcohol (BrAC).

3.0 References

3.1 None

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Supervisors and Managers**

- Observe and document employee behavior which appears to violate this policy and procedure and refer employees for drug and alcohol testing as required.
- Ensure all employees have been orientated to this procedure and are knowledgeable about, and in compliance with this procedure, associated policy and applicable programs.
- Make appropriate referrals for a drug and/or alcohol test as per this procedure as well as any client contractual agreements or governmental regulation.
- Be current with the Employee and Supervisor Training and education programs so as to be knowledgeable about the use of alcohol and drugs and be able to recognize the signs and effects of alcohol and drug uses.

- Alert and involve Human Resources (HR), the Corporate Safety, Health and Environment (SH&E) Occupational Health Manager and the Substance Abuse Program Administrator when an employee is believed to be unfit for duty due to drugs or alcohol use in violation of this policy and/or if an employee is tested for a reasonable suspicion use of drugs or alcohol.
- If any illegal drugs or drug paraphernalia are located on company premises, do not handle the items and immediately notify the following as necessary: HR, Resilience Group, the police department and the Corporate Substance Abuse Program Manager.
- Guide employees who voluntarily seek assistance for a personal substance abuse problem to appropriate resources such as the EAP or other local resource.

4.1.2 **Employees**

- Commit to a safe and drug-free workplace by complying with this policy and procedure and understanding their responsibilities.
- Read and understand the *S3NA-019-ATT1 Substance Abuse Policy Statement* detailing the Company's commitment to a drug free workplace. The signed *S3NA-019-FM1 Acknowledgement and Consent Form* attests that they have reviewed and are familiar with this procedure and understand that compliance is a condition of employment. Any questions should be directed to the Substance Abuse Administrator or HR.
- Follow the instructions of their supervisor or Substance Abuse Administrator when informed that they have been chosen for a random or client drug test as allowed by federal, state or local law and regulations. Failure to do so may result in discipline up to and including termination.
- Participate in substance abuse training programs as directed.
- Report for work Fit for Duty and remain Fit for Duty while on Company premises and worksites and adhere to the standards set out in this procedure and any applicable program.
- Notify your supervisor, HR or SH&E representative if you believe another employee or subcontractor is not Fit for Duty or exhibits conduct suggesting substance abuse.
- If having a valid driver's license is a condition of employment, report any loss of license related to drug or alcohol use immediately (no later than 24 hours after losing the license) to your supervisor.
- Consult with health care provider about any prescribed medication's effect on the ability to perform work safely and disclose work restrictions due to consumption of prescribed medications to their supervisor to determine if reasonable accommodation is needed.
- Bring legally prescribed medicine in the original packaging bearing a current label in the employee's name from a licensed pharmacist if the employee carries more than a single day of prescribed medications to work.
- Notify management of any criminal drug or alcohol conviction for a violation no later than five (5) days after such conviction.

4.2 Types of Testing

4.2.1 Employees undertaking Safety-Sensitive tasks or in a Safety Sensitive position may be required to undergo drug and alcohol testing.

4.2.2 Pre-employment Testing - Applicants extended a conditional offer of employment may be required to take, and pass, a pre-hire drug test before beginning work. Individuals who test positive or refuse the test will not be hired and will be ineligible to reapply for a period of six months. Employees who transfer from one company business group or project to another are not required to take a pre-employment drug test if their employment is without interruption, they are not subject to client testing or safety sensitive testing requirements, and they would have been expected to have taken a pre-hire or client mandated drug test.

4.2.3 Random and Annual Testing - Employees may be subject to random drug and/or alcohol testing in accordance with federal, state and local laws. In addition, employees may be subject to random or annual drug tests to meet contract requirements.

- Selections for random testing will be made by the Substance Abuse Program Administer or a Certified Third Party Administrator using employee identification numbers and a random selection process. They will be unannounced and once selected for testing, an individual may not be waived from the testing process.
- Employees will be notified to report for random tests at a time when they should be able to stop working and report immediately to the collection site. Failure to report for a test promptly when instructed to do so may be considered a refusal to test.
- Employees who may be required to submit to random or annual tests will be so notified at the time that they are hired into a covered position, when they transfer into such a position, or when random or scheduled testing becomes applicable to their position.

4.2.4 Reasonable Suspicion Testing - Employees are subject to drug and/or alcohol testing whenever AECOM supervision has reason to believe that the employee has violated this policy and procedure. Requests for tests will be based upon contemporaneous, articulable observations from supervisors suggesting that the employee may be under the influence of illegal drugs, controlled substances, or alcohol.

- Examples of observations that may lead to a test can include the employee's appearance, behavior, speech, body odors, absenteeism, job performance, tardiness, etc. Whenever possible, observations will be documented and reviewed by HR before the individual is asked to submit to a test.
- An employee asked to take a drug and/or alcohol test will be suspended without pay until test results are received. They may use Paid Time Off (PTO) time during this period. An employee who has negative test results will be returned to work status and the employee will then be paid or have their PTO restored for any lost time during that period.

4.2.5 Post Incident/Accident Testing - Employees are subject to drug and alcohol testing in accordance with state / provincial / territorial and local law whenever:

- An employee sustained or caused an injury necessitating off-site medical treatment;
- They have caused or contributed to an accident that results in property damage estimated (including to Company vehicles or equipment) of $2,500 or more (a lower cost of damage requiring testing may be identified in Business Group specific programs);

In either of these instances, the investigation and substance abuse testing must take place immediately following the incident, except that no investigation or request for test will delay the provision of urgent medical care to any person in need of assistance. Employees will not be allowed to return to work until a negative drug/alcohol test result is received.

4.2.6 Return-to-Work and Follow-up Testing - Employees who test positive for drugs or alcohol or who have otherwise violated this Policy and Procedure are subject to discipline, up to and including discharge. Depending on the circumstances, the Company may offer an employee who violates this Policy and Procedure the opportunity to seek assistance in lieu of termination through the Employee Assistance Program ("EAP") or another approved counseling program. Employees offered this opportunity will be required to be evaluated by a substance abuse professional, and to complete any course of education or treatment prescribed before returning to work. In addition, employees must have a negative drug/alcohol test prior to their return to work and follow-up drug and/or alcohol testing may be required as a condition of continued employment, for a period of up to two years following the return to work. If subject to a client-specific substance abuse policy, employees who have had a positive test result will not be permitted to return to work on the client site or facility. Return-to-Work Agreements will be tailored to the individual's circumstances and job responsibilities.

4.3 Collection and Testing

4.3.1 Consent and Refusals to Test: No sample will be collected, or test conducted on any sample, without the consent of the person being tested. However, a refusal to submit to a test will be treated as an admission of a policy violation and will usually result in termination of employment. Job applicants who refuse a test will have their job offers withdrawn.

- Attempts to tamper with, substitute, adulterate, dilute or otherwise falsify a test sample are considered refusals to submit to a test, as is a refusal to accept transportation to the testing facility, failure to appear at the testing location promptly after being asked to submit to a test, or other conduct that has the effect of frustrating the testing process. AECOM will pay the costs of all drug and/or alcohol tests it requires.

4.3.2 Test Methods: Drug test samples may include urine, hair, swab or saliva (oral fluids). All drug test samples will be screened and all presumptive positive drug tests will be confirmed using gas chromatography/ mass spectrometry (GC/MS) (or an equally accurate methodology). Drug tests will be performed by a laboratory certified by the U.S. Substance Abuse and Mental Health Services Administration for federal workplace testing, or as required by the applicable jurisdiction. Breath, blood, swab or urine tests may be used to detect the presence of alcohol. An alcohol test will be considered positive if it shows the presence of .04 percent or more alcohol in a person's system.

- Dilute or invalid results will require a recollection, and the Company may require the individual to provide an alternative test specimen as may be available and consistent with the underlying purpose of the test.

4.3.3 Collection and Chain-of-Custody: Persons being tested will be asked to provide a test sample to a trained collector. Procedures for the collection of specimens will allow for reasonable individual privacy. Urine specimens will be tested for temperature, and may be subject to other validation procedures as appropriate. The collector and the person being tested will follow chain-of-custody procedures for specimens at all times. Tests will seek only information about the presence of drugs and alcohol in an individual's specimen, and will not test for any medical condition.

4.3.4 Notification and Medical Review: Any individual whose test sample is confirmed positive for a drug or drugs will be contacted by a Medical Review Officer ("MRO") (a medical professional with an expertise in toxicology) and offered an opportunity to explain in confidence any legitimate reasons he or she may have that would explain the positive test (such as, for example, evidence that the individual holds a prescription for the substance detected). The MRO may also review suspected adulterated, substituted, and dilute specimens and make determinations about their validity.

- If the individual provides an explanation acceptable to the MRO that a drug test result is due to factors other than the consumption of illegal drugs, the MRO will order the positive test result to be disregarded and will report the test as negative to AECOM. Otherwise, the MRO will verify the test as positive and report that test result.

4.3.5 Right to Explain and Retest: Within three working days after notice of a verified positive drug or alcohol test result on a confirmatory test conducted under this Policy, the tested individual may submit information to the MRO to explain the positive result. An individual who tests positive for drugs also may ask to have his or her remaining or split test sample sent to an independent certified laboratory for a second confirmatory test, at the individual's expense, and provided that a written request is made within five business days of the date the individual of the positive test result. AECOM will notify the original testing laboratory that the employee or applicant has requested that the laboratory conduct a confirmatory retest or arrange for transfer of the sample to the laboratory selected by the individual to perform the confirmatory retest. Tested individuals will be required to pay the testing laboratory for any confirmatory retest they request. AECOM may suspend, transfer, or take other appropriate employment action against an employee pending the results of any such re-test. However, if the re-test fails to confirm as positive the individual will be reimbursed for the cost of the re-test and the prior test results disregarded.

4.3.6 The Company will provide drug and alcohol tests results to candidates and employees automatically, where state law so requires, and otherwise upon written request as may be required by law.

4.4 Inspections

4.4.1 The Company reserves the right to inspect and search all portions of its premises for drugs and other contraband. All employees, contract workers, and visitors may be asked to cooperate in inspections of their persons, work areas, and property brought on site in connection with an inspection. Employees who refuse to cooperate in any such inspections are subject to discipline, up to and including discharge**.**

4.5 Confidentiality

4.5.1 Information and records relating to drug screen test results, drug and alcohol dependencies and medical information shared with the Company in the course of administering this Policy and Procedure shall be treated as confidential and shared with HR and managers on a need-to-know basis. Information will not be released to third parties except with the consent of the individual or where relevant to a grievance, charge, claim, or other legal proceeding initiated by or on behalf of an employee or applicant, or as may be required by law or legal process.

4.6 Employee Assistance Program and Drug Free Awareness

4.6.1 Illegal drug use and alcohol misuse result in a number of adverse health and safety consequences. Information about those consequences and source of help for drug/alcohol problems is available from HR representatives who can also refer employees to the EAP for assistance with drug/alcohol related problems. Information about the EAP program is available on the Company intranet.

4.6.2 The Company will provide support to employees who voluntarily seek help for drug or alcohol problems. Depending upon the circumstances, the employee may be referred for evaluation and allowed to use accrued paid time off or be placed on leave as may be necessary to complete any prescribed education and/or treatment. Employees also may be required to document that they are successfully following a prescribed education and/or treatment plan and pass return to duty and follow-up drug and/or alcohol testing. A request for assistance will be considered voluntary only if made before the employee becomes subject to disciplinary action for violating this or another Company policy, and cannot excuse substandard performance, so AECOM encourages employees who may need assistance to seek it promptly:

4.6.3 In conjunction with the EAP, the Company will promote a drug-free awareness program to inform employees about:

- The dangers of substance abuse in the workplace.
- Available counseling, rehabilitation, and EAPs (both for self-referral or supervisory referral).
- The penalties that may be imposed for violations of this procedure.
- The Company's commitment to promoting a drug-free workplace.

5.0 Records

5.1 None.

6.0 Attachments

6.1 S3NA-019-ATT1 Substance Abuse Policy Statement

6.2 S3NA-019-FM1 Acknowledgement & Consent Form

Americas

Emergency Response Planning

S3NA-010-PR1

1.0 Purpose and Scope

1.1 Providing the requirements for preparation and planning for potential emergencies that may occur while AECOM staff are working.

1.2 Applies to all AECOM Americas-based staff working inside and outside an AECOM office, including location and project environments.

1.3 The intent of this plan is to:

- Enable prompt, informed emergency responses.
- Promote the safety of workers, visitors, and those responding to an emergency.
- Reduce the potential for destruction of goods and other property.
- Reduce the magnitude of environmental and other impacts.
- Help those responding to an emergency quickly determine and initiate proper remedial actions.
- Reduce recovery times and costs.
- Provide confidence to workers, visitors, and those responding to an emergency that emergencies will be properly managed.

1.4 This procedure represents AECOM's minimum requirements and should be augmented by more stringent local regulatory requirements and/or client requirements.

1.5 Location Specific Emergency Response Plans are to be included in the respective Office Safety, Health and Environment Plan (refer to *Global Office Safety, Health & Environment Plan*) or the location specific SH&E Plan (refer to *S3NA-209-PR1 Risk Assessment & Management).*

1.6 Emergency Response is an initial response which may require additional actions as detailed in *RS2-003-PR1 Disruptive Event Response Standard*.

2.0 Terms and Definitions

2.1 **Emergency –** An unplanned situation or event (including natural disasters) resulting in involvement of the public emergency services, police, fire, paramedic, or the environmental regulatory authorities.

2.2 **Emergency Response Coordinator –** An individual in a worksite or project environment designated to lead and direct the immediate emergency response.

2.3 **Local Resilience Coordinator (LRC)** – A manager designated as the Office or Worksite lead for local level organizational resilience who may or may not be the emergency response coordinator. The LRC is the point of contact with the Region Resilience Team in determining further action, including notifications, following an initial emergency response. Refer to *RS2-003-PR1 Disruptive Event Response Standard*.

2.4 **First Aid Provider** – Is a First Aid, CPR, and AED trained, volunteer, AECOM employee who provides emergency first aid or treatment (including performing CPR and applying an AED) to someone who is injured or suddenly ill, before emergency medical services (EMS) arrives. This is a voluntary action and not an occupational duty assigned by AECOM. They may use a limited amount of equipment to perform initial assessment and provide immediate life support and care while awaiting arrival of emergency medical services. Refer to *S3NA-012-PR1 First Aid*.

2.5 **Floor Marshall** – An individual in the office environment designated to lead and direct the immediate emergency response.

2.6 **Floor Warden** – An individual in the office environment, as required by building design and employee numbers, designated to assist the Floor Marshall in directing the immediate emergency response.

3.0 References

3.1 GRG-001-RP4 Operational Security Plan

3.2 RS2-003-PR1 Disruptive Event Response Standard

3.3 Global Office Safety, Health & Environment Plan Template

3.4 S3NA-004-PR1 Incident Reporting, Notifications & Investigation

3.5 S3NA-011-PR1 Fire Protection

3.6 S3NA-012-PR1 First Aid

3.7 S3NA-111-PR1 Bloodborne Pathogens

3.8 S3NA-209-PR1 Risk Assessment & Management

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Managers**

- Develop and implement Location Specific Emergency Response Plans and security standards for the applicable office, location and/or project personnel.
- Confirm Location Specific Emergency Response Plans and security standards are included in the respective Office Safety, Health & Environment Plan or location specific SH&E Plan.
- Confirm appropriate training of employees as determined by the potential emergency situations, regulatory requirements and, if applicable, client requirements.
- Confirm the emergency response plan is communicated to all affected personnel.
- Confirm that necessary training and resources appropriate to the potential emergencies is provided to AECOM employees.
- Confirm that necessary and appropriate emergency response equipment is readily available.
- Confirm that emergency drills are completed annually or more frequently as appropriate to the risk of the potential emergency or as required by legislation. Confirm the effectiveness of the procedure and, as needed, take corrective action. The *S3NA-010-FM1 Emergency Response Drill Report* or equivalent shall be used to confirm the completion and effectiveness of the drill.

4.1.2 **Safety, Health &Environment (SH&E) Manager**

- Assist in the development and implementation of emergency response plans and security standards for the applicable office, location and/or project personnel.
- Review and, as necessary, implement emergency response plans and security standards.

4.1.3 **Supervisors**

- Review and, as necessary, implement emergency response plans and security standards.
- Confirm employees have completed any required training associated with the identified potential emergencies.
- As applicable, confirm that employees have access to communication devices that are in good working order. Maintain current rosters of employees under their supervision.

4.1.4 **Employees**

- Participate in any required training and drill exercises.
- Report any potential or actual threatening situations to the Manager, Supervisor and/or Emergency Response Lead.
- As applicable, oriented to the potential risk of violence and instructed how to identify and respond to violent situations.
- Report an injury or adverse symptom as a result of an incident of violence and when appropriate consult a physician for treatment or referral
- Review and, as necessary, implement emergency response plans and security standards.

4.2 Emergency Response Plan (ERP)

4.2.1 An assessment shall be completed by the Manager of each location to determine the potential emergency situations and the adequate number of First Aid Providers, first aid supplies and medical requirements, including determining the response time and availability of Emergency Medical Services (EMS). Refer to *S3NA-012-PR1 First Aid.*

4.2.2 Managers will establish and implement the location specific ERP using *S3NA-010-FM2 Location Specific Emergency Response Plan Template*. The ERP shall be communicated to all affected employees.

4.2.3 The location specific ERP will include:

- The location of the muster point, first aid, fire extinguishers, fire exits, AED, and other emergency equipment.
- Defined roles and responsibilities in the event of an emergency.
- A contact list that includes, as applicable, fire, police, ambulance, poison control, First Aid Providers on location, fire wardens on location, Site Safety Officer, security, SH&E committee, SH&E Reporting number for reporting all AECOM incidents, and other required emergency contacts.
- Procedures appropriate to the potential emergency situations.
- As applicable, maps to appropriate services, such as hospital or medical clinic.
- *S3NA-010-FM2 Location Specific Emergency Response Plan Template* shall be completed according to the office or worksite's needs.

4.2.4 The location specific Emergency Response Plan (ERP) will comply with all governing regulations.

4.2.5 The location specific ERP shall be included in the location specific Office Safety, Health & Environment Plan (refer to *Global Office Safety, Health & Environment Plan*) or the location specific SH&E Plan (refer to *S3NA-209-PR1 Risk Assessment & Management*).

4.2.6 If the hazard assessment for the location indicates a need for planned evacuation or rescue, appropriate written procedures will be developed and implemented.

- Depending upon the various contributing factors to the potential emergencies, the procedures may require coordination with a third party rescue provider, or preparations for mass evacuation away from a site.
- If applicable, procedures should be developed to assist any personnel with disabilities in the event of an evacuation.

4.2.7 The location specific emergency plan will be readily available to personnel.

- Worksites shall post the ERP at all worksite entrances and/or develop alternate methods to confirm ERP accessibility, such as placing the ERP at muster points, on appropriate vehicle dashboards, driver door pockets, glove boxes, muster points, etc.

- In offices and shop locations the plan will be posted at all entrances and other suitable locations throughout the workplace, such as the SH&E noticeboard or first aid room.

4.2.8 Appropriate methods to account for AECOM employees and visitors shall be established.

- Visitor registers, tailgate/toolbox sign-in sheets and/or staff listings shall be available in the event of evacuation.
- Employees leaving location should alert appropriate personnel (supervisor, reception, or other responsible party) prior to departure, as applicable, provide expected time of return and alert the appropriate personnel upon return.

4.2.9 Staff will be trained for involvement in an emergency evacuation or rescue; however, all evacuations may require special preparation and arrangements with third party rescue providers in the following circumstances:

- work at high angles,
- work in confined spaces or where there is a risk of entrapment,
- work with hazardous substances,
- underground work,
- work on or over water,
- work in remote isolation, and
- workplaces where there are persons who require physical assistance to be moved.

4.2.10 The ERP will address a clear path of travel to and from a working area, as applicable:

- The access will be made obvious and most direct with adequate illumination.
- The access will remain clear and unobstructed at all times.
- No material or equipment may be stored or temporarily left in path of egress.
- A traffic barrier will be used for facilitating vehicle and pedestrian traffic.
- Parking areas shall not restrict access by emergency personnel and vehicles.
- The access route will have a clear line of vision into oncoming traffic lanes.

4.2.11 All staff will be advised of the location of first aid services, equipment, and supplies.

4.2.12 The ERP shall be tested for deficiencies through emergency response drills annually or more frequently as required by legislation. Emergency drills such as man-down, hurricane/tornado drill, security, first aid are recommended to be conducted and lessons learned documented quarterly.

4.2.13 The ERP shall be reviewed annually or more frequently as required by legislation.

4.3 First Aid

4.3.1 Refer to *S3NA-012-PR1 First Aid* and *S3NA-111-PR1Bloodborne Pathogens* for additional information.

4.4 Other Emergency Response Equipment

4.4.1 Portable fire extinguishers shall be provided of appropriate class, size, and quantity in accordance with local legislation and *S3NA-011-PR1 Fire Protection*.

4.4.2 Provide eye wash stations (where appropriate to hazards).

4.4.3 Maintain an ERP and emergency kit appropriate to the hazards associated with the location (e.g., earthquakes, tornadoes, hurricanes, etc.).

4.5 Communications

4.5.1 Supervisors are responsible for confirming that crews have access to communication devices that are in good working order, have reception in the area in which the crews will be working, and meet the needs of the planned check-in and emergency response procedures. This may include:

- 2-way radios,
- Cellular phones (or combination cell phone/2-way radio),
- Satellite phones,
- Car phones, or
- Personal Locator Beacons.

4.5.2 The Manager will be responsible for confirming that crews have the appropriate means of communication before leaving for the worksite. The type of communication device will depend on the location and circumstances of the job task.

4.5.3 All staff is responsible for maintaining the communication devices in good working order before leaving for the field and for ensuring that battery-operated electronic devices have been recharged or have fresh batteries.

4.5.4 All staff is responsible for keeping communication devices clean and dry to facilitate their effective operation.

4.6 Visitors

4.6.1 All visitors to the location shall receive a safety orientation that includes ERP information.

- Visitors to worksite shall review the location specific SH&E Plan or Task Hazard Analysis (THA) and attend/review and sign the applicable tailgate/toolbox meeting.
- Visitors to offices and shop locations shall sign a Sign In/Out register as this record will be used to check and make sure all visitors are accounted for in the event of an emergency (e.g. evacuation to muster point). Refer to *S3NA-010-FM5 Office / Shop Visitor Register*.

4.6.2 In the event of an evacuation, visitors working directly with an AECOM host will be the escorted by their host to the muster point.

4.6.3 For in-house meetings, safety orientations will be delivered before the meeting begins so all visitors are aware of the evacuation routes and procedures

4.7 Emergency Response

4.7.1 Employees responding to emergency situations should take no unnecessary risk. In the case of an emergency, the First Aid Provider will promptly provide injured workers with a level of care within the scope of the attendant's training, objectively record observed or reported signs and symptoms of injuries and exposures to contaminants, secure medical treatment for workers with injuries considered by the first aid attendant as being serious or beyond the scope of the attendant's training.

4.7.2 All incidents will be reported in accordance with *S3NA-004-PR1 Incident Reporting, Notifications & Investigation*.

4.7.3 If emergency action is required to correct a condition that constitutes an immediate threat to workers, only those qualified and properly instructed workers necessary to correct the unsafe condition may be exposed to the hazard and every possible effort will be made to control the hazard while this is being done.

4.7.4 In the event of an evacuation, all employees and visitors will gather together at the muster point for a roll call. Upon evacuation or dismissal, no unauthorized or nonessential personnel are allowed access to the facility or project area during an emergency.

4.7.5 All accident and emergency sites will be immediately secured to prevent unauthorized access or the possibility of further risk to workers, property, or the public at large.

4.7.6 All emergencies will be managed by the AECOM emergency management personnel identified in the ERP. This may include security personnel.

- The Local Resilience Coordinator (LRC) shall be the key point of contact with the Region Resilience Team in order to obtain further direction following an initial emergency response.
- Additional response via Resilience Teams shall be in alignment with *RS2-003-PR1 Disruptive Event Response Standard.*

4.7.7 During an emergency, AECOM Employees shall take direction from AECOM members of the emergency team, (e.g. emergency coordinator, floor wardens, etc.) and outside professional responders, as appropriate, who are in control of the situation.

4.7.8 Employees should render assistance in the safest possible manner, using appropriate personal protective equipment and precautions.

4.7.9 Other actions that may be necessary shall be included as applicable in the location's specific ERP. These include, but are not limited to:

- Notification of local authorities.
- Contact with appropriate AECOM security personnel for assistance.
- Notification of client representatives and any security group having authority on the worksite.

4.8 Post-Emergency Follow Up

4.8.1 If Regional, Geography or Enterprise Resilience Teams were convened, follow up response will be at the Team's direction.

4.8.2 Prior to resuming operations, the work area will be inspected to confirm that conditions are under control and no longer pose a hazard to employees. In the case of a fire or bomb threat, this inspection is to be done by the ranking public emergency responder. Management approval to return shall then be obtained in order to return to work.

4.8.3 The Emergency Response Procedure Action Checklist shall be completed (Contained in *S3NA-010-FM2 Location Specific Emergency Response Plan Template)*.

4.9 Security

4.9.1 Conduct an evaluation of the worksite or location, local conditions, and contract stipulations to determine a need for:

- Access Control
- Vehicle Registration
- Identification badges for employees and visitors
- Fencing
- Security Guards
- Outside Lighting
- Secure Storage Areas
- Alarm Systems

4.9.2 *S3NA-010-FM3 Site Security Checklist* may be used to evaluate a location's need for specific security and to subsequently develop appropriate measures. This form may also be used at intervals for a given location to evaluate the need for any change to the security measures in place.

4.9.3 Where physical security of a location is required, management, with the assistance of SH&E personnel, will be responsible for organizing and supervising security guards. A local bonded security force may be used for this purpose. As an alternative, an in-house security organization may be established.

4.9.4 On many projects, identification badges or numbers are provided for employees. It may be necessary to provide a qualified security officer or team to provide the following services:

- Orientation to the location for new hires and visitors.
- Substance abuse testing for new hires.
- Issuance of badges for new hires and visitors.
- Briefing and debriefing for visitors.
- Monitoring of location activities to prevent theft, espionage, and malicious damage.

4.9.5 When a security program is established, the location specific ERP, including the procedures, and fire prevention and protection programs, shall be planned and coordinated with the program's security force.

4.9.6 On many projects involving military installations, nuclear work, and defense contracts, it may be necessary to provide a qualified security officer or team to monitor activities to prevent espionage, theft, malicious damage, and any compromise of classified information.

4.9.7 Contact the Human Resources Department for assistance if personnel security clearances are required.

4.10 Violence

4.10.1 Violence in the workplace training will be conducted where there is an elevated exposure to violence or, if required by regulation. Refer to *S3NA-003-PR1 SH&E Training*.

4.10.2 A risk assessment, refer to *S3NA-010-FM3 Potential Violence Assessment Form,* will be performed in any workplace in which there exists a risk of injury to workers from violence arising out of their employment or where required by regulation.

4.10.3 The risk assessment will include the consideration of:

- Previous experience in that workplace,
- Occupational experience in similar workplaces, and
- The location and circumstances in which the work will take place.

4.10.4 If an assessment identifies a risk of injury to workers from violence, the employer will establish procedures and work environment arrangements to eliminate or minimize the risk to workers from violence.

4.10.5 Controls will be implemented and communicated to employees to address the violence hazard. Control may include, but is not limited to, working in pairs, being assisted by police or other authority, having a clear emergency response procedure, and having access to a communication device.

4.10.6 Risk Assessment/Potential Violence Inspection Forms conducted for violence will be distributed to Managers and the applicable health and safety committees**.**

4.10.7 Workplace violence may include:

- Threatening behavior such as shaking fists, destroying property, or throwing objects.
- Verbal or written threats—any expression of intent to inflict harm.
- Harassment—any behavior that demeans, embarrasses, humiliates, annoys, alarms, or verbally abuses a person and that is known to be or would be expected to be unwelcome. This includes words, gestures, intimidation, bullying, or other inappropriate activities.
- Verbal abuse—swearing, insulting, or condescending language.
- Physical attacks—hitting, shoving, pushing, or kicking.

4.10.8 The risk of violence may increase during certain times of day and location. Be sure to plan ahead and take into account time of day, what tasks will be conducted, location(s), method of travel, and who might be accompanying.

4.10.9 Be prepared. Always carry electronic communications, such as mobile phones with emergency services numbers in speed dial list. If 911 is the emergency number, confirm that both mobile signal coverage and the 911 service work from the work location(s).

4.10.10 Public Meetings or Presentations:

- Facilitate and/or provide proper instruction to project employees on this procedure and how to identify and avoid potentially violent situations in public meetings or presentations.
- Identify community and emergency contacts.
- Determine whether a community leader should accompany employees to the public meeting or presentation.
- Ask a community leader or local police if there are any homes/areas to be avoided.
- Work with community leaders to make community residents aware of the work being undertaken. If in doubt, err on the side of caution. Do not expose employees to potentially violent situations.
- Send out advance notice to area residents about the nature and purpose of the visit.

4.11 Public Visitations

4.11.1 Before entering any home or sampling site, employees shall assess the risk of violence and confirm safety of and proper protection of themselves and co-workers. If there is any doubt about individual or group safety, do not enter the premises/area.

- Where possible, work with someone from the community who is known by and knows the residents.
- Have easily visible identification available.
- Be sensitive to cultural, social, and economic differences.
- Attempt to learn about potential problems before entering the area.
- Employees may not enter premises posted with Beware of Animal signs unless the owner has confirmed employees will be safe.

4.11.2 Employees shall report all acts of violence to their Supervisor, SH&E Manager or Human Resources Manager.

4.11.3 All acts of violence will be reported by the employee to their Supervisor or Region Human Resources Manager.

- Report any physical contact or any violent threats to the local authorities immediately, and summon help.
- Any reported incidents of violence will be held in confidence and will be handled with integrity and discretion. All incidents will be handled in accordance with *S3NA-004-PR1 Incident Reporting, Notifications & Investigation* procedure. Any injuries or results of exposure to violence will be handled in accordance with AECOM policies and procedures.

5.0 Records

5.1 The Location Specific ERP will be filed in the project file.

5.2 ERPs shall be part of site SH&E audits.

5.3 Emergency Response Drill Reports, Security Checklists and Potential Violence Assessment Forms shall be maintained in the location or project safety files.

6.0 Attachments

6.1 S3NA-010-FM1 Emergency Response Drill Report

6.2 S3NA-010-FM2 Location Specific Emergency Response Plan Template

6.3 S3NA-010-FM3 Site Security Checklist

6.4 S3NA-010-FM4 Potential Violence Assessment Form

6.5 S3NA-010-FM5 Office / Shop Visitor Register

Americas

Risk Assessment & Management

S3NA-209-PR1

1.0 Purpose and Scope

1.1 This procedure requires hazard identification, risk evaluation, control measures, and documentation to manage safety, health and environment (SH&E) risks associated with work activities.

1.2 The objective is to establish and enhance SH&E performance, to mitigate and reduce losses due to injury, illness, property damage, or environmental impairment incident, and maintain regulatory compliance.

1.3 This procedure applies to all AECOM Americas-based employees and operations.

2.0 Terms and Definitions

2.1 **Control Measure** - Actions that can be taken to reduce the potential of exposure to the hazard. The control measure could be to remove the hazard or to reduce the likelihood of the risk of the exposure to that hazard being realized.

2.2 **Hazard** - An object, condition or behavior that has the potential to cause human injury or illness, property damage, damage to the environment, business interruption, or a combination of these.

2.3 **Risk** – The possibility of loss or injury.

2.4 **Task Hazard Assessment (THA) –** A THA is a tool for evaluating work activities for the purpose of:

- Identifying the SH&E hazards and risks associated with the activity being performed;
- Identifying and implementing control measures to eliminate or reduce hazards and risks; and,
- Evaluating the effectiveness of control measures and making modifications as needed.

3.0 References

3.1 S3NA-002-PR1 Stop Work Authority

3.2 S3NA-010-PR1 Emergency Response Planning

4.0 Procedure

4.1 Roles & Responsibilities

4.1.1 **SH&E Manager**

- Assisting management personnel to identify any necessary SH&E planning documentation required.
- Assisting in the preparation of necessary SH&E risk assessment documentation.
- Reviewing and approving SH&E risk assessment documentation prior to its implementation for work activities.
- Providing SH&E technical and regulatory input as necessary.

4.1.2 **Manager**

- Confirming the completion of SH&E risk assessment documentation as required, that addresses the full range of work activities, SH&E risks and that all requirements and procedures are implemented and enforced during the work activities.
- Confirming SH&E requirements are implemented successfully, including but not limited to:
    - Subcontractor evaluations

- SH&E training
- Personal protective equipment
- First aid and emergency response
- Client requirements

- Contacting the SH&E Manager to discuss SH&E risk assessment documentation needs/ requirements at the start of each new project involving AECOM and at designated intervals or:
  - When changes occur to the work operations or work location/ conditions
  - When work activities are modified/ changed, or
  - When additional tasks are added to the work scope.
- Confirming that the SH&E Plan has been reviewed and approved by the SH&E Manager prior to its use by AECOM personnel or prior to release to clients, outside agencies or organizations.
- Making appropriate resources available to protect the health and safety of AECOM employees, the environment and to comply with occupational health and safety, and environmental legislation and for the effective implementation of this procedure.
- Identifying and reporting to a Manager/Supervisor when changes occur to the work operations or work location/conditions.
- Identifying appropriate and applicable SH&E regulatory requirements, and implement into respective SH&E Plan.

4.1.3 **Employee**

- Obtaining necessary training identified in the SH&E Plan and associated documents.
- Understanding the potential hazards and controls of the task before work commences.
- Complying with all required controls as identified in the SH&E Plan and associated documents. Reporting any program, SH&E plan or regulatory variances to their Supervisor.

4.2 Risk Assessment Strategy

4.2.1 Hazard Identification

Hazard identification is the precursor to being able to assess risk. Before undertaking any activity, the hazards shall be identified by persons competent to recognize them using professional experience and training including the following:

a. Utilization of a formal hazard identification process;
b. Information from review and improvement processes;
c. Consideration of hazardous materials required for task(s);
d. Location of work and proximity to outside hazards or equipment;
e. Anticipation or possible change of conditions;
f. Consideration of risk of human error;
g. Identifying level of training required for task; and
h. Any other factors that can introduce hazard or risk into the activity.

4.2.2 Hazard identification should consider:

a. Routine and non-routine activities;
b. Activities of all persons having access to the workplace (including contractors and visitors);
c. Human behavior, capabilities and other human factors;

d. Identified hazards originating outside the workplace capable of adversely affecting the health and safety of persons under the control of AECOM within the workplace;

e. Hazards created in the vicinity of the workplace by work-related activities under the control of AECOM and neighboring activates not under AECOM control;

f. Infrastructure, equipment, and materials at the workplace, whether provided by AECOM or others;

g. Changes or proposed changes in the organization of AECOM, its activities, or materials;

h. Modification to the SH&E management system, including temporary changes, and their impacts on operations, processes, and activities;

i. Any applicable legal obligations relating to risk assessment and implementation of necessary controls;

j. The design of work areas, processes, installations, machinery/equipment, operating procedures, and work organization, including their adaptation to human capabilities; and

k. Driving and travel activities.

4.2.3 Risk Assessment

a. Evaluate the work area for hazards as defined above. This applies to field, office, and travel settings.

b. Determine whether identified hazards could affect employees, subcontractors, members of the public, visitors, or others.

c. Assess the severity and probability of any identified hazard occurring. This is generally based on experience, although incident statistics are available for most industries. The assessment of probability must also take into consideration the frequency with which exposure to a particular hazard will take place (e.g., the probability of occurrence is much greater if the activity is a daily event involving a number of individuals, compared with the same activity carried out twice a year by few individuals as part of a maintenance procedure).

d. Severity

Be realistic when considering how severe the result of exposure to a hazard could be. For example, it is remotely possible that someone tripping over a cable in an office may be killed, but the most probable result is bruising or a fractured bone. If, however, the cable is trailing across the top of a very busy stairway, a more severe injury is possible.

The following table shall be used to evaluate severity:

Severity – Potential Consequences				
	People	**Property Damage**	**Environmental Impact**	**Public Image/Reputation**
Catastrophic	Fatality, Multiple Major Incidents	>$1M USD, Structural collapse	Offsite impact requiring remediation	Government intervention
Critical	Permanent impairment, Long term injury/illness	>$250K to $1M USD	Onsite impact requiring remediation	Media intervention
Major	Lost Time /Restricted Work	> $10K to $250K USD	Release at/above reportable limit	Owner intervention
Moderate	Medical Treatment	> $1K to $10K USD	Release below reportable limit	Community or local attention
Minor	First Aid	</=$1K USD	Small chemical release contained onsite	Individual complaint

e. Probability

Determining the probability of a hazard actually causing harm can be much more difficult than determining the severity. The factors affecting the analysis of probability are:

- The number of times the situation occurs
- The position of the hazards
- Distractions
- The duration of exposure
- Quantities of materials involved
- Environmental conditions
- Competence of the people involved
- Condition of equipment.

In analyzing the probability of harm, it will be necessary to take into account the possibility of the control measures not being used because of human error, lack of maintenance, difficulty in compliance, complexity, etc.

The following table shall be used to determine probability:

Probability		
Frequent	Expected to occur during task/activity	9/10
Probable	Likely to occur during task/activity	1/10
Occasional	May occur during the task/activity	1/100
Remote	Unlikely to occur during task/activity	1/1,000
Improbable	Highly unlikely to occur, but possible during task/activity	1/10,000

4.2.4 Risk Matrix

A quantitative risk rating can be derived for each hazard using the following table.

Probability	**Severity**				
	5 - Catastrophic	4 – Critical	3 – Major	2 – Moderate	1 - Minor
5 – Frequent	**25**	**20**	**15**	**10**	**5**
4 – Probable	**20**	**16**	**12**	**8**	**4**
3 – Occasional	**15**	**12**	**9**	**6**	**3**
2 – Remote	**10**	**8**	**6**	**4**	**2**
1 - Improbable	**5**	**4**	**3**	**2**	**1**

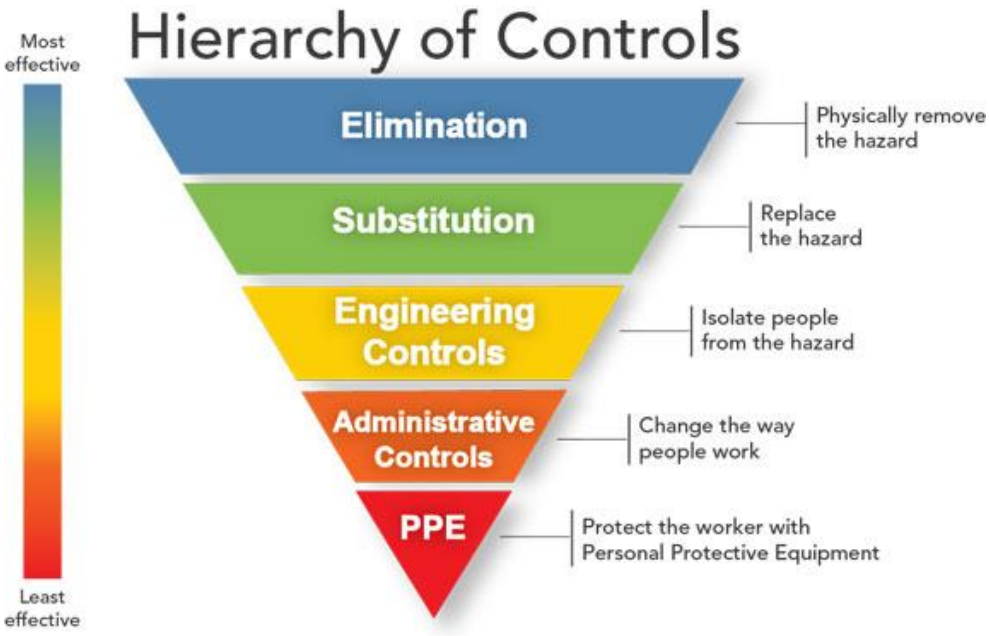
Use of the quantitative risk table shown above can help to determine whether or not the level of risk is tolerable. This can assist in deciding priorities for action. In general, higher risks (yellow and red) may require the provision of considerable additional resources involving special equipment, training, high levels of supervision, and consideration of the most effective methods of eliminating or controlling hazards. Lower-level risks may be considered as acceptable, but actions should still be taken to try to reduce them further, if possible. The risk rating for a project should be revised if the scope of work changes and at a minimum, the risk rating should be re-assessed on an annually basis.

Risk Rating (Probability x Severity)	Risk Acceptance Authority
1 to 4 (Low)	Risk is tolerable, manage at local level
5 to 9 (Medium)	Risk requires approval by Operations Lead/Supervisor & SH&E Manager
10 to 25 (High)	Risk requires the approval of the Operations Manager & SH&E Director

4.2.5 Hierarchy of Controls

Controlling exposures to hazards is the fundamental method of protecting workers. Traditionally, a hierarchy of controls has been used as a means of determining how to implement feasible and effective control solutions.

The idea behind this hierarchy is that the control methods at the top of graphic are potentially more effective and protective than those at the bottom. Following this hierarchy normally leads to the implementation of inherently safer systems, where the risk of illness or injury has been substantially reduced.



Source: http://www.cdc.gov/niosh/topics/hierarchy/

Eliminating a hazard is the most effective means to manage a hazard. Substitution and engineering strategies include replacing a hazardous substance with a safer one, reducing the hazard (e.g., ventilation), or isolating it from where employees are working (e.g., enclosing a noisy machine).

Administrative controls include policies, training, job rotation, signage, or temporary barriers to warn of a hazard or describe safe procedures.

Personal protective equipment (PPE) such as safety glasses and hardhats place a barrier between the worker and the hazard, but do not prevent the occurrence of the incident. PPE is considered the least effective method of controlling a hazard because it depends on proper selection and fit, employee compliance, and availability.

4.3 Preplanning for Development of Risk Assessment Documentation

4.3.1 Coordination must be made by management with representatives of the client, regulatory authorities (if needed), and other appropriate personnel to determine and coordinate such items as:

a. Measures to protect the public and/or other persons exposed to the work operations.

b. Client requirements and local, state, and/or federal laws and regulations that are applicable to the project.

c. Procedures for handling and reporting incidents, property damage, and other emergencies.

d. Disciplinary policies and management of restricted access for company employees and subcontractors/vendors.

4.3.2 As soon as possible, conduct an initial review of the work location and review the proposed work activity to determine, to the extent possible, existing or probable hazardous conditions and restricted areas.

4.4 Risk Assessment Documentation

Risk assessment documentation includes SH&E Plans, Pre-Job Hazard Assessments, Daily Tailgate Meetings and Task Hazard Assessments.

4.4.1 **SH&E Plan.** All AECOM office locations are required to prepare an SH&E Plan using *S3NA-209-FM1 Office SH&E Plan Template*. A SH&E Plan is required for work activities outside of an AECOM office. The SH&E Plan is often required by regulation, insurance policy requirements, or client requirement. A template is provided in *S3NA-209-FM2 Industrial Site / Project SH&E Plan Template*. In addition, *S3NA-209-FM3 Procedure Checklist* can be used to assist in determining which AECOM SH&E procedures apply to the scope of work. Applicable procedures shall be attached to the SH&E Plan. A typical SH&E Plan includes the following components:

a. Descriptions of roles and responsibilities for the activity.

b. Hazard analysis for each task and operation found in the work plan.

c. Supplementary information to the attached procedures (e.g., jurisdiction-specific requirements, client requirements, etc.)

d. Supervision.

e. Training requirements.

f. Personal protective equipment requirements for the separate tasks or operating areas.

g. Medical surveillance requirements (for chemical exposure, noise, radiation, etc.).

h. Frequency and types of monitoring for physical and chemical hazards.

i. Pre-entry briefings requirements for visitors and workers.

j. Location-specific Emergency Response Plan. Refer to *S3NA-010-PR1 Emergency Response Planning.*

k. Client requirements that are more stringent than AECOM's SH&E requirements.

l. In California, the SH&E Plan must also address the Injury Illness Prevention Program. Refer to *S3NA-209-ATT1* for additional information.

m. A SH&E Plan for hazardous waste operations may also include:

- Site access and control measures.
- Site specific information on chemical, biological or radiation hazards.
- Decontamination procedures.
- Confined Space Entry plan.
- Spill containment plan.
- Waste management.

n. A SH&E Plan for construction activities may also include:

- Traffic plan and site access controls.
- Electrical and machinery protective measures.
- Trench and excavation safety.
- Fall protection and rescue plans.
- Storage for combustible and flammable materials.
- Sediment and community noise control plans.

o. A SH&E Plan for a demolition project may also include:

- Materials movement plan.
- Critical task sequencing.
- Explosives safety.
- Dust control measures.
- Removal of asbestos and lead-containing materials.

4.4.2 **Pre-Job Hazard Assessment.** Pre-Job Hazard Assessment is essential to ensure that hazards and risks are recognized. A Pre-Job Hazard Assessment describes the task being performed, the inherent risks, and the control measures for those risks.

- Pre-Job Hazard Assessments are completed before the work activities commence and are updated based on lessons learned.
- Workers involved in the task should participate in the hazard assessment process so that best practices are shared and all possible hazards of the task are identified.

Pre-job Hazard Assessments are performed by:

- Identifying the principle steps of each task being performed.
- Potential hazards are identified for each step and the initial risk rating is determined using the Risk Matrix.
- Control measures are then identified including PPE for each hazard.
- Each hazard is then re-evaluated and assigned a final risk rating using the Risk Matrix.
- If the final risk rating is a 5-9 (medium risk) or 10-25 (high risk), additional hazard controls shall be identified and applied until the final risk rating is reduced to 4 or below. If the final risk rating cannot be reduced to 4 or lower, additional approvals are needed before the activity can begin.

Pre-Job Hazard Assessments may be completed as a stand-alone document, or may be incorporated into an SH&E Plan. Pre-Job Hazard Assessments are similar to Activity Hazard Analysis (AHA), Job Hazard Analysis (JHA), Job Safety Analysis (JSA) and other terms and formats; however, unless otherwise indicated by client requirement, *S3NA-209-FM4 Pre-Job Hazard Assessment* shall be utilized.

Information collected during the Pre-Job Hazard Assessment must be referenced as part of the site- specific SH&E Plan. In addition Pre-Job Hazard Assessments must be communicated to employees and subcontractors on-site. Copies of the Pre-Job Hazard Assessments will be kept on-site for review.

4.4.3 **Daily Tailgate Meeting.** A tailgate meeting for all project personnel will be held daily (excluding fixed-facility locations where AECOM employees permanently work full time). A record of the meetings will include the name of all attendees, items discussed, and date/time of meeting. *S3NA-209-FM5 Daily Tailgate Meeting Form* may be used to document the meeting.

At a minimum, the meeting will involve representatives from all organizations with a direct contractual relationship with AECOM on the project site. Other contractors working in the area of AECOM's activities should also be invited to the meeting when possible. All members of the meeting should be engaged and encouraged to participate and provide input and feedback. Objectives for the meeting should include:

- Eliminating injuries, illnesses, and damage to the environment or property.
- Review planned work activities.
- Clarify roles and responsibilities.
- Confirm work crew is fit-for-duty.
- Assess, identify and mitigate hazards.
- Share lessons learned and observations.
- Review simultaneous operations with other non-AECOM controlled activities (e.g., other contractors performing work in the vicinity of AECOM's operations, fuel delivery at the location, utility company working near AECOM operations).

4.4.4 **Task Hazard Assessment (THA).** A THA is the most important element in an effective hazard identification and risk reduction program. *S3NA-209-FM6 Task Hazard Assessment* shall be completed before every assigned task at the work location. The focus of the analysis shall be on the specific assigned task and the evaluation of risks and assignment of control measures based on actual work conditions.

A THA is a portion of the overall job scope, focused at the specific foreman and/or crew level. Task Hazard Assessments must be completed prior to the start of work. Re-assessment must also be completed when a significant change of scope occurs or if conflicting work is being done. Completion of the THA involves both the site supervision and employees involved in the work.

Task Hazard Assessment steps:

- Assemble employees involved in the work.
- Review the scope of work being performed.
- Break the task into individual steps.
- Identify actual and potential hazards.
- Rank the risk using the Risk Matrix.
- Develop appropriate controls measures for each hazard.
- Rank the post control measure risk using the Risk Matrix.
- Review the assessment.
- Confirm communication of the THA to all affected employees.
- Confirm the THA is reviewed by any visitors or additional or new personnel brought on to perform the task.

If the final risk rating is a 5-9 (medium risk) or 10-25 (high risk), additional hazard controls shall be identified and applied until the final risk rating is reduced to 4 or below. If the final risk rating cannot be reduced to 4 or lower, additional approvals are required before the activity can begin.

Employees shall monitor the activities for compliance with the THA. Workers should stop any work on a task if conditions change from the planned and agreed approach to the work. The THA should be updated to reflect new conditions or changes in task methods.

4.5 Key Elements in Risk Management at a Site

4.5.1 Regularly, or at least once per month, conduct safety meetings for supervisory personnel, including those of other contractors and subcontractors. Suggested action items for these meetings include:

a. Reviewing of the safety procedures and policies applicable to the project.

b. Identifying responsibilities of the various parties, including contractor(s) and subcontractor(s) obligations.

c. Reviewing noted and anticipated hazards, and plan methods to eliminate or control them.

d. Discussing incidents and near misses to determine causes and steps necessary to prevent reoccurrence.

e. Discussing suggestions and ideas for improving the project's safety program.

f. Maintaining a record of these meetings; this will be done by the safety representative or supervisor.

4.5.2 Regular inspections of active work areas will be made by the project supervisors and the site SH&E representative. To be effective, such inspections should occur on all shifts, should be unannounced, and should occur at varied intervals.

a. Imminent danger situations must be stopped and corrected immediately. Refer to *S3NA-002-PR1 Stop Work Authority.*

b. Inadequate or deficient protective measures and unsafe or unhealthy work practices must be brought to the immediate attention of the appropriate supervisor and/or manager for correction and disciplinary action, as required.

c. Inform the manager of all deficiencies not immediately correctable, and/or that may result in damage to facilities, equipment, or work in progress, or that create hazardous exposures to employees or the public.

4.5.3 Signs and posters of appropriate size and design, and bearing standard pertinent regulations, will be used to convey warnings, directions, and instructions to personnel and the public, as required by the client and other applicable regulations. The observance of such safety and incident prevention signs will be strictly required of company employees and visitors while on the project site.

4.5.4 Consideration must be given to make the project environmental protection plan effective. The type and extent of the measures needed for pollution control, hazardous materials handling, hazardous waste control and disposal, and for relating occupational health issues will depend upon the contract stipulations, hazard involved, type of operation, and the mandatory requirements of regulatory authorities. Such measures will include appropriate control methods necessary to prevent or reduce to safe levels exposure to hazardous substances.

4.5.5 It is the practice of AECOM to commend and reward employees and their supervisors for achieving excellence in their field of work, particularly when that work is performed safely. Project management is encouraged to promote and participate in safety recognition programs by developing project-specific safety goals and including safety incentive programs in project budgets. Project goals should include proactive goals such as training participation and training support, safety observations conducted, and management participation in safety reviews (e.g., safety walk-downs).

4.5.6 All employees are empowered and expected to stop work or not start work when it is unsafe. Employees will be trained on stop work authority upon initial assignment. Refer to *S3NA-002-PR1 Stop Work Authority*.

4.6 Other Requirements

4.6.1 The following requirements apply to SH&E risk assessment documentation:

- Preparation of the SH&E documentation may be performed by a member of the project team or SH&E.
- SH&E documentation (including draft versions of documents) will be reviewed by a SH&E Manager prior to release for outside agency review (e.g., clients, regulatory agencies, etc.) and prior to its field implementation.

- Changes to approved SH&E documentation require concurrence from a SH&E Manager (or designee). This includes those made in response to changing field conditions or operational requirements and those made in response to regulator/client comments. Any written responses made to regulator/client comments also must be reviewed by the SH&E Manager.
- The SH&E documentation for any project lasting twelve (12) months or longer will be reviewed at periodic intervals, but at least annually. The SH&E Manager will review the changes and determine whether modifications are required to the existing SH&E planning documentation. This confirms that the documentation continues to reflect the current scope of work and knowledge of site conditions, and that any revised regulatory requirements are properly addressed. The Manager will provide a master copy of the SH&E documentation to be maintained on site for reference by personnel, together with copies of any required SH&E-related records or operational documentation. The master copy must be current in all respects, and will include any changes or modifications made as work progresses.
- Managers will confirm that SH&E documents have been reviewed with affected personnel prior to implementation of field work. Sign-off and concurrence is mandatory and to be kept in the project records.

5.0 Records

5.1 Completed SH&E Plans, Pre-job Hazard Assessments, Tailgate Meeting Forms and Task Hazard Assessment will be filed in the appropriate project file.

6.0 Attachments

6.1	S3NA-209-ATT1	California Injury & Illness Prevention Program
6.2	S3NA-209-FM1	Office SH&E Plan Template
6.3	S3NA-209-FM2	Industrial Site / Project SH&E Plan Template
6.4	S3NA-209-FM3	Procedure Checklist
6.5	S3NA-209-FM4	Pre-Job Hazard Assessment
6.6	S3NA-209-FM5	Daily Tailgate Meeting Form
6.7	S3NA-209-FM6	Task Hazard Assessment
6.8	S3NA-209-FM6-A	Task Hazard Assessment – Management Services Group
6.9	S3NA-209-FM7	Office Relocation Plan

Americas

Stop Work Authority Table

S3NA-002-ATT1

AECOM Role		* Formal Safety Stop Work Authority and use of the AECOM Red Card		
Contract Type	**SH&E Performance Role**	**Imminent Danger - Immediately Dangerous to Life, Health, and the Environment**	**Violation of organization or regulatory safety rules, but not deadly / not an immediate threat**	**Safe workplace, but employee feels uncomfortable in situation**
Self-Perform AECOM – directed work	Oversight of self and coworkers	**Yes** Use *Stop Work Order – AECOM Employees and Direct Subcontractors S3NA-002-FM1*.	**Yes** – primarily if activity could lead to a significant injury or incident. May require the use of *Stop Work Order S3NA-002-FM1* depending upon situation.	**Yes** – Even in a safe workplace, if employee is uncomfortable with their work situation, employee can stop their own work.
Subcontractor Oversight AECOM – directed work	Oversight of subcontractor	**Yes** Use *Stop Work Order – AECOM Employees and Direct Subcontractors S3NA-002-FM1*.	**Yes**– primarily if activity could lead to a significant injury or incident. May require the use of *Stop Work Order S3NA-002-FM1* depending upon situation.	**Yes** - Even in a safe workplace, if sub-contractor employee is uncomfortable with their work situation, employee can stop their own work.
PM-CM Contractor – controlled work	AECOM PM-CM has specific contractual role for safety oversight of contractor	**Yes** - AECOM employee can confront contractor worker and/or contractor supervisor/foreman and identify the imminent danger situation for contractor to immediately correct; AECOM employee shall notify their manager; completion of a written stop work order may be warranted. Use *Stop Work Order – Project Management / Construction Management S3NA-002-FM2*.	**Yes** – AECOM employee can inform contractor worker and/or contractor supervisor/foreman. AECOM employee shall immediately notify their manager. Manager shall monitor and track to provide to the client for contractor closure of outstanding safety issues.	**N/A**
PM-CM Contractor – controlled work	AECOM PM-CM has not contractually agreed to the specific responsibility of safety oversight.	AECOM Employee can inform contractor site supervisor/foreman and identify the Imminent Danger situation; AECOM employee shall immediately notify their manager. Manager shall immediately notify client.	**No**	**N/A**
No contract with party performing unsafe activity but on same jobsite or project location	No relationship except being on the same client property or project location.	Employee can confront contractor site supervisor/foreman and identify the imminent danger situation; AECOM employee shall immediately notify manager. Manager shall immediately notify client in charge of the party performing the unsafe activity.	**No**	**N/A**

* Notes:

- Appropriate reporting (e.g. LifeGuard, IndustrySafe) must be completed. Refer to *S3NA-004-PR1 Incident Reporting, Notifications & Investigation* for guidance.
- In most cases only the task needs to be stopped for an imminently dangerous situation. Unless required by the AECOM/Client contract, stopping or shutting down the whole project should be by the project manager only in coordination with the client.
- When an imminently dangerous situation is stopped and work is corrected, the responsible organization should investigate and identify the systemic issue to prevent a reoccurrence. When it is an AECOM employee or AECOM subcontractor, the Near Miss incident shall be reported and investigated to the same degree as if a serious incident actually occurred.
- In all cases, if an AECOM employee or subcontractor is in an imminently dangerous situation they shall remove themselves from the location until there is a safe work environment.
- The AECOM Safety Red Card is derived from its use in football (soccer), where circumstances are such that a referee has to stop the play, similar to an imminently dangerous situation on a project site. The Safety Red Card is a physical tool that reinforces the Stop Work Authority Procedure.
- All intervention should be done tactfully with the message, “I am pointing out the imminently dangerous situation because I care about your life and health.”

Americas

Bloodborne Pathogens

S3AM-111-PR1

1.0 Purpose and Scope

1.1 Define the AECOM procedures for eliminating and/or controlling occupational exposure to Bloodborne Pathogens on AECOM projects and activities.

1.2 A written Exposure Control Plan shall be developed and implemented during all AECOM operations where there is a reasonable potential for occupational exposure of AECOM employees and/or subcontractors to bloodborne pathogens as a regulated waste.

1.3 This procedures requirements apply to all AECOM Americas employees and operations. Any jurisdictional requirements exceeding those identified in this procedure shall be met when conduction work in the given jurisdiction.

2.0 Terms and Definitions

2.1 **Blood** – Human whole blood; human blood components such as plasma or platelets; and human blood products such as clotting factors.

2.2 **Bloodborne Pathogens (BBP)** – Pathogenic microorganisms that are present in human blood and that can infect and cause disease in persons who are exposed to blood containing these pathogens including but not limited to hepatitis B virus (HBV), human immunodeficiency virus (HIV), hepatitis C, malaria, syphilis, babesiosis, brucellosis, leptospirosis, arboviral infections, relapsing fever, human T-lymphotrophic virus Type I, and viral hemorrhagic fever (Ebola).

2.3 **Exposure Control Plan** *(S3AM-111-ATT1)* – A plan that addresses the requirements applicable to specific AECOM projects and activities designed to eliminate or minimize employee exposure. The Exposure Control Plan shall be incorporated into the location specific SH&E Plan and shall be accessible to all employees. The Exposure Control Plan shall include:

- Exposure determination.
- The schedule and method of implementation for:
  - Methods of compliance;
  - Hepatitis B Vaccination;
  - Post exposure Evaluation;
  - Communications of Hazards to employees; and
  - Record Keeping.
- Documentation methods for exposure incidents, to include:
  - Routes of exposure; and
  - The circumstances for which and exposure incident occurred.

Note: In the State of California this plan shall also address exposures to airborne pathogens.

2.4 **SH&E Plan** – A document prepared for a specific project or program that details the hazards, precautions, emergency planning, medical, and training requirements for that project or program.

2.5 **Occupational Exposure (Exposed) –** Reasonably anticipated skin, eye mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties. Employees will be considered to be potentially exposed, even though they are using the universal precautions specified for the project or program.

2.6 **Other Potentially Infectious Materials (OPIM)** – Body fluids and tissues including: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid, amniotic fluid, saliva, and any other body fluid that is visibly contaminated with blood. When it is difficult or impossible to differentiate between body fluids, all body fluids should be treated as if they are potentially infectious.

Note: In the State of California airborne pathogens are also considered infectious materials.

2.7 **Regulated Waste** – (1) liquid or semi-liquid blood or other potentially infectious materials; (2) contaminated items that would release blood or other potentially infectious materials in a liquid or semi-liquid state if compressed; (3) items that are caked with dried blood or other potentially infectious materials and are capable of being released during handling; (4) objects contaminated with blood that can pierce the skin; and (5) pathological and microbiological wastes containing blood or other potentially infectious materials.

2.8 **Source Individual** – An individual, typically one who has been injured, whose blood or saliva has come in contact with another individual, typically one who has rendered first aid or Cardio Pulmonary Resuscitation (CPR) to the injured party.

2.9 **Universal Precautions** – All body fluids and materials potentially contaminated by body fluids will be considered to be infectious unless the fluids were from the person performing the clean up or decontamination activities. All employees coming in contact with another person's body fluids shall assume that the fluids are infectious and shall wear prescribed Personal Protective Equipment.

3.0 References

3.1 S3AM-003-PR1 SH&E Training

3.2 S3AM-004-PR1 Incident Reporting, Notifications & Investigation

3.3 S3AM-017-PR1 Injury & Illness Recordkeeping

3.4 S3AM-128-PR1 Medical Screening & Surveillance

3.5 S3AM-208-PR1 Personal Protective Equipment

3.6 S3AM-209-PR1 Risk Assessment & Management

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Occupational Health Manager**

- Will review and maintain all medical records generated as a result of post-exposure follow-up and maintain all medical records related to the follow-up.
- Will, where appropriate, consult with AECOM's local medical providers about follow-up recommendations.

4.1.2 **SH&E Manager**

- Will review project / program-specific Exposure Control Plans (normally part of the SH&E Plan) prior to the initial mobilization, at least annually for continuing projects or programs, and whenever necessary to reflect modified tasks or procedures that affect occupational exposure to bloodborne pathogens.
- Will consult with the Occupational Health Manager regarding all bloodborne pathogens exposure incidents.
- Will maintain training records and post-exposure follow-up information.
- Will confirm that site-specific training is conducted for all employees working at sites where regulated wastes were disposed or for employees who may be occupationally exposed while working at a facility that handles regulated wastes.

- Will confirm the Hepatitis B vaccine is made available to all employees with a potential occupational exposure (e.g. paramedic, medical laboratory employee, etc.).
- Will review all incident reports and arrange for post-exposure follow-up with AECOM's local medical provider.
- Will offer recommendations on how to prevent an incident from recurring.

4.1.3 **Manager**

- See that all recommendations made by the SH&E Manager are implemented.
- Support the SH&E Manager in their efforts to prevent occupational and non-occupational exposures to bloodborne pathogens.

4.1.4 **Employee**

- Use all PPE and universal precautions required to prevent exposure to infectious materials.
- Follow the exposure control methods outlined in their Exposure Control Plan.
- Report potential exposure incidents to their Supervisor or Manager immediately.

4.2 Potential Exposure Situations

4.2.1 There are a few activities within AECOM where potential occupational exposures to blood or other potentially infectious materials are of concern. These activities may include:

- Investigations of properties that received regulated wastes.
- Site visits or audits at Treatment Storage and Disposal facilities where medical waste is handled.
- Site visits or audits at medical or health care facilities.
- The provision of first-aid or cardiopulmonary resuscitation (CPR) to AECOM, subcontractor, or client personnel (if the action is part of the employee's occupations duties [e.g. paramedic] and not provided as a voluntary action).

4.2.2 Although AECOM does offer first-aid and CPR training to its employees on a regular basis, providing such aid is often on a voluntary basis and not directed by AECOM. As such, potential exposures may not be considered occupational exposures within the context of the OSHA Bloodborne Pathogens Standard. Site-specific Exposure Control Plans shall differentiate voluntary first-aid duties from occupational exposures as a component of the exposure determination. Refer to *S3AM-209-PR1 Risk Assessment & Management.*

4.3 Unforeseen Exposure Situations

4.3.1 Occasionally, potentially infectious material is encountered during a activity where none was expected; when this happens, the work shall be stopped, employee training conducted, and an exposure control plan prepared prior to resuming activities with potential exposures.

4.4 Employee Training

4.4.1 All personnel who will work on projects or programs which involve potential contact with regulated wastes will be required to attend a training class prior to the start of the project or program and annually for continuing projects or programs. Refer to *S3AM-003-PR1 SH&E Training.* The specific requirements and provisions of the written Exposure Control Plan shall be provided to each AECOM Employee and subcontractor assigned to work at the program / project.

4.4.2 Either of the following two sources of employee training will be used by AECOM to educate Employees on the hazards of exposure to bloodborne pathogens:

- The local chapter of the American Red Cross or other recognized training provider.
- AECOM's in-house training program.

4.4.3 Training sessions will review the following:

- Requirements of OSHA's Bloodborne Pathogens Standard or equivalent, applicable jurisdictional requirements.
- Review of AECOM's Bloodborne Pathogen Procedure (this document).
- Situations within AECOM that may involve exposure to bloodborne pathogens.
- Bloodborne diseases and symptoms of disease.
- Means of transmission.
- Work practice controls to reduce risk.
- Use of personal protective equipment to reduce risk.
- Incident reporting.
- AECOM's Post-Exposure Medical Follow-Up Procedures:

4.4.4 When contracting for CPR and first-aid training sessions, AECOM will request that each session include a section on the hazards associated with exposure to bloodborne pathogens and protective measures that shall be followed when administering first aid, CPR, or other emergency medical care. At the end of the session, Employees will be provided with a copy of this procedure. This procedure will be reviewed and a question-and-answer session will be conducted at the end of the presentation.

4.4.5 If the training provider cannot provide such training, AECOM will conduct a Blood Borne Pathogen training session prior to the start of the first aid or CPR class.

4.4.6 AECOM has and will have little control over employees who have not received AECOM provided first aid or CPR training, but who choose to perform Good Samaritan acts. Any Employee who does perform a Good Samaritan act that results in exposure to blood or other potentially infectious materials will, however, be provided with post-exposure medical follow-up as described in this procedure.

4.5 Personal Protective Equipment

4.5.1 All body fluids and materials potentially contaminated by body fluids will be considered to be infectious. All Employees coming in contact with another person’s body fluids shall assume that the fluids are infectious and shall wear prescribed personal protective equipment (PPE), refer to *S3AM-208-PR1 Personal Protective Equipment*.

4.5.2 The use of PPE to prevent exposure is more appropriate for the types of occupational and non-occupational exposures Employees might encounter than is the use of engineering or work practice controls that are more effectively instituted in medical care or laboratory facilities where employees are actually handling blood and other potentially infectious materials.

4.5.3 PPE such as Tyvek coveralls, shoe covers, and gloves will be provided to all field team members involved in site activities where regulated wastes may be present. Site-specific PPE requirements will be identified in the written Exposure Control Plan. The same type of PPE will also be available, if it is deemed necessary, for Employees involved with activities at TSD facilities that handle regulated wastes.

4.5.4 PPE will be provided to affected Employees at no cost.

4.6 Universal Precautions Kits

4.6.1 In those work areas where there is the potential for exposure to infectious materials, a universal precaution kit shall be readily available. The kit shall permit the clean-up, neutralization, transportation, and disposal of up to 1 litre of blood or body fluids. The kit shall contain the following items at a minimum:

- Safety shield/mask combination
- Liquid proof apron
- Medical-grade vinyl/nitrile gloves
- Liquid solidifier/deodorizer
- Pickup scoop with scraper
- Red biohazard waste bag with tie
- Germicidal solution with dry wipe
- Antimicrobial hand wipe
- ID tag
- Instructions for use

4.7 Personal Hygiene

4.7.1 Special provisions will be made so that hand washing facilities are available on-site for sites that are known to be contaminated with regulated wastes. Alcohol wipes will be available in the event that hand washing facilities are not immediately available.

4.7.2 To reduce the potential for infection, if skin contact with blood or other potentially infectious materials occurs, the exposed area should be washed with non-abrasive soap and water as soon as possible. Hand washing will also help to prevent the transfer of contamination from the hands to other areas of the body or other surfaces that may be contacted later. Even when protective gloves are worn, hands should be washed with non-abrasive soap and running water as soon as possible after the gloves are removed.

4.7.3 The use of an alcohol wipes should not be relied upon as the primary means of personal hygiene. Hands should be thoroughly washed with soap and running water as soon as possible.

4.7.4 If mucous membranes, such as the eyes, come in direct contact with blood or other potentially infectious materials, the area should be washed or flushed with water as soon as possible and reported immediately.

4.8 Reporting Exposure Incidents

4.8.1 All incidents in which an employee has been exposed to blood or other potentially infectious materials shall be reported to the employee's Supervisor and to the SH&E Manager immediately. An IndustrySafe on-line report shall be completed in accordance with *S3AM-004-PR1 Incident Reporting, Notifications & Investigation*. After reviewing the report, the SH&E Manager will provide recommendations, when appropriate, for preventing recurrence of the incident.

4.9 Medical Follow-Up to Exposure Incidents

4.9.1 Once notified, the SH&E Manager will in turn discuss the incident with AECOM's Occupational Health Manager and/or medical provider and make arrangements for an evaluation, refer to *S3AM-128-PR1 Medical Screening & Surveillance*. Prompt medical attention is important in the event of an exposure incident. If the incident occurs in the field, the Employee will either be asked to visit the local hospital or, if he/she chooses, return immediately to the office to visit AECOM's local medical provider.

4.9.2 An attempt will be made to test the affected employee, and if applicable, the source individual's blood, for bloodborne pathogens. No testing will be performed without the written consent of the exposed Employee or the source individual. If initially, the exposed Employee or the source individual does not consent to HIV serological testing, but does consent to HBV serological testing, AECOM will make provisions with the local medical provider to preserve the blood sample for at least 90 days in the event that after counselling efforts, the Employee voluntarily consents to HIV testing.

4.9.3 AECOM will rely on the professional judgment of its Occupational Health Manager and/or local medical providers in the event of an exposure incident. Evaluations and follow-up procedures will be provided according to the recommendations of the United States Public Health Service (USPHS), World Health Organization, or other Public Health organization in Canada and other countries in the Americas current at the time these evaluations and procedures take place. Minimally, a post-exposure evaluation and follow-up will include the following elements:

- Documentation of the route(s) of exposure
- Circumstances under which the exposure incident occurred
- Identification and documentation of the source individual in the case of first aid or emergency medical treatments
- Collection and testing of source individuals and exposed employee's blood for HBV and HIV serological status as soon as feasible and upon consent
- Post-exposure vaccination when medically indicated, as recommended by the USPHS
- Counselling, if necessary
- Evaluation of reported illnesses

4.9.4 Any and all follow-up recommendations offered by the physician will be immediately instituted by the SH&E Manager with the guidance of the Occupational Health Manager and/or the local medical provider and at no cost to the affected Employee. Repeat testing, counselling, and follow-up, if recommended, will also be provided at no cost to the Employee. AECOM will rely on the Occupational Health Manager and/or the local medical provider to provide counselling to Employees concerning infection status, including results of and interpretation of medical tests and advising the Employee about the protection of personal contacts.

4.9.5 All medical providers shall submit to AECOM's Occupational Health Manager and the affected Employee a written opinion of the post-exposure evaluation within 15 days of the completion of the evaluation.

4.9.6 All medical records generated as a result of the post-exposure evaluation will be retained in the office of the Occupational Health Manager, and as applicable AECOM's medical services provider, under lock and key and will be maintained with the strictest confidentiality. Refer to *S3AM-017-PR1 Injury & Illness Recordkeeping.*

4.10 Hepatitis Vaccination

4.10.1 Prior to performing site visits or field investigations where regulated wastes are stored, processed, or known to have been disposed of, AECOM will consult with the Occupational Health Manager and/or the local medical providers to determine if a hepatitis A or B vaccination is appropriate given the site conditions and the proposed scope of work. Where possible the first Hepatitis B vaccinations will be given prior to working at sites with known, potential occupational exposures.

4.10.2 Although AECOM does offer first-aid and CPR training to its Employees on a regular basis, providing such aid is often voluntary and not as a specified job duty of an Employee. As such, potential exposures may not be considered occupational within the context of the government Bloodborne Pathogens Standard. Pre-exposure hepatitis vaccinations will not typically be offered for voluntary roles.

4.10.3 Post-exposure hepatitis vaccination will be offered to Employees involved in an exposure incident within 24 hours of possible exposure.

4.10.4 The vaccinations discussed above shall be provided to Employees at no cost if required by the exposure determination.

4.11 Housekeeping

4.11.1 Other than through the provision of first aid or CPR, there is no potential for occupational exposure to blood or other potentially infectious materials within any of the AECOM offices. Therefore, the housekeeping requirements and requirements for warning signs and labels contained in the OSHA Bloodborne Pathogens standard are not applicable to our office operations.

4.11.2 When working at a site where regulated wastes have been disposed of, the specific housekeeping and warning sign requirements will be prescribed by the client and/or in the site-specific HASP.

4.11.3 When working at a client's facility, AECOM will review the facilities plan for compliance with all the requirements of the Bloodborne Pathogens Standard and will observe all housekeeping requirements, wear required PPE, and acknowledge all warning signs and labels as specified in the client's plan. If the client does not have an effective plan, AECOM will prepare a plan as part of the written Exposure Control Plan.

4.12 Regulated Waste Generated by AECOM

4.12.1 Any regulated waste generated by AECOM as a result of first aid activities or clean-up of potentially infectious material will be collected in sealed, watertight containers and disposed of according to the Host Employer's BBP program or disposed of through a permitted regulated waste facility.

4.12.2 Disposal manifests shall be maintained in accordance with local or governmental regulations.

4.13 Material Decontamination

4.13.1 Any areas or equipment that are contaminated by potentially infectious material will be decontaminated using a 10% solution of household bleach. Utilize appropriate personal protective equipment to control exposure to the bleach (e.g. safety goggles, gloves, etc.). Refer to *S3AM-208-PR1 Personal Protective Equipment*.

4.14 Procedure and Plan Review

4.14.1 All Exposure Control Plans for projects or programs extending over one year shall be reviewed annually by the SH&E Manager and affected Employees.

5.0 Records

5.1 Each SH&E Manager will maintain records and provide copies of the records to the Occupational Health Manager, related to bloodborne pathogens in accordance with the provisions of the standard and *S3AM-017-PR1 Injury & Illness Recordkeeping.*

5.2 Records maintained in accordance will include bloodborne pathogens exposure incidents, post-exposure follow-up, vaccination status, and training for all Employees with potential occupational exposure.

5.3 Employee medical and training records required by this procedure shall be provided upon request for examination and copying to the Employee, to anyone having written consent of the subject employee, or to State, Province, or Federal Occupational Safety and Health regulatory agencies.

6.0 Attachments

6.1 S3AM-111-ATT1 Bloodborne Pathogens Exposure Control Plan

6.2 S3AM-111-FM1 Hepatitis B Vaccination Declination

Americas

Cold Stress

S3NA-112-PR1

1.0 Purpose and Scope

1.1 To protect employees from the severest effects of cold stress (hypothermia) and cold injury and to identify exposures to cold working conditions under which it is believed nearly all employees can be repeatedly exposed without adverse health effects.

1.2 This procedure applies to all AECOM Americas based employees and operations working outdoors in damp and cool (below 50 degrees Fahrenheit [°F] or 10 degrees Celsius [°C]) conditions or anytime temperatures are below 32°F or 0°C.

2.0 Terms and Definitions

2.1 **Cold Stress** – The production of physiological effects due to cold temperatures and\or wind chill.

2.2 **Equivalent Chill Temperature (ECT)** – Also known as Wind Chill (see below).

2.3 **Frostnip** – Superficial cooling of tissues without cellular destruction.

2.4 **Frostbite –** Freezing of tissue, resulting in tissue destruction.

2.5 **Hypothermia –** Condition of reduced core body temperature to 95^{o}F (35^{o}C) resulting in loss of dexterity, loss of mental alertness, collapse, and possible death.

2.6 **Wind Chill –** The combined effect of air temperature and wind. Also expressed as "equivalent chill temperature" (ECT), wind chill is defined as heat loss resulting from the effects of air temperature and wind velocity upon exposed skin.

3.0 References

3.1 S3NA-003-PR1 SH&E Training

3.2 S3NA-128-PR1 Medical Screening & Surveillance Program

3.3 S3NA-208-PR1 Personal Protective Equipment

3.4 S3NA-314-PR1 Working Alone

3.5 S3NA-315-PR1 Working On or Near Water

3.6 S3NA-333-PR1 Marine Safety & Vessel Operations

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Manager**

- Ensuring the safety of employees on their project sites, consistent with regulatory standards.
- Implement cold stress prevention measures as applicable at each work site.
- Develop/coordinate a work-warning regimen, as applicable.
- Confirm cold stress hazard assessments/evaluations were completed for the planned activities.
- Assign employees physically capable of performing the assigned tasks. Consider acclimation to cold weather when evaluating employee capability.
- Confirm employees are properly trained to recognize the symptoms of cold stress.

4.1.2 **Safety, Health and Environment (SH&E) Manager**

- Conduct/support cold stress assessments/evaluations.
- Conduct/support incident investigations related to potential cold stress-related illnesses.
- Assist project teams develop appropriate work-warming regimens.
- Provide cold stress awareness training.

4.1.3 **Supervisor**

- Identify the tasks that may be most impacted by cold stress and communicate the hazard to the assigned employees.
- Confirm that employees have been trained on the recognition of cold stress-related illnesses.
- Confirm that adequate supplies of warm fluids/drinks are readily available to employees.
- Confirm that a warm/sheltered rest area is available, as applicable.
- Conduct cold stress monitoring, as applicable.
- Implement the work-warming regimen.
- Confirm that first aid measures are implemented once cold stress symptoms are identified.
- Confirm that employees are physically capable of performing the assigned tasks and are not in a physically compromised condition.

4.1.4 **Employee**

- Observe each other for the early symptoms of cold stress-related illnesses.
- Maintain an adequate intake of available fluids.
- Report to work in a properly rested condition.
- Report all suspected cold stress-related illnesses.

4.2 Requirements

4.2.1 Carefully plan work anticipated to be performed in cool or cold conditions. If possible, heavy work should be scheduled during the warmer parts of the day or when the wind is most calm. Include costs in project budgets for specialized equipment and supplies needed to complete the field activities.

4.2.2 Staff working in extreme cold (wind chill or ECT below 10^{o}F or -12^{o}C) shall not work alone. The Buddy System shall be utilized to keep an eye on each other and to watch for signs of cold stress. Refer to *S3NA-314-PR1 Working Alone*. Watch for symptoms and signs of hypothermia

4.2.3 Monitor weather forecasts and weather conditions such as ambient temperature, wind speed, and precipitation. Use observations prior to entering and while in the field to ensure appropriate protections are in place:

- If possible, move the work to a warm location.
- If possible and as applicable, erect shelters or screens around the work area.
- If possible, heat the work area.
- If possible, adjust schedule according to the cold conditions, work level and worker acclimatization.
- Implement a work-warming regimen by taking breaks out of the cold. As applicable, consult *S3NA-112 ATT1 Temperature Thresholds* to determine wind chill and work-warming schedule.
- Take frequent short breaks in warm dry shelters to allow your body to warm up. Limit time of exposure to the cold. If shelter is not readily available, consider supplying temporary shelters.

- Provide assistance to prevent body heat loss, such as:
    - Providing appropriate sources of heat (e.g. warm packs, portable heaters, etc.).
    - Use of insulating materials on equipment handles when temperatures drop below 30°F (-1°C).

4.2.4 All staff working in extreme cold or snow conditions should understand the following guidelines for preventing and detecting hypothermia and frostbite; refer to *S3NA-112-ATT2 Symptoms & Treatment*:

- Ensure appropriate PPE requirements are established and adhered to.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Because prolonged exposure to cold air or to immersion in cold water at temperatures even well above freezing can lead to dangerous hypothermia, whole-body protection shall be used.
- Eat high calorie snacks to help maintain body metabolism.
- Confirm extra blankets or sleeping bags are on-site.
- Drink plenty of warm liquids. It is easy to become dehydrated in cold weather.
- Avoid caffeine and alcohol, which can act as diuretics. Alcohol consumption, depending upon quantity, can dilate blood vessels enhancing body heat loss or constrict blood vessels decreasing heat delivery to extremities.
- NEVER IGNORE SHIVERING. Persistent or violent shivering is a clear warning that you are on the verge of hypothermia.
- If you experience frost bite or hypothermia, find shelter and warmth and contact a medical practitioner if symptoms persist, refer to *S3NA-128-PR1 Medical Screening & Surveillance*.

4.3 Training

Before they begin work in a cold environment, employees that might be exposed to cold stress will be informed of the potential for cold stress and how to prevent cold stress. Employees that have not had the training within the twelve prior months shall repeat the training before exposure to cold stress, refer to *S3NA-003-PR1 SH&E Training*. Employees potentially exposed to cold stress will receive training including, but not limited to:

4.3.1 Sources of cold stress, the influence of protective clothing, and the importance of acclimatization.

4.3.2 How the body loses heat.

4.3.3 Recognition of cold-related illness symptoms.

4.3.4 Cold stress preventative/corrective measures including, but not limited to:

- Weather monitoring.
- Proper eating and drinking practices.
- Work-warming schedules and proper re-warming techniques.
- Buddy system.
- Safe cold work practices appropriate to the work that is to be performed.
- Proper use of cold environment personal protective clothing.

4.3.5 The harmful effects of excessive alcohol consumption in a cold stress environment.

4.3.6 The hazards associated with unstable snow or ice build ups.

4.3.7 First aid procedures for symptoms related to cold stress.

4.4 Personal Protective Equipment (PPE)

Wearing the right clothing is crucial to avoiding cold stress. The type of fabric also makes a difference. Cotton loses its insulation value when it becomes wet. Wool, on the other hand, retains its insulation even when wet. Adequate insulating dry clothing will be required in air or wind chill temperatures below 40 °F (4.4°C)

All PPE will comply with the requirements of *S3NA-208-PR1 Personal Protective Equipment* and consider the following requirements:

4.4.1 Wear at least 3 layers of clothing to help prevent cold stress. It is important to preserve the air space between the body and the outer layer of clothing to retain body heat.

- Wear a middle layer of down, wool, or similar materials to provide insulation.
- Avoid cotton, especially blue jeans.
- Wear an outer layer to break the wind and allow some ventilation (e.g., Gortex® or nylon)
- Do not wear tight clothing. Loose clothing allows better ventilation.

4.4.2 Wear proper clothing, including head coverings and gloves or mittens for cold, wet, and windy conditions.

4.4.3 Wear a hat or hardhat liner. Up to 40 percent of body heat can be lost when the head is left exposed.

4.4.4 Use insulated footwear with adequate traction to prevent slips and falls.

4.4.5 Wear insulated boots or other insulated footwear, and insulated gloves to help reduce the chance of frostbite.

4.4.6 Keep a change of dry clothing available in case work clothes become wet.

4.4.7 Eye and face protection for employees employed outdoors in a snow and/or ice-covered terrain should be supplied.

- Sunglasses (with UVA and UVB protection) and sunscreen should be used when there is a persistent combination of snow and direct sun.
- Special safety goggles to protect against blowing ice crystals and ultraviolet light and glare (which can produce temporary conjunctivitis and/or temporary loss of vision) should be required when there is an expanse of snow coverage causing a potential eye exposure hazard.
- Ensure face guards are used to protect skin in cold, windy conditions, including riding on an unshielded vehicle.

4.5 General Cold Stress Prevention Measures

4.5.1 In order to prevent hypothermia:

- Wear appropriate clothing and PPE as determined by the weather conditions.
- When active, ventilate excess heat by opening or removing outer layers of clothing to avoid sweating.
    - Start with the mitten or gloves, unless protection from ice, snow, or cold metal surfaces is needed.
    - Next remove head gear and neck wrappings.
    - Then coats/parkas should be opened at the waist and sleeves.
    - Finally, layers of clothing should be taken off.
    - When resting or tired, or colder conditions are encountered, add additional layers of clothing/ close outer layers in the reverse of the above order, or get out of the cold. Have a sweet drink but do not indulge in heavy eating.

- Garments worn to keep out rain and spray should also allow water vapor to escape.
- Take advantage of heat from the sun and stay out of the wind as much as possible.
- Have available emergency shelter providing protection from wind and rain and insulation from the ground.
- Replace wet clothing. If wet clothing cannot be replaced, then cover it with a layer of non-breathing material to prevent evaporation. Place an insulation layer over this non-breathing material.
- Get adequate rest; conserve energy.
- Get adequate nutrition to replenish energy stores; rest after meals.
- Drink adequate fluids to avoid dehydration.
- If any project / location staff member shows signs of hypothermia, stop and treat him/her.

4.5.2 In order to prevent frost bite:

- Dress to prevent hypothermia and protect the feet and hands.
- Avoid obstruction of circulation by, for example, tight boots or tightly fitting clothing.
- Avoid nicotine (particularly cigarettes) and do not consume alcohol.
- Keep ears and nose covered and out of the wind.
- Frostbite of the corneas of the eyes can be prevented by protective goggles.
- Adopt a “buddy system” of constantly watching the faces of others in the party for white skin tissue, which is evidence of frostbite (frostnip).
- Practice constant personal vigilance for signs of trouble in one’s own fingers and toes; when in doubt, investigate thoroughly before it is too late.

4.5.3 Adequate, insulating dry clothing that will help maintain core temperatures above 96.8°F (37°C) shall be provided to employees if work is performed in air temperatures below 40°F (4.4°C). Wind chill cooling rate and the cooling power of air are critical factors. The higher the wind speed and the lower the temperature in the work area, the greater the insulation value of the protective clothing required.

4.5.4 An Equivalent Chill Temperature (ECT) chart relating the actual dry bulb air temperature and the wind velocity is presented in *S3NA-112-ATT1 Temperature Thresholds*. Unless unusual or extenuating circumstances exist, cold injury to other than hands, feet, and head is not likely to occur without the development of the initial signs of hypothermia. Superficial or deep local tissue freezing will occur only at temperatures below 32°F (0°C) regardless of wind speed. However, older employees, those with circulatory problems and those with previous cold injuries require special precautionary protection against cold injury. The use of extra insulating clothing and/or a reduction in the duration of the exposure period are among the special precautions that should be considered.

4.5.5 Continuous exposure of skin should not be permitted when the air speed and temperature results in an ECT of –25°F (-32°C) or below.

4.5.6 At air temperatures of 40°F (4.4°C) or less, it is imperative that employees who become immersed in water or whose clothing becomes wet be immediately removed from the cold environment, provided a change of clothing, and be treated for hypothermia.

4.5.7 If the air velocity at the job site is increased by wind, draft, or artificial ventilating equipment, the cooling effect of the wind should be reduced by shielding the work area or by wearing an easily removable windbreak garment.

4.5.8 Adequate protection, such as general ventilation, shall be incorporated into any warming shelter design to prevent carbon monoxide poisoning.

4.5.9 Operation of internal combustion or similar devices within warming shelters is prohibited.

4.5.10 If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work should be modified or suspended until adequate clothing is made available or until weather conditions improve.

4.5.11 Walking and working surfaces shall be cleared of ice and snow to prevent slips and falls.

4.5.12 Confirm that employees carry fire starter materials if working in remote areas.

4.5.13 Supplies such as PPE, fuels, enclosures, de-icing, traction aids, warm drinks, and batteries will be specified by the SH&E Manager and/or the Manager and made available. These supplies will be inspected at least weekly during cold weather projects and replaced when necessary.

4.6 Cold Stress Prevention Measures for the Hands

4.6.1 Special protection of the hands is required to maintain manual dexterity for the prevention of accidents including, but not limited to the following:

- If fine work is to be performed with bare hands for more than 10 to 20 minutes in an environment below 60^{o}F (15^{o}C), special provisions should be established for keeping the employees' hands warm. For this purpose, warm air jets, radiant heaters (fuel burner or electric radiator), or contact warm plates may be utilized. Metal handles of tools and control bars should be covered by thermal insulating material at temperatures below 30^{o}F (-1^{o} C).
- If the air temperature falls below 60^{o}F (15^{o}C) for sedentary work, 40^{o}F (4.4^{o} C) for light work, or 20^{o}F (-6^{o}C) for moderate work, and fine manual dexterity is not required, employees should use gloves.

4.6.2 To prevent contact frostbite, employees should wear anti-contact gloves:

- When cold surfaces below 20°F (-6°C) are within reach, each employee should be warned to prevent inadvertent contact by bare skin.
- If the air temperature is 0°F (-18°C) or less, employees should protect their hands with mittens or appropriate gloves. Machine controls and tools for use in cold conditions should be designed so that they can be handled without removing the mittens or gloves.
- Ensure an adequate supply of dry gloves is available to replace wet gloves.

4.6.3 Provisions for additional total body protection are required if work is performed in an environment at or below 40^{o}F (4.4^{o}C). The employees should wear cold protective clothing appropriate for the level of cold and physical activity.

4.6.4 Additional Cold Stress Prevention Measures:

For work practices at or below 10^{o}F (-12^{o}C) ECT, the following will apply:

- The employee should be under constant protective observation (buddy system or supervision).
- The work rate should not be so high as to cause heavy sweating that will result in wet clothing. If heavy work is being performed, rest periods should be taken in heated shelters and opportunities to change into dry clothing should be provided.
- New employees should not be required to work full time in the cold during the first days of employment until they become acclimated to the working conditions and required protective clothing. Refer to *S3NA-112-ATT1 Temperature Thresholds* for guidance.
- The weight and bulkiness of clothing should be included in estimating the required work performance and weights to be lifted by the employee.
- The work should be arranged in such a way that sitting still or standing still for long periods is minimized. Unprotected metal chair seats should not be used. The employee should be protected from drafts to the greatest extent possible.

4.6.5 Employees handling evaporative liquid (gasoline, alcohol, or cleaning fluids) at air temperatures below 40°F should take special precautions to avoid soaking of clothing or gloves with the liquids because of the added danger of cold injury due to evaporative cooling. Special note should be taken of the particularly acute effects of splashes of "cryogenic fluids" or those liquids with a boiling point that is just above ambient temperature.

4.6.6 Trauma sustained in freezing or subzero conditions requires special attention, because an injured employee is predisposed to cold injury. Special provisions should be made to prevent hypothermia and freezing of damaged tissue in addition to providing for first aid treatment.

4.7 Hypothermia in Water

4.7.1 Loss of body heat heat to the water is a major cause of deaths in boating and working near water incidents. Often the cause of death is listed as drowning; however, the primary cause is often hypothermia. It should also be noted that alcohol lowers the body temperature around 2 to 3 degrees by dilating the blood vessels. Do not drink alcohol around cold water. The following table shows the effects of hypothermia in water:

WATER TEMPERATURE		EXHAUSTION	SURVIVAL TIME
32.5°F	(0°C)	Under 15 minutes	Under 15 to 45 minutes
32.5 to 40°F	(0 to 4°C)	15 to 30 minutes	30 to 90 minutes
40 to 50°F	(4 to 10°C)	30 to 60 minutes	1 to 3 hours
50 to 60°F	(10 to 16°C)	1 to 2 hours	1 to 6 hours
60 to 70°F	(16 to 21°C)	2 to 7 hours	2 to 40 hours
70 to 80°F	(21 to 27°C)	3 to 12 hours	3 hours to indefinite
Over 80°F	(27°C)	Indefinite	Indefinite

4.7.2 Some points to remember when water is a potential hazard:

- Wear a personal flotation device when drowning is a potential hazard. Refer to *S3NA-315-PR1 Working On or Near Water*, and *S3NA-333-PR1 Marine Safety & Vessel Operations*.
- If the water is less than 50°F (10°C), wear a wet suit or dry suit for work in water (e.g., wading, or if a significant potential to fall in water exists).
- While in the water, do not attempt to swim unless to reach nearby safety. Unnecessary swimming increases the rate of body heat loss. Keep the head out of the water. This will increase survival time.
- Keep a positive attitude about rescue. This will increase chances of survival.
- If there is more than one person in the water, huddling is recommended to conserve body heat.

4.7.3 If an employee or equipment is to work on ice and the water beneath the ice is or may be more than 3¼ feet (1m) deep at any point:

- Test the ice prior to commencing to ensure it will support the load to be placed on it. Ongoing testing may be necessary.
- If there is any risk of falling through the ice employees must wear personal protective equipment that will ensure buoyancy and protect against hypothermia at all times while on the ice.

4.8 Work-Warming Regimen

4.8.1 If work is performed continuously in the cold at an equivalent chill temperature (ECT) at or below 19°F (–7°C), heated warming shelters (tents, cabins, rest rooms, etc.) should be made available nearby. The employees should be encouraged to use these shelters at regular intervals; the frequency will depend on the severity of the environmental exposure. Refer to *S3NA-112-ATT1 Temperature Thresholds* for guidance.

4.8.2 The onset of heavy shivering, minor frostbite (frostnip), the feeling of excessive fatigue, drowsiness, irritability, or euphoria are indications for immediate return to the shelter.

4.8.3 When entering the heated shelter, the outer layer of clothing should be removed and the remainder of the clothing should be loosened to permit sweat evaporation or a change of dry work clothing provided.

4.8.4 A change of dry work clothing should be provided as necessary to prevent employees from returning to the cold environment with wet clothing.

5.0 Records

5.1 Exposure assessments will be documented in the location's files.

6.0 Attachments

6.1 S3NA-112-ATT1 Temperature Thresholds

6.2 S3NA-112-ATT2 Symptoms & Treatment

Americas

Heat Stress

S3AM-113-PR1

1.0 Purpose and Scope

1.1 Establishes a Heat Illness Prevention Program to guide employees in preventing heat illness, recognition of the symptoms of heat stress-related illnesses and in taking the appropriate corrective action.

1.2 This procedure applies to all AECOM Americas-based employees and operations.

2.0 Terms and Definitions

2.1 **Acclimated –** Employees who have developed physiological adaptation to hot environments characterized by increased sweating efficiency, circulation stability, and tolerance of high temperatures without stress. Acclimatization occurs after 7 to 10 consecutive days of exposure to heat and much of its benefit may be lost if exposure to hot environments is discontinued for a week.

2.2 **Chemical Protective Clothing (CPC)** – Apparel that is constructed of relatively impermeable materials intended to act as a barrier to physical contact of the Employee with potentially hazardous materials in the workplace. Such materials include Tyvek® coveralls (all types) and polyvinyl chloride coveralls and rain suits.

2.3 **Heat Cramps** – A form of heat stress brought on by profuse sweating and the resultant loss of salt from the body.

2.4 **Heat Exhaustion** – A form of heat stress brought about by the pooling of blood in the vessels of the skin and in the extremities.

2.5 **Heat Rash** – A heat-induced condition characterized by a red, bumpy rash with severe itching.

2.6 **Heat Stress** – The combination of environmental and physical work factors that constitute the total heat load imposed on the body.

2.7 **Heat Stroke** – The most serious form of heat stress, which involves a profound disturbance of the body's heat-regulating mechanism.

2.8 **Sunburn** – Caused by unprotected exposure to ultraviolet radiation present in sunlight that is damaging to the skin (Refer to *S3AM-121-PR1 Non-Ionizing Radiation*). The injury is characterized by red painful skin, blisters, and/or peeling.

2.9 **Unacclimated** – Employees who have not been exposed to hot work conditions for one week or more or who have become heat-intolerant due to illness or other reasons.

3.0 References

3.1 S3AM-003-PR1 SH&E Training

3.2 S3AM-004-PR1 Incident Reporting, Notifications & Investigation

3.3 S3AM-010-PR1 Emergency Response Planning

3.4 S3AM-121-PR1 Non-Ionizing Radiation

3.5 S3AM-208-PR1 Personal Protective Equipment

3.6 S3AM-209-PR1 Risk Assessment & Management

4.0 Procedures

4.1 Roles and Responsibilities

4.1.1 Managers

- Evaluate the need for heat illness prevention measures and incorporate as appropriate into the Safe Work Plan or Task Hazard Analysis.
- Allocate sufficient resources for the management of heat illness in the field including the provision of water, a shaded break area, and sufficient schedule to allow for breaks.

4.1.2 Safety, Health and Environment (SH&E) Manager

- Provide heat illness awareness training.
- Assist in developing appropriate work-rest schedules.
- Conduct/support incident investigations related to potential heat stress-related illnesses.

4.1.3 Supervisor

- Identify those tasks that may be most impacted by heat stress and communicate the hazard to the assigned Employees.
- Confirm that Employees have been trained on the recognition of heat illness.
- Confirm that this procedure, along with any applicable Safe Work Plan and/or Task Hazard Analysis (and heat exposure control plan that may be contained therein) are made available to affected Employees.
- Confirm that adequate supplies of appropriate fluids are readily available to Employees.
- Confirm that a proper rest area is available.
- Conduct heat illness monitoring, as applicable.
- Implement the work-rest schedule.
- Confirm that first aid measures are implemented once heat stress symptoms are identified.
- Confirm personnel are physically capable of performing the assigned tasks and are not in a physically compromised condition.
- Report all suspected heat illnesses.

4.1.4 Employee

- Observe each other for the early symptoms of heat illnesses.
- Maintain an adequate intake of available fluids.
- Be familiar with heat stress hazards, predisposing factors, and preventative measures.
- Report to work in a properly vested and hydrated condition.
- Report all suspected heat stress-related illnesses.

4.2 Restrictions

4.2.1 The Buddy System is required when working in high heat conditions; Employees shall not work alone.

4.2.2 Employees shall not be exposed to levels exceeding those specified for the given work level and work-rest regimen as listed in *S3AM-113-ATT1 Temperature Thresholds*.

4.2.3 Clothing corrections shall be applied in accordance with the tables provided in *S3AM-113-ATT1 Temperature Thresholds*.

4.3 Exposure Controls

4.3.1 It shall be determined whether Employees are or may be exposed to hazardous heat levels. The Supervisor shall:

- Conduct a heat stress assessment to determine the potential for hazardous exposure of Employees. Assessment shall include, but not limited to:
  - Ambient temperature.
  - Amount of sunshine (cloudy, clear). Refer to *S3AM-121-PR1 Non-Ionizing Radiation* additional direction concerning ultraviolet radiation exposures.
  - Other radiant heat sources (e.g. motor, fire, etc.).
  - Humidity.
  - Air flow.
  - Amount or type of physical labor being performed,
  - Physical condition of the Employees (e.g., acclimated/not)
  - Protective clothing in use.
  - Referral to *S3AM-113-ATT1 Temperature Thresholds* to assist in determining whether hazardous heat exposures may exist.
- If potential for hazardous exposure is identified, the Supervisor shall develop and implement a heat stress exposure control plan within the Safe Work Plan and/or Task Hazard Analysis. Refer to *S3AM-209-PR1 Risk Assessment & Management.*

4.3.2 If Employees are or may be exposed, the Supervisor shall implement engineering controls (e.g., shelters, cooling devises, etc.) to reduce the exposure of Employees to levels below those specified for the given work level and work-rest regimen as listed in *S3AM-113-ATT1 Temperature Thresholds*.

4.3.3 If engineering controls are not practicable, the Supervisor shall reduce the exposure of Employees to levels below those listed in *S3AM-113-ATT1 Temperature Thresholds* by providing administrative controls, including a work-rest cycle or personal protective equipment, if the equipment provides protection equally effective as administrative controls.

4.3.4 If Employees are or may be exposed, the Supervisor shall provide and maintain an adequate supply of cool, fresh, potable water close to the work area for the use of a heat exposed Employee. Water shall be provided (paid) by the project or program; if Employees purchase their own drinking water because water is not otherwise available on site, they shall be reimbursed.

4.3.5 If an Employee shows signs or reports symptoms of heat stress or strain, they shall be removed from the hot environment and treated by an appropriate first aid attendant on site, if available, or by a physician, refer to *S3AM-113-ATT2 Symptoms & Treatment* for more specifics.

4.4 Heat Stress Planning

4.4.1 Heat stress can be a significant site hazard, especially for Employees wearing CPC. To prepare for emergency response planning, refer to *S3AM-010-PR1 Emergency Response Planning* procedure.

4.4.2 The project and site specific risks need to be planned using the SH&E Plan and the Task Hazard Assessments (THA). Refer to the *S3AM-209-PR1 Risk Assessment & Management* procedure.

4.4.3 The heat a worker is exposed to may be a combination of air temperature, radiant heat, and humidity. The WBGT (wet-bulb globe thermometer) is a useful index of the environmental contribution to heat stress. Because WBGT is only an index of the environment, the contributions of

work demands, clothing, and state of acclimatization shall also be accounted for, as described in the following steps.

- Monitor ambient temperatures and conduct heat stress monitoring in accordance with the location specific SH&E Plan. Revise the heat stress monitoring and controls if there are any reports of discomfort due to heat stress.
- Monitor temperatures in each unique environment in which workers perform work (e.g., take WBGT measurements inside truck cabs for truck drivers, and take separate WBGT measurements in the outdoor area where field employees work, etc.). Follow manufacturer's instructions on proper use of the WBGT.
- Determine if individual workers are acclimatized or un-acclimatized. Full heat acclimatization requires up to 3 weeks of continued physical activity under heat-stress conditions similar to those anticipated for the work. Its loss begins when the activity under those heat-stress conditions is discontinued, or when there is a sustained increase in temperatures of 10 °F (5.6 °C) or more, and a noticeable loss occurs after 4 days. A worker can be considered acclimatized for the purpose of this procedure when they have been exposed to the site conditions (including level of activity) for 5 of the last 7 days.
- Determine the approximate workload of each worker or group of workers. The following examples (Table 1) can be used for comparison:

Table 1
Examples of Activities within Workload Categories

Categories	Example Activities
Resting	Sitting quietly
	Sitting with moderate arm movements
Light	Sitting with moderate arm and leg movements
	Standing with light work at machine or bench while using mostly arms
	Using a table saw
	Standing with light or moderate work at machine or bench and some walking about
Moderate	Scrubbing in a standing position
	Walking about with moderate lifting or pushing
	Walking on level at 3.5 miles/hr (6 km/hr) while carrying 6.6 lbs (3kg) weight load
Heavy	Carpenter sawing by hand
	Shoveling dry sand
	Heavy assembly work on a non-continuous basis
	Intermittent heavy lifting with pushing or pulling (e.g., pick-and-shovel work)
Very Heavy	Shoveling wet sand

- Determine the approximate proportion of work within an hour during a typical shift. Typically, the initial work schedule will be 60 minutes of work per hour (100 percent work) with a small break in the morning and afternoon, as appropriate, and a 30-minute lunch break mid-day.
- For workers wearing cloth coveralls (e.g., Nomex fire resistant clothing), add 3 to the measured WBGT. For impermeable clothing, such as Tyvek or Saranex, the WBGT procedures cannot be used. For these situations, workers should begin physiological monitoring as soon as the temperature in the work area exceeds 70ºF (21°C).
- Use the collected information to develop appropriate work to rest schedules as detailed in *S3AM-113-ATT1 Temperature Threshold*.

4.4.4 Given the work demands (light, moderate, heavy or very heavy), heat of the work environment, and such aspects as PPE in use, workload will be adjusted appropriately to allow for proper acclimation.

- This is the process by which the body "gets used to" hot work environments. This is achieved by slowly increasing workloads.
- New and returning Employees (absent one week or more) who have not had time to acclimatize may be more susceptible to heat related illnesses, even in seemingly low risk heat exposures.
- All Employees shall be allowed time to acclimatize in the event of a heat wave. All Employees assigned to a new process with additional heat exposures shall be allowed to acclimatize.
- Minimize workload and gradually increase as tolerance is built up. Allow for more frequent breaks.
- While acclimatization normally takes approximately 5 to 7 days, heightened monitoring of these Employees will be maintained for the first 14 days.

4.4.5 Employees shall be instructed in the recognition of heat stress symptoms, the first aid treatment procedures for severe heat stress, and the prevention of heat stress injuries. Employees shall be encouraged to immediately report any heat stress that they may experience or observe in fellow Employees. Supervisors shall use such information to adjust the work-rest schedule to accommodate such problems.

4.4.6 Wherever possible, a designated break area should be established in an air conditioned space, or in shaded areas where air conditioning is impractical. The break area should be equipped to allow Employees to loosen or remove protective clothing, and sufficient seating should be available for all Employees. During breaks, Employees shall be encouraged to drink plenty of water or other liquids, even if not thirsty, to replace lost fluids and to help cool off. Cool water should be available at all times in the break area, and in the work area itself unless hygiene/chemical exposure issues prevent it.

4.5 Symptoms and Treatment

4.5.1 Refer to *S3AM-113-ATT2 Symptoms & Treatment*.

4.5.2 Employees who exhibit ANY signs of significant heat stress (e.g., profuse sweating, confusion and irritability, pale, clammy skin) shall be relieved of all duties at once, made to rest in a cool location, and provided with large amounts of cool water.

4.5.3 Anyone exhibiting symptoms of heat stroke (red dry skin, or unconsciousness) shall be taken immediately to the nearest medical facility. Steps shall be taken to cool the person during transportation (clothing removal, wet the skin, air conditioning, etc.).

4.5.4 Severe heat stress (heat stroke) is a life-threatening condition that shall be treated by a competent medical authority.

4.6 Prevention

4.6.1 Requirements for working in extreme heat may be triggered by a regulatory established criteria (e.g. CAL/OSHA requires high heat procedures when temperature equals or exceeds 95°F) or as a result of a hazard analysis assessing various contributory factors (refer to *S3AM-113-ATT1 Temperature Thresholds*). Employees working in extreme heat or sun should understand and apply the following guidelines for preventing and detecting heat exhaustion and heat stroke.

- When possible, begin hydrating at least three days prior to working in high heat conditions.
- Review the heat stress exposure control plan within the Safe Work Plan and/or Task Hazard Analysis.
- If the supervisor is not immediately available confirm a reliable method of communication is in place to allow for contact with supervision. In the absence of cellular reception a satellite phone or similar device may be required.

- Take frequent short breaks in areas sheltered from direct sunlight; eat and drink small amounts frequently.
- Try to schedule work for the coolest part of the day, early morning and evening.
- Avoid strenuous physical activity outdoors during the hottest part of the day.
- Avoid sudden changes of temperature. Refer *to S3AM-113-ATT1 Temperature Thresholds*.
- Air out a hot vehicle before getting into it.
- Obtain medical direction if taking diuretics during hot weather (a lower dose may be necessary).
- When working in heat, drink 1 quart of water per hour of work.
- Avoid caffeine and alcohol as they increase dehydration.
- Monitor urine frequency and color to detect dehydration. Refer to the *S3AM-113-ATT3 Dehydration Chart.*
- The Buddy System is required when working in high heat conditions to enable effective communication and cross-observation for indications of heat stress.
- Initiate emergency response procedures when necessary, including contacting emergency medical services as appropriate and in accordance with the Emergency Response Plan.

4.6.2 Personal Protective Equipment

- Review the *S3AM-208-PR1 Personal Protective Equipment* procedure.
- Wear a hat and light-colored, loose-fitting clothing to reflect the sun.
- Apply sunscreen to exposed skin (SPF 30 or greater, follow directions on label).
- Wear sunglasses with UV protection.
- Pack extra water to avoid dehydration (try freezing water in bottles overnight to help keep the water cooler for longer during the day).

4.7 Work-Rest Schedule Practices

4.7.1 Intake of fluid will be increased beyond that which satisfies thirst, and it is important to avoid "fluid debt," which will not be made up as long as the individual is sweating.

- Two 8-ounce glasses of water should be taken prior to beginning work, then up to 32 ounces (1 quart) per hour during the work shift; fluid replacement at frequent intervals is most effective.
- The best fluid to drink is water; liquids like coffee or soda do not provide efficient hydration and may increase loss of water.
- If commercial electrolyte drinks (e.g., Gatorade) are used, the drink should be diluted with water, or 8 ounces of water should be taken with each 8 ounces of electrolyte beverage.

4.7.2 Additional salt is usually not needed and salt tablets should not be taken.

4.7.3 Replacement fluids should be cool and fresh, but not cold.

4.7.4 Breaks will be taken in a cool, shaded location, and any impermeable clothing should be opened or removed.

- A relatively cool, shaded area shall be provided for breaks when working in hot environments. For hazardous waste sites, the rest area should be located in the support zone adjacent to the contamination reduction zone, situated so that part of it is in the decontamination area so workers can take breaks without going through full decontamination.

- If shade is not available, shaded areas shall be constructed. This same type of canopy can be set up to shade personnel performing various types of work in hot weather.
- Cooling measures other than shade (e.g., misting, air conditioned break areas, air conditioned vehicles, etc.) can be used in lieu of shade provided it can be demonstrated that they are at least as effective in cooling employees.
- Employees should have access to these rest areas at break times and at any other time when suffering from heat illness or believing a preventive recovery period is needed.

4.7.5 Dry clothing or towels will be available to minimize chills when taking breaks.

4.7.6 Manual labor will not be performed during breaks, other than paperwork or similar light tasks.

4.7.7 Other controls that may be used include:

- Scheduling work at night or during the cooler parts of the day (6 am–10 am, 3 pm–7 pm).
- Erecting a cover or partition to shade the work area.
- Auxiliary cooling - wearing cooling devices beneath protective garments, but over any underclothing.
  - If cooling devices are worn, only physiological monitoring will be used to determine work activity.
  - These vests typically provide cooling via one of two methods: the use of ice or other frozen media, or the use of a vortex cooler. Each method has its advantages and disadvantages.
  - The frozen media vest requires a means for freezing the media, and the media (usually water or "blue ice") will melt, requiring replacement.
  - The vortex cooler tends to cool more uniformly. Instead of frozen media, this vest uses the expansion of compressed air to cool the wearer. The drawback is the compressed air requirement, but this is negated when the wearer is already using an airline respirator supplied by a compressor. A vortex cooler should not be supplied from air cylinders, as this will draw down the cylinders rapidly.
- Auxiliary cooling should be considered when the following conditions exist:
  - Ambient temperature over 80°F (26°C).
  - Workers are wearing impermeable garments (i.e., Tyvek, Saranex, Chemrel, etc.).
  - It is desirable to have long work shifts with minimum interruption.

4.8 Evaluating the Work-Rest Schedule's Effectiveness

4.8.1 Once a work-rest schedule is established, the Supervisor shall continually evaluate its effectiveness through observation of Employees for signs/symptoms of heat stress. Have workers assess themselves and their body's reaction to the heat and work conditions (self-assessment), and report any signs or symptoms of heat illness. These can include nausea or dizziness, heat cramps, extreme thirst, or very dark urine.

4.8.2 Measurement or physiological monitoring of each Employee's vitals (e.g., pulse, blood pressure, and temperature) can provide additional information in determining if the schedule is adequate. Refer to *S3AM-113-ATT1 Temperature Thresholds* for additional guidance on when physiological monitoring should be conducted.

4.8.3 Frequency of physiological monitoring is increased or decreased depending upon such factors as worker fitness, acclimatization, temperature of the work environment, type of PPE, etc.

Based on the results of the physiological monitoring and on the workers' self-assessments, the work period may be adjusted as follows:

- The work period may be increased (generally, by 5- to 10-minutes intervals, up to a maximum of 4 hours) if the results of the first 2 hours of the physiological monitoring and the workers' self-assessments indicate that workers are recovering adequately (see below), and on the judgment of the SH&E Manager.
- The work period shall be decreased if the results of the physiological monitoring and the workers' self-assessment indicate that workers are NOT recovering adequately (see below).

4.8.4 If physiological monitoring is conducted, the Employee and/or the SH&E Manager (or appropriate designate) shall measure and record body temperature and pulse rate as described below.

4.8.5 Monitor body temperature to determine if Employees are adequately dissipating heat build-up. Ear probe thermometers which are adjusted to oral temperature (aural temperature) are convenient and the preferred method of measurement. Determine work/rest regimen as follows:

- Measure oral body temperature at the end of the work period. Oral body temperatures are to be obtained prior to the employee drinking water or other fluids.
- If temperature exceeds 99.6°F (37.5°C), shorten the following work period by 1/3 without changing the rest period.
- If, at the next rest period, temperature still exceeds 99.6°F (37.5°C), the worker should not be allowed to continue work until repeated temperature measurements are in the acceptable range (i.e., less than 99.6°F). Do not leave the worker alone during the recovery time. Watch for signs of heat illness and be prepared to implement emergency response as necessary.
- Do not allow a worker to wear impermeable PPE when his/her oral temperature exceeds 100.6°F (38.1°C).

4.8.6 At the start of the workday each Employee's baseline pulse rate (in beats per minute [bpm]) is determined by taking a pulse count for 15 seconds and multiplying the result by four or by using an automated pulse count device. Pulse rates can then be measured at the beginning of each break period and two minutes thereafter to determine if the rest period allows for adequate recovery.

- Take the radial (wrist) pulse as early as possible in the rest period and determine the worker's heart rate in beats per minute. The heart rate is determined by counting the pulse for ten seconds and multiplying the number by 6 to get the beats per minute. Record this as P1.
- Wait 2 minutes and repeat the pulse measurement. Record this as P2.
- If P1 is greater than or equal to 110 beats per minute (bpm) and if (P1 – P2) is less than or equal to 10 bpm (indicating that workers are not recovering adequately), shorten the next work cycle by 1/3 without changing the rest period.
- At the next rest period, if P1 is still equal to or greater than 110 bpm, and if (P1 – P2) is still less than or equal to 10 bpm, shorten the following work cycle by 1/3 without changing the rest period.
- At the third rest period, if P1 is still equal to or greater than 110 bpm and (P1 – P2) is still less than or equal to 10 bpm, the worker should not be allowed to continue work until repeated pulse measurements are in the acceptable range (i.e., P1 is less than 110 bpm and (P1 – P2) is greater than 10 bpm). Do not leave the worker alone during the recovery time. Watch for signs of heat illness and be prepared to implement emergency response as necessary.

4.8.7 Use of an automated or similar blood pressure device will be used to assess each Employee's blood pressure at the beginning and end of each break period to determine if the rest period allows adequate cooling by applying the following criteria:

- If the blood pressure of an Employee is outside of 90/60 to 150/90, then the Employee will not be allowed to begin or resume work; extend the break period by at least five minutes, at the end of which blood pressure rates will be re-measured and the end-of-break criteria again applied.

4.8.8 All physiological monitoring of heat stress will be documented using *S3AM-113-FM1 Heat Stress Monitoring Log.*

4.9 Training

4.9.1 Employees and their Supervisors that may be exposed to the hazard will be trained and oriented to the hazard and the controls prior to work commencing.

4.9.2 Those Employees, including Supervisors, potentially exposed to heat stress will receive training, refer to the *S3AM-003-PR1 SH&E Training* procedure. Training will include, but is not limited to:

- Sources of heat stress (environmental and personal), influence of protective clothing, and importance of acclimatization;
- How the body handles heat and acclimatization;
- Recognition of heat-related illness symptoms;
- Preventative/corrective measures including, but not limited to;
  - Employees will be informed of the harmful effects of excessive alcohol consumption in the prevention of heat stress.
  - All Employees will be informed of the importance of adequate rest and proper diet in the prevention of heat stress.
- First aid procedures for heat stress-related illnesses; and
- Immediate reporting of any heat-related incident (injury, illness, near-miss), refer to the *S3AM-004-PR1 Incident Reporting, Notifications & Investigation* procedure.

5.0 Records

5.1 None

6.0 Attachments

6.1 S3AM-113-ATT1 Temperature Thresholds

6.2 S3AM-113-ATT2 Symptoms & Treatment

6.3 S3AM-113-ATT3 Dehydration Chart

6.4 S3AM-113-FM1 Heat Stress Monitoring Log

Americas

Radiation

S3AM-120-PR1

1.0 Purpose and Scope

1.1 The primary aim of AECOM's Radiation Safety Program is to provide an appropriate standard of protection for employees without unduly limiting the beneficial practices that result in radiation exposure. This procedure provides AECOM requirements for:

- Limiting occupational and public exposure to ionizing radiation;
- Developing plans to control occupational exposure to radioactive materials, and
- Implementing radiological exposure assessment activities whenever employees are working with ionizing radiation or radioactive materials.

1.2 The Radiation Safety Program is intended to prevent the occurrence of deterministic effects, by keeping doses As Low As Reasonable Achievable (ALARA), and to confirm that all reasonable steps are taken to reduce the probability of stochastic effects.

1.3 This procedure applies to all AECOM Americas-based employees and operations.

1.4 Any exceptions to this procedure must be approved in writing by the Business Group Radiation Safety Officer (RSO).

2.0 Terms and Definitions

2.1 **Absorbed dose** – The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy): 1 Gy = 100 rad.

2.2 **Activity** – The rate of disintegration or transformation or decay of radioactive material. The units of activity are "disintegrations per second (or minute)" (dps or dpm), curie (Ci) and the Becquerel (Bq).

- 1 Ci = 37,000,000,000 dps (3.7 x 1010 dps)
  1 Ci = 2,220,000,000,000 dpm (2.22 x 1012 dpm)
  1 Bq = 1 dps

2.3 **Administrative Exposure Limit- (AL)** Established to support implementation of the ALARA philosophy and confirm compliance with regulations.

2.4 **Adult** – An individual 18 years of age or more.

2.5 **Agreement State** – A state that has executed an agreement with the U.S. Nuclear Regulatory Commission (NRC) transferring to the state the responsibility for regulating uses of certain radioactive materials within its borders.

2.6 **Airborne radioactive material** – Any radioactive material dispersed in the air in the form of dusts, fumes, particles, mists, vapors or gases.

2.7 **ALARA (As Low As is Reasonably Achievable)** – Means making every reasonable effort to maintain exposures to radiation as far below regulatory dose limits as is practical, consistent with the purpose for which the licensed or registered activity is undertaken, as well as activities with occupational radiation exposures, taking into account the state of technology, the economics of improvements in relation to benefits to public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of ionizing radiation.

2.8 **Background radiation** – Radiation from cosmic sources; non-technologically enhanced naturally occurring radioactive material, including radon, except as a decay product of source or special nuclear material, and including global fallout as it exists in the environment from the testing of nuclear explosive devices.

2.9 **Bioassay** – The determination of kinds, quantities, or concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement, in vivo counting, or by analysis and evaluation of materials excreted or removed from the human body.

2.10 **Business Group Radiation Safety Officer (Business Group RSO) –** The member of the Safety, Health and Environment (SH&E) Department designated by the Business Group Vice President of SH&E to manage all AECOM radiation issues related to ionizing radiation and/or radioactive materials.

2.11 **Committed Dose Equivalent** The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by a person during the 50-year period following the intake.

2.12 **Committed effective Dose Equivalent** The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues (HE,50 = SWT HT,50).

2.13 **Declared Pregnant Woman** – A woman who voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman withdraws the declaration in writing or is no longer pregnant.

2.14 **Deterministic Effects** – Health effects, the severity of which varies with the dose and for which a threshold is believed to exist.

2.15 **Derived Air Concentration (DAC)** – The concentration of a given radionuclide in air which, if breathed by Reference Man (1.2 cubic meters of air per hour) for a working year of 2,000 hours under conditions of light work, results in an intake of one annual limit of intake (ALI).

2.16 **Disintegration per Minute (dpm)** - The rate of emission by radioactive material as determined by correcting the counts per minute observed by a detector for background, efficiency, and window size associated with the instrument.

2.17 **Dose** – A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, total organ dose equivalent or total effective dose equivalent.

2.18 **Dose equivalent (HT) –**means the product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and Sievert.

2.19 **Dosimeter** – Devices designed to be worn or carried by a single individual for the assessment of dose equivalent. Examples of individual monitoring devices are film badges, thermoluminescent dosimeters (TLD) and pocket ionization chambers.

2.20 **Embryo/fetus** – The developing human organism from conception until the time of birth.

2.21 **Entrance or access point –** Any opening through which an individual or extremity of an individual could gain access to radiation areas or to licensed or registered sources of radiation. This includes portals of sufficient size to permit human access, irrespective of their intended use.

2.22 **Exposure** – being exposed to ionizing radiation or to radioactive material. A measure of ionization produced in air by x- or gamma radiation. The unit of exposure is the coulomb per kilogram (C/kg) or the roentgen (R): 1 R = 2.58 x 10-4 C/kg.

2.23 **Exposure rate** – The exposure per unit of time, typically milliroentgen per hour (mR/h).

2.24 **External dose** – That portion of the dose equivalent received from any source of radiation outside the body.

2.25 **Extremity** – Hand, elbow, arm below the elbow, foot, knee, and leg below the knee. The arm above the elbow and the leg above the knee are considered part of the whole body.

2.26 **Fixed Contamination** - Radioactive material that cannot readily be removed from surfaces by nondestructive means such as causal contact, wiping, brushing, or washing.

2.27 **Frisking** - Process of monitoring personnel for contamination.

2.28 **Five-year Dosimetry Period** – The period of five calendar years beginning on January 1 of the year following the year in which the Canadian Radiation Protection Regulations came into force (2000) and every period of five years after that period (e.g., 2000 – 2005, 2005- 2010, 2010 – 2015, etc.).

2.29 **Gray (Gy)** – The System International (SI) unit of absorbed dose. One Gy is equal to an absorbed dose of 1 joule per kilogram (100 rad).

2.30 **High radiation area** – Means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 millisievert) in 1 hour at 30 centimeters from any source of radiation or from any surface that the radiation penetrates.

2.31 **Internal dose** – That portion of the dose equivalent received from radioactive material taken into the body.

2.32 **Ionizing radiation** – Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter. Ionizing radiation includes gamma rays and x rays, alpha and beta particles, high-speed electrons, neutrons, and other nuclear particles.

2.33 **License** – A form of permission given by an Agreement State, the NRC, or the Canadian Nuclear Safety Commission (CNSC) to an applicant who has met the requirements for licensing set out by that Agency

2.34 **Licensed material –** Radioactive material received, possessed, used or transferred under a license issued by a regulatory agency.

2.35 **Licensee** – Any person or organization that is licensed by a regulatory agency.

2.36 **Member of the public –** Any individual, except an individual who is performing assigned duties for a licensee or registrant involving exposure to sources of radiation.

2.37 **Minor** – An individual less than 18 years of age.

2.38 **Natural radioactivity** – Radioactivity of naturally occurring nuclides whose location and chemical and physical form have not been altered by man.

2.39 **Naturally Occurring Radioactive Material (NORM) -** Includes radioactive elements found in the environment. Long-lived radioactive elements of interest include uranium, thorium and potassium, and any of their radioactive decay products, such as radium and radon. These elements have always been present in the earth's crust and within the tissues of all living beings.

2.40 **Non-ionizing Radiation** – Any type of electromagnetic radiation that does not carry enough energy per quantum to ionize atoms or molecules. Near ultraviolet, visible light, infrared, microwave, radio waves, and low-frequency RF (longwave) are all examples of non-ionizing radiation. Sources of non-ionizing radiation include lasers, communication devices and towers, and high-voltage power lines.

2.41 **Nuclear Energy Worker** – See “Radiation Worker.”

2.42 **Occupational dose –** The dose received by an individual in the course of employment in which the individual’s assigned duties involve exposure to sources of radiation. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the public.

2.43 **One-year Dosimetry Period –** The periods of one calendar year beginning on January 1.

2.44 **Personnel Dosimetry** - Devices designed to be worn by a single person for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), and pocket ionization chambers.

2.45 **Radiation Producing Device** – Any device capable of producing ionizing radiation except those devices with radioactive material as the only source of radiation [e.g., x-ray fluorescence devise].

2.46 **Radiation Protection Program (RPP)** – This radiation safety program also functions as a General RPP used to address the radiation safety needs associated with a general set of operational activities involving the use of or exposure to radioactive materials, or ionizing radiation. A project or site-specific RPP is used to address the radiation safety needs associated with a specific work location or field activity or to supplement the requirements of the general RPP.

2.47 **Radiation Safety Officer (RSO)** – The person appointed to oversee and manage the specific radiation safety issues associated with a particular use or contact with radioactive material or exposure to ionizing radiation, in accordance with an established RPP.

2.48 **Radiation Work Permit (RWP) –**Permit that identifies radiological conditions, establishes worker protection and monitoring requirements, and contains specific approvals for radiological work activities. The RWP serves as an administrative process for planning and controlling radiological work and informing the worker of the radiological, health, and safety issues.

2.49 **Radiation Worker –**Worker whose job assignment requires work on, with, or in the proximity of radiation production machines or radioactive materials. A radiological worker has the potential to be exposed to more than 100 mrem per year, which is the sum of the dose equivalent to external irradiation and the committed effective dose equivalent to internal irradiation.

2.50 **Radioactive material** – Any material (solid, liquid, or gas) that emits ionizing radiation spontaneously.

2.51 **Radioactivity** – The disintegration of unstable atomic nuclei with the emission of radiation.

2.52 **Radon Progeny** – Includes the following radioactive decay products of radon-222: polonium-218, lead-214, bismuth-214, and polonium-214.

2.53 **Removable Contamination -** Radioactive material that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing, or washing.

2.54 **Restricted area** – An area, access to which is limited by the licensee or registrant for the purpose of protecting individuals against undue risks from exposure to sources of radiation. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

2.55 **Sealed source** – 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 that are likely to be encountered in normal use and handling.

2.56 **Stochastic effects** – Health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

2.57 **Survey** – An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, and/or presence of sources of radiation. When appropriate, such evaluation includes, but is not limited to, tests, physical examination of location of materials and equipment, and measurements of levels of radiation or concentration of radioactive material present.

2.58 **Technologically Enhanced Naturally Occurring Radioactive Material (TENORM)** – Any naturally occurring radioactive materials not subject to regulation under the Atomic Energy Act whose radionuclide concentrations or potential for human exposure have been increased above levels encountered in the natural state by human activities.

2.59 **Total Effective Dose Equivalent (TEDE**) means the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

2.60 **Total Organ Effective Dose Equivalent (TODE**) The sum of the deep dose equivalent (for external exposures) and the committed dose equivalent to an individual organ or tissue (for internal exposures).

2.61 **Unrestricted area** – An area, access to which is neither limited nor controlled by the licensee.

2.62 **Whole body** – For purposes of external exposure, head, trunk (including male gonads), arms above the elbow, or legs above the knees.

2.63 **Working level** – The concentration of radon progeny in 1 cubic meter that has a potential aloha energy of 2.08 x 10-5 joules.

3.0 References

3.1 S3AM-003-PR1 SH&E Training

3.2 S3AM-121-PR1 Non-Ionizing Radiation

3.3 S3AM-122-PR1 Gauge Source Radiation

3.4 S3AM-123-PR1 Respiratory Protection

3.5 S3AM-208-PR1 Personal Protective Equipment

3.6 S3AM-209-PR1 Risk Assessment & Management

4.0 Procedures

4.1 Roles and Responsibilities

4.1.1 **Business Group RSO**

A person to whom the VP of SH&E has delegated the responsibility for the Radiation Safety Program. The RSO may designate employees with experience and appropriate radiation credentials to support the radiation safety program. Confirm that Project Managers understand their responsibilities for development and implementation RPPs as applicable to the planned work activities. Further Business Group RSP responsibilities include:

- Review and approve all initial and renewals applications for radioactive material/special nuclear material license prior to submittal.
- Approve the appointment of each AECOM license/site RSO.
- Provide AECOM management and operations personnel with technical assistance in the identification, control, and safe handling of radioactive materials.
- Investigate any employee radiation exposures above the administrative limits.
- Review annual activity summary reports submitted by the License/Program/Site RSO.

4.1.2 **License/Program/Site Radiation Safety Officer (Site RSO)**

The Business Group RSO will designate or approve a qualified employee to be a Site RSO. The Site RSO will be responsible to the Project Manager and to the Business Group RSO for implementation of Radiation Protection Programs (RPP) and performance of project radiation safety responsibilities. The Site RSO receives radiation safety technical guidance from the AECOM Business Group RSO. Responsibilities of the Site RSO include:

- Manage all license, program, or project radiation safety procedures as specified in the applicable RPP.
- Review real-time monitoring results to determine compliance with the RPP-specified requirements.
- Maintain administrative and operational compliance with all license conditions and requirements.
- Identify individuals or work groups containing individuals who are likely to receive doses exceeding 0.1 rem/year, to the responsible Manager.
- Manage site dosimetry program, if applicable.
    - Evaluate the need for bioassay; ensure they are completed if required.
    - Confirm Employees are trained in the proper wear, handling, and storage of dosimeters.
    - Distribute and collect dosimeters, and review results.
    - Provide Employees with their annual dose reports.

- Provide copies of all dosimetry results to the Business Group RSO on an annual basis.

- Notify the Business Group RSO of any suspect personnel exposures above administrative limits.
- Confirm that Employees working with radioactive material or ionizing radiation sources have received all necessary safety-related training, certifications and/or licenses.
- Conduct and document all ALARA dose assessment investigations and lost dosimeter investigations.
- Confirm that the presence of radioactive materials, ionizing radiation sources, radiation-producing devices, radiologically controlled areas, contamination areas, airborne radioactivity areas, and radiation areas at project work sites are identified (where reasonably possible) prior to commencing field activities.
- Notify the Employee if he or she is likely to exceed their ALARA goal and discuss options for managing the situation.
- Submit an annual summary report to the Business Group RSO which includes the following.
  - Exposure monitoring (cumulative project dose).
  - Exposure trends or ALARA issues.
  - Annual audit findings.
  - Licensing actions.

4.1.3 **Manager (Operations)**

- Notify and get approval from the Business Group RSO of possession of or intent to acquire radioactive material under any general or specific radioactive material license or conduct field work at sites with the potential for employee radiation exposures.
- Notify the Business Group RSO of the intent to renew, or amend an existing AECOM radioactive materials license.
- Provide the Business Group RSO with the names and qualifications of individuals who may be designated as AECOM License/Program/Site RSOs.
- With the support of the Site RSO, identify individuals or work groups containing individual who are likely to receive doses exceeding 0.1 rem/year.
- Confirm Project Managers/ Site Supervisors, are aware of his/her Radiation Protection Program responsibilities.
- Operations Managers, Project Managers, and Project Safety Professionals are responsible for implementing any required radiological exposure assessment procedures in their work activities.

4.1.4 **Project Manager** / **Site Supervisor**

Confirms that the project is conducted in accordance with the requirements of contract documents, applicable regulations, radioactive material license conditions and ALARA requirements. . He/she has authority over all work activities of AECOM employees and subcontractors both on the job site and involved in off-site project support. The Project Manager is responsible for organizing the field team, including the Site Supervisor, Site RSO, and the Site Safety Officer. The Project Manager is responsible for communication and information exchange with the client and regulatory authorities and will officially represent AECOM in all project-related coordination. Further responsibilities include:

- Consult with the Business Group RSO or designee to determine if a site-specific RPP will be required.

- Identify project sites that do not involve direct exposure to or work with radioactive materials, but have the potential for incidental exposure to radiation.
- Involve the Site RSO in the planning phase of radiological work to be accomplished.
- Confirm that all radiation safety issues associated with their projects are properly addressed, and worker safety is confirmed through development of appropriate radiological safety requirements and procedures.
- Confirm that RPPs are prepared, reviewed, and approved in accordance with this procedure.
- Confirm that Employees working with radioactive material or ionizing radiation sources have received all necessary safety-related training, certifications and licenses.
- Facilitate compliance with client-required radiation safety programs in coordination with the Site RSO.

4.1.5 **Employees**

Before an Employee (including subcontractor personnel) may engage in handling or processing radioactive material or radioactive contaminated materials or perform the decontamination activities at the site, he or she will receive site-specific radiation safety training and acknowledge receipt of that training by signing a statement to that effect. Each Employee will comply with this AECOM Radiation Safety Program and all RPP provisions, guidance, and procedures. Further responsibilities include:

- Work in accordance with all established RPP requirements, and radiation work permits.
- Will not disturb or handle any radioactive material or work in any identified radiation area without appropriate training and safety procedures.
- Notify the Project Manager of the presence or suspected presence of previously unidentified radioactive material or ionizing/non-ionizing radiation sources in the workplace, and cease all work activities involving potential exposure to ionizing/non-ionizing radiation until further direction is received.
- Be generally aware of their current, annual, dose-to-date.
- Participate in ALARA evaluations, as requested.
- Implement the ALARA controls specified in plans and procedures,
- Immediately report to the Program/Site RSO or Project Manager any situations where they believe that they or another employee may have had an internal deposition of radioactive material.
- Properly wear, handle, and store any dosimeter or other dose assessment device issued to them.

4.2 Restrictions

4.2.1 This Radiation Safety Program was developed with the premise that the success of any program designed to minimize exposures and avoid accidents must necessarily rely on the experience, ability, and forethought of the user. The policies and procedures contained in the Radiation Safety Program are designed to achieve a reasonable and practical standard of safety in compliance with government regulations and codes and a degree of safety awareness for those who work with radiation devices.

4.2.2 This Radiation Safety Program, including the related policy, manual, and safe job procedures, must be adhered to for all tasks which involve nuclear densometers. Specific requirements for the safe management of nuclear densitometer and gauge sources are provided in AECOM procedure *S3AM-122-PR1 Gauge Source Radiation*.

4.2.3 Only Employees trained in the use and handling of nuclear densometers are authorized to handle or receive these devices. This includes technicians using the devices or anyone shipping them by ground transportation or by air.

4.2.4 Specific safety requirements related to non-ionizing radiation are provided in *S3AM-121-PR1 Non-Ionizing Radiation*.

4.2.5 This Radiation Safety Program does not apply to AECOM Employees who are working full-time under another client-supported radiation safety program. For example, AECOM Employees working on a Department of Energy site who are actively monitored under the site's program are not subject to the requirements of this AECOM Radiation Safety Program. However, Employees visiting a site or working temporarily under a client-supported program should provide dose monitoring reports to the Site RSO, if they are also working under this AECOM Radiation Safety Program.

4.3 Training Requirements

4.3.1 Training requirements for a project or program shall be provided in or referenced in the applicable RPP.

4.3.2 AECOM Employees shall receive radiation safety training and certifications commensurate with their job duties. Employees may require training to a level such that occupation (non-public) dose limits apply. These persons will then be qualified as Radiation Workers (U.S.), Nuclear Energy Workers (Canada) or Naturally Occurring Radioactive Material (NORM) Surveyors.

4.3.3 Records shall be maintained to demonstrate compliance with the training requirements, refer to *S3AM-003-PR1 SH&E Training*. Training records shall include either a copy of an examination showing a passing score of 80 percent or higher or a certificate from an outside vendor. For Radiation Awareness (RA) training, no test or certificate is required. RA training can be documented with a training sign-in sheet, e-mail acknowledgement from the trainer, or similar documentation.

4.3.4 Radiation safety training is required under the following circumstances:

- Before being permitted unescorted access to radiologically controlled areas (i.e., areas posted with the radiation trefoil symbol);
- Before exceeding public dose limits during access to radiologically controlled areas (i.e., areas posted with the radiation trefoil symbol);
- Before handling, storing, or transporting nuclear gauge sources;
- When there is a significant change to radiation protection policies and procedures that may affect the individual;
- When specified in the program-specific or license-specific RPP;
- When required by a state permit or other regulation for the possession of a radiation-producing devise; and
- When required by a client for site access to perform a specific task.

4.4 Training Topics

4.4.1 Radiation safety training shall be detained in the RPP and should include the following topics to the extent appropriate to each individual’s prior training, work assignments, degree of exposure to potential radiological hazards, and applicable program or license:

- Risk of exposure to radiation and radioactive materials, including prenatal radiation exposure;
- Basic radiation fundamentals and radiation protection concepts;

- Controls for both routine and emergency actions implemented at the local level to manage and maintain doses ALARA (e.g., physical design features, administrative controls, limits, policies, procedures, alarms, radiation survey instrumentation, dose monitoring devices and other measures);
- Transportation and storage of radioactive materials;
- The individual's rights and responsibilities for implementing the facility's radiological protection program;
- The individual's responsibilities for implementing ALARA measures; and
- Reports the individual may request.

4.5 Training Courses

4.5.1 AECOM recognizes multiple training levels that are commensurate with an Employee's job functions as described below. For these descriptions, Radiation Worker training is considered the same as Nuclear Energy Worker training.

4.5.2 RA – This course contains the basics in radiation protection and should be site/project specific.

- This training is for AECOM Employees that may require non-routine or short-term unescorted access to radiological controlled areas (excluding Radiation Areas and Airborne Radiation Areas) to perform work functions.
- This training is also acceptable for short-term site assessment activities for sites with known low-levels of radiation and contamination or where a qualified health physics or radiation protection technician has control of site access.
- RA training is also given to personnel who work in areas where radioactive materials are stored but do not have authorized access to the materials or areas where radioactive materials may be inadvertently encountered (such as during environmental sampling in uncontrolled areas).
- Personnel who receive RA training are NOT considered Radiation Workers or Nuclear Energy Workers and public dose limits apply. To exceed public dose limits, Employees must be trained to one of the requirements below.

4.5.3 Site-Specific Radiation Worker Training- This course is designed to provide the OSHA 1910.1096 (i)(2) and site-specific training necessary to work in a radiation area or exposed to radioactive materials.

- The instruction shall include safety problems resulting from exposure to materials, instructed in the applicable provisions on exposure protection, and where individuals can get information on their radiation exposure.

4.5.4 NORM Surveyor – This course is designed to provide surveyor training for individuals performing "NORM" surveys. Topics include why survey, types of surveys, types of equipment surveyed, and techniques in the operation, use, and handling of various radiation survey instruments.

4.5.5 Radiation Worker I (RWI) – This course contains the core academics and the appropriate practical factors.

- This training is for radiological workers whose job assignments require routine access to Radiological Buffer Areas and Radiation Areas.
- RW I training is also suggested for unescorted entry into Radioactive Material Areas containing either sealed radioactive sources or radioactive material labelled in accordance with 10 CFR 20, 10 CFR 835, or applicable Agreement State regulations.
- RW I training alone does not prepare the Employee to work around higher radiation levels or with contaminated materials. It is suggested that RW I tasks be limited to inspections, tours and activities that involve work on non-radiological systems.

4.5.6 Radiation Worker I Training with High/Very High Radiation Area Training – This course contains the core academics, the High/Very High Radiation Area (HR/VHR) module, and the appropriate practical factors.

- The HR/VHR Area lesson plan may be added to the RW I course to give personnel unescorted entry into High Radiation Areas where contamination is not a concern.

4.5.7 Radiation Worker II Training (RW II) – This course consists of the core academics, the HR/VHR module, the Contamination Control module, and the appropriate practical factors.

- This training is recommended for the radiological worker whose job assignments involve unescorted entry into High Radiation Areas, Contamination Areas, High Contamination Areas, and Airborne Radioactivity Areas.
- Further, Employees who have potential contact with hot particles or use glove boxes with high contamination levels should complete RW II training.
- RW II training prepares the Employee to work around higher radiation levels and with contaminated materials normally associated with radiological facilities/activities.

4.5.8 Nuclear Gauge Training – All Employees asked to work with nuclear gauges will be trained in safe radiation work practices and procedures in accordance with *S3AM-122-PR1 Gauge Source Radiation*.

4.5.9 Other Instrument-Specific Training – All Employees asked to work with devises that emit ionizing or non-ionizing radiation will be trained in safe work practices and procedures.

4.6 ALARA

4.6.1 Even though current occupational exposure limits provide a very low risk of injury, it is prudent to avoid unnecessary exposure to radiation. AECOM's objective is thus to reduce occupational exposures as far below the specified limits as is reasonably achievable by means of good radiation protection planning and practice, as well as commitment to policies that foster vigilance against departures from good practice.

4.6.2 In addition to maintaining doses to individuals ALARA, the sum of the doses received by all exposed individuals should also be maintained at the lowest practicable level. It would not be desirable, for example, to hold the highest doses to individuals to some fraction of the applicable limit if this involved exposing additional people and significantly increasing the sum of radiation doses received by all involved individuals.

4.6.3 Two basic assumptions are considered necessary in this program for keeping occupational exposures as far below the specified limits as is reasonably achievable. Those two conditions are management commitment to maintaining exposures as low as is reasonably achievable, and the personnel responsible for radiation protection should be continuously vigilant for means to reduce exposure.

4.6.4 ALARA Policy Statement and Implementation

- It is AECOM's policy to plan and conduct its radiological activities safely and in such a fashion as to protect the health and safety of its employees, subcontractors, members of the public, and the environment. To achieve this, AECOM shall confirm that efforts are taken to reduce radiological exposures and releases to the environment ALARA, taking into account social, technical, economic, practical and public policy considerations. AECOM is committed to implementing a radiological control program that reflects this policy.
- To implement this policy, AECOM shall:
    - Review radiological operations and analyze the hazards;
    - Develop and implement controls that reduce or eliminate unnecessary dose and keep the necessary doses low and document the controls in the RPP or other work document.
    - Document areas surveyed for radioactive material and retain record of the survey.

- Establish ALARA goals for individuals or work groups.
- Provide feedback to Employees and Managers by tracking an individual's dose (from all operations) relative to his/her ALARA goal.
- Re-evaluate the situation if it appears an individual is likely to exceed his/her ALARA goal.

4.6.5 ALARA Committee

- Form an ALARA Committee for each site for which ALARA goals will be developed and when there is a potential for exposure to ionizing radiation at levels that significantly exceed natural background.
- At a minimum, this Committee will be made up of the Site RSO, the Project or Site Manager, the Health Physics Supervisor (if applicable), and one representative of the site labor force.
- The Committee will meet periodically to review previous site radiation exposure, air monitoring, effluent monitoring, and contamination level data to assess the presence of unacceptable trends.
- The Committee will also assess the success of the radiological controls, serve as a forum for recommendations for improvements, and maintain a written record of the Committee's activities in the project files. The Committee will also support the development of project or site-specific ALARA goals.

4.6.6 ALARA Goals and Evaluations

- ALARA goals shall be established for individuals who may be involved in operations that could result in exposures greater than 100 mrem (1 mSv) from all operations in a calendar year. The Program/Site RSO shall work with the radiation safety committee to establish ALARA goals in conjunction with the Project Manager or Program Manager. The ALARA goals should be:
  - Based on historical values for this type of work or on estimations of dose and should be modified either up or down depending upon the nature of the work involved.
  - Approved by the Project Manager or Program Manager and exposed individual's supervisor.
  - Periodically evaluated relative to accrued dose received by the worker.
  - If it is observed that an individual is approaching 100 mrem (1 mSv) for the year and no ALARA goal has been established, then the Program/Site RSO will notify the Business Group RSO of this and provide an ALARA goal.
- The License/Program/Site RSO shall:
  - Conduct and document a post-job review/critique if the program ALARA goal of 0.5 rem or 40 DAC- hours in a year is exceeded.
  - Notify the Employee if they is approaching his/her ALARA goal;
  - Complete an ALARA re-evaluation prior to allowing an Employee to exceed an ALARA goal or raising an ALARA goal;
  - Inform the Business Group RSO of any increased ALARA goals; and
  - Evaluate and respond (as appropriate) to increasing dose, airborne, or contamination trends and other indicators that could be precursors to unnecessary dose.
- An ALARA evaluation (see form *S3AM-120-FM1 ALARA Evaluation*) is required for individuals or work groups who have an ALARA goal of 500 mrem (5 mSv) or more for a given calendar year. As part of the evaluation, the Program/Site RSO is responsible to the Business Group RSO to provide names of individuals who have ALARA goals greater than 500 mrem (5 mSv).

4.7 RPP and Radiation Work Plans

4.7.1 AECOM projects shall comply with the SH&E procedures with respect to project planning, hazard identification, and communication.

4.7.2 The project SH&E documents should identify radiation hazards and mitigate the risk through the use of proper engineering and administrative controls to minimize the spread of contamination and maintain low exposure levels.

4.7.3 Manager (Operations)/Project Managers will confirm that a General RPP or Site RPP is completed by or approved by the Corporate RSO prior to initiating operations if required as described below.

4.7.4 General RPP – This Radiation Safety Program will function as a general RPP.

4.7.5 Site RPP shall be prepared on a project-by-project basis for field operations where:

- AECOM Employees may enter any radiation area;
- AECOM Employees may enter a radiologically controlled area without an escort operating under a separate RPP;
- AECOM Employees may enter areas where radionuclide airborne concentrations exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the ALI or 12 DAC-hours, and respiratory protection is not in use.

4.7.6 The Site RPP must be a stand-alone document, or may be incorporated into other project health and safety documentation (e.g., health and safety plans). (Refer to *S3AM-209-PR1 Risk Assessment & Management*.) The RPP must:

- Be prepared by the designated Site RSO or other radiation safety professional, and reviewed by the Business Group RSO or designee*;*
- Address all radiological hazards associated with the identified use of licensed radioactive material, exposure/contact with radioactive material, or exposure to ionizing radiation;
- Provide appropriate and applicable training requirements, monitoring procedures, dosimetry requirements, protective equipment requirements, operational safety procedures and limitations for each identified radiological hazard;
- Identify specific minimization procedures consistent with AECOM's ALARA requirements; and
- Address storage and transportation issues, security and operator qualification requirements, device maintenance requirements, leak testing requirements, and any other radioactive material license compliance needs when prepared for a radioactive material license.

4.7.7 Radiation Work Permit (RWP)

- An RWP is issued for short, non-routine tasks to provide inform Employees of the radiological controls and entry requirements for a specific work activity and is valid only for the duration of the activity.
- If RWPs are expected to be used during a project or to implement a specific program, the RPP must define the terms of issuance, approval, and implementation. Generally the RWP is prepared by the Site RSO and approved by the Manager. (Refer to S3AM-120-FM2, *Radiation Work Permit*.) Employees must be trained on the RWP, read it, and signed-off on it before performing a task described in the RWP

4.7.8 Hazardous Work Permit (HWP)

- An HWP is a combination document issued to inform Employees of both radiological and hazardous material exposure and entry requirements for short, non-routine tasks on to provide additional protection under a project/program RPP.

- If HWPs are expected to be used during a project or to implement a specific program, the RPP must define the terms of issuance, approval, and implementation. Generally the HWP is prepared by the Site RSO and approved by the Manager. (Refer to S3AM-120-FM3, *Hazardous Work Permit*.) Employees must be trained on the HWP, read it, and signed-off on it before performing a task described in the HWP.

4.8 Considerations for Non-Radiological Hazards. Implementation of a radiation safety control may introduce unintended consequences that may negatively impact the overall safety of the operation. For example:

4.8.1 Excessive protective clothing or equipment used to control dose or personnel contamination events may have deleterious consequences, such as heat stress and ergonomic impacts.

4.8.2 Respirators used to reduce intakes of radionuclides may impair visual acuity and communications capabilities among Employees.

4.8.3 Protective clothing and equipment used to protect Employees from chemical hazards may slow down work, leading to increased worker dose.

4.9 Radiation Protection Standards

4.9.1 The U.S. and Canadian government agencies have established limits on annual radiation exposure for occupationally exposed workers, including exposures to radon (10 CFR 20, SOR-2000/203).

4.9.2 These limits have been shown to prevent deterministic effects of radiation exposure while limiting the probability of stochastic effects.

4.9.3 Additionally AECOM has established its own set of administrative limits to confirm compliance with Federal regulations and to implement the AECOM ALARA philosophy.

4.10 Occupational Dose Limits

4.10.1 Tables 1 and 2 provide the legal U.S. and Canadian dose limits as well as AECOM's administrative dose limits.

4.10.2 Note that doses from background radiation, therapeutic and diagnostic medical and dental exposures, and those resulting from participation as a subject in medical research programs are not included in dose records or when assessing compliance with the occupational dose limits.

4.11 Occupationally Exposed Minors

4.11.1 AECOM policy is no worker under 18 years of age will be allowed to work on site where there is the potential for exposure to radiation. This requirement is consistent with EM-385-1-1, Section 6E, which does not allow the occupational radiation exposure of minors.

Table 1 – Occupational Dose Limits (English units)

	United States	Canada	AECOM
	10 CFR 20, Subpart C	**SOR-2000/203, Sect. 13**	**Administrative Limit**
Total Effective Dose Equivalent (TEDE)	5 rem/yr	5 rem/yr	500 mrem/yr
Total Organ Dose Equivalent (TODE)	50 rem/yr	NA	5 rem/yr
Shallow Dose Equivalent (SDE)	50 rem/yr	50 rem/yr	5 rem/yr
Extremity Dose Equivalent	50 rem/yr	50 rem/yr	5 rem/yr
Lens of Eye Dose Equivalent	15 rem/yr	15 rem/yr	1.5 rem/yr
Individual Member of the Public	2 mrem/hr	NA	2 mrem/hr
	100 mrem/yr	100 mrem/yr	100 mrem/yr
Occupational Dose to Minors	10% of above limit	NA	NA
Dose to Embryo/Fetus of a Declared Pregnant Worker	500 mrem	400 mrem	100 mrem/ gestation

Table 2 – Occupational Dose Limits (SI units)

	United States	Canada	AECOM
	10 CFR 20, Subpart C	**SOR-2000/203, Sect. 13**	**Administrative Limit**
TEDE4	50 mSv/yr	50 mSv/yr	5 mSv/yr
TODE	500 mSv/yr	NA	50 mSv/yr
SDE	500 mSv/yr	500 mSv/yr	50 mSv/yr
Extremity Dose Equivalent	500 mSv/yr	500 mSv/yr	50 mSv/yr
Lens of Eye Dose Equivalent	150 mSv/yr	15 rem/yr	15 rem/yr
Individual Member of the Public	0.02 mSv/hr	NA	0.02 mSv/hr
	1 mSv/yr	1 mSv/yr	1 mSv/yr
Occupational Dose to Minors	10% of above limit	NA	NA
Dose to Embryo/Fetus of a Declared Pregnant Worker	5 mSv	4 mSv	1 mSv/gestation

4.12 Embryo/Fetus of a General Employee

4.12.1 A special situation arises when a Radiation Worker or Nuclear Energy Worker becomes pregnant. Under these conditions, radiation exposure could also involve exposure to the embryo or fetus. A number of studies have indicated that the embryo or fetus is more sensitive than the adult, especially during the first trimester of pregnancy. This can be a concern since many users are unaware of their pregnancy during the first month or two of gestation. Hence, the NRC and the CNSC require that all occupationally exposed Employees be instructed in the potential health risks associated with prenatal radiation exposure.

4.12.2 As defined in 10 CFR 20.1003, a "declared pregnant woman" (refer to S3AM-120-FM4, *Declaration of Pregnancy*) means a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception. The maximum permissible exposure to the fetus of a declared pregnant worker during the gestation period is 10 percent of the NRC's annual limits or 500 mrem. An effort should be made to avoid substantial variation of uniform monthly exposure rate. There are very few locations within AECOM where radiation levels are high enough that a fetus could potentially receive a dose that approaches these limits.

4.12.3 The National Council on Radiation Protection and Measurements (NCRP) Report No. 116 recommends a monthly equivalent dose limit of 0.05 rem (0.5 mSv) to the embryo/fetus once the pregnancy is known. In view of the NCRP recommendation, any monthly dose of less than 0.1 rem (1 mSv) is not a substantial variation above a uniform monthly dose rate and as such will not require justification (specified in NRC Regulatory Guide 8.13).; however, a monthly dose greater than 0.1 rem (1 mSv) should be justified (specified in NRC Regulatory Guide 8.13)

4.12.4 If a Radiation Worker or Nuclear Energy Worker becomes pregnant, she shall declare her pregnancy in writing. This can be done by email or by letter to the Site RSO applicable, using form S3AM-120-FM4, *Declaration of Pregnancy*, or the equivalent. It is recommended the Worker's applicable human resources representative be notified. A member of the Site RSO staff will assess her potential radiation exposure and measures to keep her exposures ALARA and make any appropriate accommodations. (See form S3AM-120-FM5, *Embryo/Fetus Initial Dose Calculations*.) Early declaration of a pregnancy is encouraged and confidentiality is maintained at all times.

4.12.5 AECOM's administrative limit of 500 mrem (5 mSv) based on CNSC regulations. If notification of a pregnancy is not made in writing, the radiation exposure limits remain at the occupational limits of 5 rem (50 mSv) per year. An individual may also "un-declare" her pregnancy in writing at any time (using form S3AM-120-FM6, *Withdrawal of Declaration of Pregnancy*, or the equivalent).

4.13 Planned Special Exposures (PSE)

4.13.1 PSE are not practiced at AECOM.

4.14 Means of Exposure Control

4.14.1 Means of controlling Employee exposures for a project or program shall be provided in the applicable RPP.

4.14.2 There are three basic ways in which Employees can control exposure to a radioactive source: limit exposure time, increase their distance from the source, and the interposition of a shielding material.

4.14.3 These concepts are thoroughly presented in AECOM radiation safety training but should also be continuously reinforced through daily or weekly radiation safety briefings. AECOM projects shall use postings, labels, project/task plans, "dry-runs," engineering controls, and PPE as appropriate to limit occupational exposures.

4.15 Postings

4.15.1 Access to radioactive materials is controlled by posting areas containing radiation fields, radioactive materials, and/or radioactive contamination.

4.15.2 AECOM's policy shall be to post areas as required below based on U.S. radiation protection regulations (10 CFR 20).

4.15.3 Projects in Canada shall also post in accordance with these requirements unless Canadian regulators or the client require that areas only display postings based on Canadian regulations (SOR-2000/203).

4.15.4 Warning signs shall be durable and legible and shall bear the radiation warning symbol (tri-foil) and the applicable caution. The three blades and the central disk of the tri-foil symbol shall be:

- Magenta or black; and
- Located on a yellow background

4.15.5 Postings shall be displayed at the boundary of and at every point of access to an area, room or enclosure and bare the applicable words below.

4.15.6 Signs and postings should be removed by health physics only and only when conditions no longer warrant that posting.

4.15.7 Where physical barriers do not exist, pole barriers shall be erected using yellow and magenta or yellow and black rope.

4.15.8 Postings shall include the following language:

- "Caution (or Danger) Contamination Area" – Any area where removable contamination levels exceed or are likely to exceed those specified in Table 3 (from 10 CFR 835, Appendix D).
- "Caution (or Danger) Radiation Area" – Any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 mrem in 1 hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates (i.e., dose rates in the area exceed 5 mrem/hr or 50 µSv/hr).
- "Caution (or Danger) High Radiation Area" – Any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 100 mrem in 1 hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates (i.e., dose rates in the exceed 100 mrem/hr or 1.0 mSv/hr).
- "Caution (or Danger) Very High Radiation Area" – Very high radiation area means an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in 1 hour at 1 meter from a radiation source or 1 meter from any surface that the radiation penetrates (i.e., dose rates exceed 500 rads/hr or 5 Gy/hr). No AECOM personnel shall have access to a Very High Radiation Area without written approve from the Site RSO.
- "Caution (or Danger) Airborne Radioactivity Area" – Any area, accessible to individuals in which airborne radioactivity levels could result in an individual being exposed to a concentration in excess of the following concentrations. Work in an Airborne Radioactivity Area must be conducted in accordance with a Respiratory Protection Program approved by the Site RSO or designee.
    - In excess of the DAC specified in appendix B, to 10 CFR 20.1001-20.2401, 10 CFR 835 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 ALI or 12 DAC-hours.

4.15.9 The following postings are required only on Canadian project sites (SOR-2000/203):

- "RAYONNEMENT-DANGER-RADIATION" – when there is a radioactive nuclear substance in a quantity greater than 100 times its exemption quantity in the area, room or enclosure or there is a reasonable probability that a person in the area, room or enclosure will be exposed to an effective dose rate greater than 2.5 mrem/hr (25 µSv/hr).

4.15.10 No Employee shall post or keep posted a sign that indicates the presence of radiation, a nuclear substance, or prescribed equipment at a place where the radiation, nuclear substance, or prescribed equipment indicated on the sign is not present.

Table 3 – Surface Contamination Values[1] in dpm/100 cm2 (60 dpm = 1 Bq)

Radionuclide	Removable[2,4]	Total (Fixed + Removable)[2,3]
U-nat, U-235, U-238, and associated decay products	[7]1,000	[7]5,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above[5]	1,000	5,000
Tritium and STCs[6]	10,000	See Footnote 6

[1]The values in this appendix, with the exception noted in footnote 6 below, apply to radioactive contamination deposited on, but not incorporated into the interior or matrix of, the contaminated item. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides 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]The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 $cm^2$is less than three times the value specified. For purposes of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) From measurements of a representative number of sections it is determined that the average contamination level exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm^2area exceeds three times the applicable value.

[4]The amount of removable radioactive material per 100 $cm^2$of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note—The use of dry material may not be appropriate for tritium.) When removable contamination on objects of surface area less than 100 $cm^2$is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

[5]This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

[6]Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to confirm the surface contamination value provided in this appendix is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a "Total" value does not apply. In certain cases, a "Total" value of 10,000 dpm/100 cm^2may be applicable either to metals, of the types which form insoluble special tritium compounds that have been exposed to tritium; or to bulk materials to which particles of insoluble special tritium compound are fixed to a surface.

[7]These limits only apply to the alpha emitters within the respective decay series.

4.16 Labelling

4.16.1 In the U.S., the Site RSO shall confirm that each container of licensed radioactive material bears a durable, clearly labelled with:

- The radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL."

- A label containing the name, quantity, contamination levels, dose rates, date of measurement and form of the radioactive substance in the container or device.

4.16.2 In Canada, the Site RSO shall confirm that no person shall possess a container or device that contains a radioactive substance unless the container or device is labelled with the following.

- The radiation warning symbol and the words “RAYONNEMENT — DANGER —RADIATION.”
- A label containing the name, quantity, contamination levels, dose rates, date of measurement and form of the radioactive substance in the container or device.

4.17 Personal Protective Equipment

4.17.1 PPE is the least effective control for minimizing the exposure to high-energy beta radiation and gamma radiation and should be used in conjunction with other PPE requirements, typically required for construction sites. Refer to *S3AM-208-PR1 Personal Protective Equipment*, including:

- Long sleeves & pants;
- Boots;
- Hard hats and safety eyewear (where required); and
- In some cases protective materials containing a shield such as lead (e.g. common during X-rays) should be used.

4.17.2 PPE can be effective in protecting against alpha radiation and low-energy beta radiation and respiratory protection should be considered for work in areas with known or potential airborne contamination. PPE requirements are included in the RPP and/or the RWP.

4.18 Visitors

4.18.1 To control exposures to site visitors, site visitors must be escorted at all times.

4.18.2 Visitor escorts must point out any hazardous area that a visitor may be entering and must confirm that all AECOM radiation safety rules and precautions are observed.

4.18.3 The arrival and departure of site visitors should be recorded in a visitors log and on the RWP if applicable.

4.18.4 Visitors shall be provided temporary dosimetry in accordance with the RPP and dosimeter results shall be recorded in a visitor log.

4.19 Surveys and Instrumentation

4.19.1 Radiation surveys are used to identify and quantify radiological hazards and to document compliance administrative and regulatory limits.

4.19.2 The Site RSO and all field Employees must work together to confirm safety in the workplace and to protect both the public and the environment from the harmful effects of radiation.

4.19.3 The Site RSO is responsible to make or cause to be made, surveys that:

- May be necessary for the licensee to comply with the requirements of the AECOM Radiation Safety Program or Site/Program RPP;
- Are reasonable under the circumstances to evaluate;
- The magnitude and extent of radiation levels;
- Concentrations or quantities of radioactive material; and
- The potential radiological hazards.

4.19.4 The Site RSO shall confirm that instruments and equipment used for quantitative radiation measurements (e.g., dose rate and effluent monitoring) are calibrated periodically for the radiation measured.

4.19.5 The Site RSO shall confirm that a licensed (Canada) or certified (U.S.) dosimetry service is used to measure and monitor the doses of AECOM personnel that may receive any dose in excess an AECOM administrative dose limit.

4.19.6 For U.S. operations, all personnel dosimeters (except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to the extremities) that require processing to determine the radiation dose and that are used to comply with applicable regulations must be processed and evaluated by a certified dosimetry processor:

- Holding current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology and
- Approved in this accreditation process for the type of radiation or radiations included in the NVLAP program that most closely approximates the type of radiation or radiations for which the individual wearing the dosimeter is monitored.

4.20 Types of Surveys

4.20.1 Radiation surveys may be performed to measure exposure or dose rates from sources of radiation that are in buildings, soil, or water. Surveys shall be conducted as necessary to prevent exposures from exceeding occupational dose limits and to confirm areas are posted in accordance with action levels.

4.20.2 Exposure and dose rate calculations may be substituted for actual radiation surveys if based on reliable scientific, peer-reviewed assumptions/historical data.

4.20.3 Contamination surveys may be performed to monitor the magnitude and extent of loose surface and/or fixed contamination on building floors/walls/surfaces, equipment, materials, supplies, or personnel.

4.21 Selection of Instruments

4.21.1 The selection of a proper radiation detection instrument is extremely important in implementing a proper radiation protection program and for measuring the proper types and levels of radiation required to meet project objectives.

4.21.2 Those selecting instruments must consider the minimum level of detection, the type of radiation measured, the energy level of the radiation source and the detector's ability to measure it, and durability of the instrument to perform in the prescribed field conditions.

4.21.3 Personnel using radiological instrumentation shall be trained in the proper operation, use and instrument limitations.

4.21.4 Project Managers and Site Supervisors should consult with the Site RSO, the Business Group RSO, or designee before purchasing, renting or using radiation detection instruments.

4.21.5 Personnel using radiological instrumentation shall be trained in the proper operation, use and instrument limitations.

4.22 Instrument Calibration and Maintenance

4.22.1 All instruments will be calibrated by a qualified calibration/repair facility at least annually in accordance with manufacturers' instructions. A calibration certificate will be maintained on site for each instrument and included in the project file (maintained for 3 years) and in the final report.

4.22.2 Each instrument shall be checked at the beginning and end of each shift with check sources to verify that it's responding adequately. Unless more stringent site-specific criteria have been established satisfactory performance test results will be within +/- 20% of the expected response. If the instrument fails the post-survey source check, the Site RSO will review all data collected during that time period with the instrument and will adjust it or discard it, as appropriate. The affected data shall be flagged and later studied by the Site RSO to determine if they are useable.

4.22.3 Control charts shall be maintained to monitor the performance of field instruments for the duration of the project. If survey equipment requires repair during a workday, it shall be repaired and its proper function verified before it is returned to use.

4.22.4 Project or group-specific procedures may be developed to provide more detailed procedures and forms for instrument calibration and maintenance.

4.23 External Dose Monitoring

4.23.1 Use of external dosimetry or other method of estimating worker exposure for a project or program shall be described in the applicable RPP. All contact with the radiation badge service company for a new project or program is to be made through the Site RSOs and will coordinate delivery and receipt of dosimeters and dose reports.

4.23.2 External radiation dosimeters such as TLDs or optically stimulated luminescent dosimeters appropriate for the radiations to be monitored shall be issued by the Site RSO to the individual and shall be required to be worn by:

- Adults, minors and declared pregnant women likely to receive, in one year, a dose from sources external to the body in excess of 10 percent of the administrative dose limits, or Individuals entering a HR/VHR Area; and
- Individuals responding to emergencies involving radioactive material or ionizing radiation.

4.23.3 Individuals who are likely to exceed 10 percent of the applicable extremity-absorbed dose limit must wear ring dosimeters.

4.23.4 The Site RSO shall determine the “likely to exceed 10 percent” status of an individual, the dosimeter type, the wear period, exchange period, etc. Any AECOM Employee shall immediately notify the Site RSO of changes in site conditions or radiation producing device procedures that could significantly increase or decrease radiation doses to personnel or which could otherwise affect the need for external dosimetry.

4.23.5 Radiation dosimeters shall:

- Not be issued for wear periods greater than 3 months;
- Not be deceptively exposed;
- Be issued to only one person and not shared;
- Not be stored near sources of radiation when is storage;
- Not be exposed to high heat, chemical or physical insults, or washed in a washing machine;
- Not be worn during medical or dental x-ray examinations; and
- Not be worn after medical administration of radioactive materials (thyroid ablation therapy, cardiac stress tests, diagnostic nuclear medicine tests, etc.) until approved by the Site RSO.

4.23.6 No person shall wear dosimeters issued by AECOM while working for another employer or institution without prior approval from the Site RSO. Employees shall notify the Site RSO if they are concurrently working for another (non-AECOM) employer and working with sources of ionizing radiation or radioactive material.

4.23.7 Employees shall notify the Program/Site RSO immediately upon learning of possible deceptive exposures of dosimeters. Intentional deceptive exposures of dosimeters are forbidden and may result in enforcement actions.

4.23.8 Lost or damaged dosimeters shall be reported to the Site RSO as soon as possible. Persons who have lost or damaged their dosimeters shall be required to provide documentation of doses.

4.24 Wearing Dosimeters

4.24.1 Whole body dosimeters shall be worn at the location on the whole body likely to receive the highest dose. Normally this is the mid-section of the torso unless otherwise specified. The “whole body” is defined as the area between the knees and the neck including the upper arms.

4.24.2 Whole body dosimeters shall be worn inside PPE such as coveralls and leaded aprons.

4.24.3 For fetal monitoring for declared pregnant females, whole body dosimeters should be worn on the abdomen. If a leaded apron is worn (as in radiology), the dosimeter should normally be placed on the abdomen, under the apron.

4.24.4 Extremity dosimeters shall be placed on the applicable hand or foot. Ring dosimeters shall be placed on the dominant hand facing in (palm side of the hand). Extremity dosimetry requirements are provided in the RWP.

4.24.5 If multiple dosimeters are required, the procedure for wearing these dosimeters shall be described in the RPP or RWP.

4.25 Reporting Dose

4.25.1 Employees of AECOM that are assigned dosimetry badges shall collect and return used dosimeters to the Site RSO promptly prior to receiving replacement dosimeters at the beginning of a new wear period. The Site RSO will then send the Employee dosimeters, along with the control dosimeter, to the contracted dosimetry provider. Upon receiving the results from them, the Site RSO shall notify the Employees of their reported dose and place copies of the reports in the project files. Dose records are copied and summaries provided to the employee on an annual basis or at the end of project that lasts less than one year.

4.25.2 AECOM Employees may make a written request to obtain a copy of his/her dose records at any time. These records are maintained by and are available from the Site RSO.

4.25.3 After termination of employment, the Site RSO shall provide the former employee with a dose report (termination report) in the recorded dose exceeded 10 percent of any radiation dose limit in the applicable reporting period.

4.26 Internal Dose Monitoring

4.26.1 Use of internal monitoring for a project or program shall be described in the applicable RPP. This section identifies the procedure to be followed when determining if and when Employees are to be included in an internal radiation dose monitoring program. An internal radiation dose monitoring program helps verify that the implemented radioactive material controls maintain internal employee exposures ALARA.

4.26.2 This section applies to AECOM operations and should be used as guidelines for subcontractors who perform radiological investigation, characterization, and remediation work for AECOM. The term Employee refers only to AECOM personnel and the requirements apply only to them and not to subcontractor personnel.

4.26.3 Initial Employment

- New Employees beginning work with AECOM whose job duties specifically require working with and/or exposure to loose or airborne radioactive materials routinely shall inform the Site RSO of their previous radiation exposure history, if any. NRC Form 4 or equivalent may be used.
- Applicable Employees with a previous radiation exposure history who cannot provide documentation of their previous internal exposure shall submit a urine specimen for radiological analysis and/or submit to having a whole body radiation count if requested by the Site RSO.

- Employees without previous radiological exposure experience shall be required to initially submit a urine specimen or have a whole body count accomplished prior to beginning work with radioactive materials.

4.26.4 Initiation of a Project

- Employees assigned to work in a radiologically controlled area where there is loose and/or airborne radioactive material and there is a potential for internal deposition of radionuclides, shall, at the direction of the Site RSO, submit either a 24-hour urine specimen for radiological analysis prior to being permitted in the radiologically controlled area. This requirement establishes the individual's internal radionuclide deposition baseline.
- No Employee shall be permitted in an area where there is the potential for internal deposition of radioactive material without having a baseline bioassay established.
- Bioassays shall only be required if radionuclide(s) present can be effectively monitored for using bioassay methods.

4.26.5 Routine Bioassays

- For Class D (Absorption Type F) radionuclides, a weekly, bi-monthly, or monthly specimen(s) will be collected. A change in sampling frequency may be performed if the Site RSO determines that more sampling is necessary.
- For Class W (Absorption Type M) radionuclides, monthly to quarterly specimens will be collected. A change in sampling frequency may be performed if the Site RSO determines that more sampling is necessary.
- For Class Y (Absorption Type S) radionuclides, quarterly or annual specimens will be collected. A change in sampling frequency may be performed if the Site RSO determines that more sampling is necessary.
- Any Employee who has reason to believe that he/she may have had an internal deposition of radioactive material shall note the time of the suspected intake and promptly notify the Site RSO and Project Manager as soon as possible. When an investigation by the establishment that internal deposition could have occurred, the Employee shall provide a urine specimen for radiological analysis.

4.26.6 Termination of a Project/Exit Bioassay

- At the completion of the project, upon demobilization from the radiologically controlled area, upon termination of employment, or at a time determined by the Site RSO, each Employee who participated in a routine bioassay program shall submit either a urine specimen for radiological analysis or submit to a whole body count at the direction of the Site RSO.

4.26.7 Exceptions to Exit Bioassay

- The Site RSO may request from the Business Group RSO an exception to the above requirement be made. At a minimum, the written request for exception should include measurements and/or calculations that demonstrate that no legal or administrative dose limit was exceeded. The Business Group RSO will approve or disapprove of the request for exception and provide the decision in writing to the Site RSO.

4.26.8 Emergency Response Projects

- Some projects, by their nature, require emergency response personnel to assist in mitigating and/or removing conditions that exist outside normal operating parameters. These responses usually require immediate attention.
- Applicable procedures for emergency response bioassays are found in *S3AM-120-ATT1 Bioassays Procedure*.

4.27 On-Site Management of Radioactive Materials

The on-site management of radioactive materials for a project or program shall be described in the applicable RPP. The safe and efficient management of radioactive material (RAM), low-level radioactive waste (LLRW), and limited generation of Mixed LLRW is paramount to the success of many of field projects. General controls that should be in place for the storage of RAM, LLRW and MLLW include:

- Materials and waste should be segregated and only be stored in a designated Radioactive Material Area.
- Storage of non-radioactive materials in a Radioactive Materials Area is discouraged.
- Each Radioactive Material Area should be approved by the Site RSO.
- The Site RSO or Site Supervisor should conduct walkthroughs of the Radioactive Materials Area to ensure material and waste is properly segregated and stored.
- Generally outdoor storage of RAM is discouraged. However outdoor storage of waste and contaminated equipment may be necessary. Ensure all material is properly stored and contained to prevent the release of radioactivity. Additionally ensure the area is properly secured from inadvertent access and is properly posted.
- RAM should be stored in a manner that reduces combustible loading. The use of cardboard containers for storage is discouraged.
- Flammable or combustible materials should not be stored adjacent to Radioactive Materials Areas.
- Fire protection measures, such as smoke detectors, water sprinklers and fire extinguishers, should be considered when establishing a Radioactive Materials Area.

The following sections address specific on-site controls that's should be in place to confirm that materials will be managed properly without creating unnecessary exposures or spreading contamination.

4.27.1 Material Controls

RAM should only be stored in areas that are clearly designated as Radioactive Materials Areas. Each RAM package stored in a radioactive materials area must be clearly labelled with a "Radioactive" warning label on the outside of the package (10 CFR 20.1904 [a]). Additionally, RAM should be stored such that:

- o Storage areas shall be cordoned off to prevent unauthorized access. If public access to the project site is not strictly controlled, RAM storage areas should be locked in a cage, room or building, or enclosed by a fence.
- o Storage areas having dose rates in excess of 5 mrem/hr at 1 foot from any surface are "radiation areas" and shall posted as such (10 CFR 20.1902 [a]).
- o Storage areas having dose rates in excess of 100 mrem/hr at 1 foot from any surface are "high radiation areas" and shall be posted as such and locked or guarded (10 CFR 20.1902 [b]).
- o Areas in which RAM is used or stored shall be posted as a Radioactive Materials Area (10 CFR 20.1902 [c]).
- o RAM should be stored to minimize exposure in accordance with the ALARA concept. Shielding may be necessary to reduce dose rates to acceptable levels. The Site RSO is responsible for maintaining exposures ALARA.
- o Storage areas shall, at a minimum, be surveyed quarterly for radiation and contamination unless otherwise authorized by the Corporate RSO. Unexpected changes in radiation or contamination levels should be reported to the Corporate RSO as soon as possible.

4.27.2 Contamination Control

- General contamination control methods should be described in RPPs. However, some specific practices may be implemented to help control the spread of contamination during the handling of RAM.
- Personnel should perform and document a survey on incoming used material that may come into contact with radiological contamination. This survey will include scanning measurements and removable contamination smears or large-area maslin wipes and should be conducted before the container enters a controlled area. Survey forms should include a unique container number and date of survey. Should contamination be identified, the container will not be used and the container provider must be notified immediately by the Project Manager or Site Supervisor.
- When practical, personnel should bag or wrap material coming from a Contamination, High Contamination, or Airborne Radioactivity Area if it is confirmed or suspected of having removable radioactive contamination above the site release criteria prior to placing the material in a storage or waste container. Thick or durable bags and plastic wrap should be used to reduce the possibility of punctures and tears. Material with sharp edges or projections should be taped or additionally protected to confirm package integrity. Wrapping or bagging contaminated materials will limit spreading contamination to the interior of the container. If the RAM has removable contamination levels that far exceed the release criteria (e.g., 100 times), additional packaging controls such as double-wrapping, or bagging should be used.
- Alternatively, a reusable waste container, such as an intermodal, may be lined with plastic. Often such containers may be placed at the edge of a contaminated area so that material can be placed into it directly, without prior wrapping. Measures must still be taken to protect the outside of the container and the surrounding area from contamination.
- Removable contamination surveys should be taken on the exterior of waste containers and nearby surfaces each day that waste is placed in the containers to confirm that waste loading activities are not contaminating the container or loading area.

4.27.3 Segregation of Materials

AECOM personnel should attempt to segregate RAM and LLRW by like materials to prevent the unwanted mixing of materials. The following measures should be taken at project sites:

- Solid material shall be stored and packaged separately from liquid materials.
- Liquid materials shall be stored in such a manner that a secondary containment will limit the spread of the material in the event a storage container leaks or ruptures.
- Materials contaminated only with radionuclides with short half-lives (< 120 days) should be placed in separate containers to allow for decay-in-storage.
- Radioactive syringe needles, broken glass, laboratory glassware, and other sharps shall be packaged in a thick-walled plastic bottle with a tight-fitting screw top, a sharps container, or plastic pail.
- Hazardous or potentially hazardous materials shall not be stored with or placed in a container with RAM or LLRW.
- All pathogenic (capable of spreading disease) waste must be deactivated.

4.27.4 LLRW Minimization

AECOM shall institute waste minimization practices at project sites to reduce the generation of radioactive waste and spread of contamination. The following practices should be instituted to support waste minimization:

- Restrict material entering controlled areas to those needed for performance of work. Specifically, packaging materials should remain outside of radiological areas.

- Reuse equipment when practical.
- On larger projects, reserve an assortment of tools primarily for use in controlled areas. Tools should be maintained in a designated storage or distribution area or a contaminated tool crib within the controlled area.
- Emphasize training in waste reduction philosophies and waste minimization techniques.

4.27.5 Naturally Occurring Radioactive Materials

- NORM and TENORM consist of radioactive elements found in the environment, such as uranium, thorium and potassium and any of their decay products, such as radium and radon. They are present in very low concentrations in the earth's crust and are brought to the surface through many activities such as oil and gas exploration or mining and through natural processes like leakage of radon gas to the atmosphere or through dissolving in ground water. They cause problems in many industries and transportation.
- Project Managers on sites suspected of containing NORM should contact the Business Group RSO or designee for information on NORM-related issues such as safety, instrument selection, transportation and disposal, etc. Many states and provinces deal with NORM regulations differently.
- It is recommended the Project Manager or Site Supervisor be familiar with the correct rules and regulations specific to the project site, and determine if employees using radiological instruments need to be trained as NORM Surveyors.
- MicroRoentgen or MicroRem instrumentation is the type of detector most recommended to observe low levels of NORM.

4.27.6 Gauge Sources

- Only Authorized Users trained in the use and handling of portable gauges are authorized to handle the gauges.
- The Business Group RSO is responsible for overall administration, management, coordination, effectiveness, and control of the radiation safety program for AECOM. The Site RSOs are authorized to supervise and administer the radiation safety program at the AECOM locations where gauge sources are stored. Specific requirements for the safe management of gauge sources is provided in AECOM procedure *S3AM-122-PR1 Gauge Source Radiation*.

4.27.7 Transportation

In general, AECOM does not ship radioactive waste from a project site to a disposal facility.

- Project Managers should use certified radioactive waste brokers to support shipments of radioactive waste.
- However, AECOM may be involved in the transportation of radiologically contaminated environmental samples, exempt radioactive check sources, and regulated radioactive gauge sources. Shipping procedures should be provided in by project- or program-specific documents. In the event that a project does not have appropriate procedures to ship radioactive materials, the Project Manager should contact the Site RSO or the Business Group RSO.
- DOT and the CNSC have very specific rules and regulations that govern the transportation of radioactive materials. The DOT's Hazardous Material Regulations are found in 49 CFR 172 and 49 CFR 173. AECOM Employees involved in shipping radioactive materials shall meet the training requirements provided in the appropriate regulations.

4.28 Emergency Procedures

4.28.1 Emergency procedure for a project or program shall be provided in or referenced in the applicable RPP.

4.28.2 Medical Emergencies

- A medical emergency is a situation that presents a significant threat to the health of Employees on site. Chemical exposure, heat stress, injuries, and poisonous insect bites can cause medical emergencies. Proper care must be initiated immediately. Proper care may be in the form of first aid treatment or emergency hospitalization.
- Emergency medical care always has priority over health physics/radioactive contamination concerns and will not be delayed because of such concerns. If possible, health physics personnel should accompany or follow contaminated or potentially contaminated victims to the medical care facility with survey instruments to help medical care providers address this issue.

4.29 Unexpected Levels of Radiation or Airborne Radioactivity

4.29.1 AECOM performs surveys and calculations to demonstrate that exposure rates and airborne radioactivity mandate the use of dosimetry and respiratory protection.

4.29.2 Should these surveys and calculations indicate ambient dose rates greater than 50 mR/hr or airborne radioactive could be greater than 5 percent of an applicable DAC (or if the unity rule applied to airborne radioactivity exceeds 0.05), the Business Group RSO shall be notified and they will then determine the requirements, if any, for additional health physics measure, such as self-reading dosimeters and respiratory protection.

4.30 Excessive Personnel Contamination

4.30.1 Generally, in application of the ALARA principle, no personnel contamination is tolerable.

4.30.2 Any detected personnel contamination shall be reported to the Site RSO immediately. The Site RSO will investigate the cause of and determine the extent of any personnel contamination. The Site RSO will document the incident in case dose evaluations are required later. The Site RSO will report the incident to the Site Supervisor and Project Manager at the earliest opportunity.

4.30.3 Contaminated personnel shall be decontaminated, with assistance from support personnel, prior to exiting the Controlled Area (RCA) or the general area where the contamination occurred. Contaminated personnel shall be decontaminated using materials such as soap and water, waterless hand cleaner, and paper towels or rags whenever possible. All contaminated areas on the body, including hair, should be thoroughly decontaminated. If clothing is contaminated, it should be removed in a way to minimize further contact with the substance.

4.30.4 The Business Group RSO will be consulted for additional guidance if these basic decontamination measures are not completely effective.

4.31 Suspected Inhalation or Ingestion

4.31.1 The Site Supervisor and Business Group RSO will be notified immediately of suspected inhalation or ingestion of radioactive material. The Business Group RSO shall provide appropriate instructions for a suitable response, which may include bioassay.

4.32 Internal Program Assessment

4.32.1 AECOM shall conduct internal assessments of the Radiation Safety Program at least annually to identify its strengths and weaknesses, areas of vulnerability, and noncompliance. The assessment shall include a review of the annual summary reports provided to the Business Group RSO by Site RSO's, examination of the radiological protection program content, and implementation.

5.0 Records

5.1 The Site RSO shall maintain records of ALARA evaluations for a period of 5 years.

5.2 ALARA evaluations shall also be transmitted to the Employee's Area Safety Manager and placed in the Employee's safety training file.

5.3 The Program and Site RSOs shall maintain records of periodic ALARA trending, annual ALARA summary reports, and ALARA evaluations for a period of 5 years.

5.4 General Record-Keeping Requirements

5.4.1 The following records presented in Table 4 shall be maintained by AECOM personnel. These records shall be maintained in a readily retrievable manner that will be subject to internal AECOM inspection and/or regulatory audit.

5.4.2 Surveys, instrument control records, and waste generation/transportation/disposal records generated during work performed for a client at a temporary job location shall become part of the project file and retained or transfer to the client along with other project documents. If work is being performed under an AECOM license, however, all records are also retained by the Site RSO. All records that describe or support assigning occupational dose to AECOM personnel, regardless of whose license the dose was acquired under, shall be maintained by AECOM.

Table 4 – Record Keeping Requirements

Record to Retain	Retention Period	Retained By (Copies To)
Provisions of the Radiation Protection Program for an AECOM License	Until License is Terminated by Agency	Site RSO
Audits of License's Program	3 years	Site RSO
Radiation, Contamination, and Airborne Surveys	3 years	Site RSO or Project File
Instrument Calibrations	3 years	Site RSO or Project File
Training Records	3 years	Site RSO and Project File
Surveys used to perform dose estimates when no instrument data are present	For the life of the company	Site RSO and Human Resources)
Measurements and calculations to determine intake of radionuclides	Forever	Site RSO
Results of air samples, surveys, and bioassays used to determine intake of radionuclides	Forever	Site RSO
Measurements of calculations and measurements used to evaluate the release of radioactive effluents to the environment	Forever	Site RSO
Records of internal and external dose	Forever	Site RSO
Records for Planned Special Exposures	Forever	Site RSO
Records of Individual Monitoring results	Forever	Site RSO
Records of doses to individual members of the public	Forever	Site RSO
Records of Waste Disposal	Until License is terminated by Agency	Site RSO or Project File

6.0 Attachments

6.1 S3AM-120-ATT1 Bioassays Procedure

6.2 S3AM-120-FM1 ALARA Evaluation

6.3 S3AM-120-FM2 Radiation Work Permit

6.4 S3AM-120-FM3 Hazardous Work Permit

6.5 S3AM-120-FM4 Declaration of Pregnancy Form

6.6 S3AM-120-FM5 Embryo/Fetus Initial Dose Calculation

6.7 S3AM-120-FM6 Withdrawal of Declaration of Pregnancy

Americas

Personal Protective Equipment

S3NA-208-PR1

1.0 Purpose and Scope

1.1 Provide an effective Personal Protective Equipment (PPE) Program to protect AECOM employees from potential workplace safety and health hazards.

1.2 This procedure applies to all AECOM Americas-based employees and operations.

1.3 The proper use of appropriate PPE, in combination with effective engineering and administrative controls, can provide AECOM employees with protection against potential workplace hazards and can reduce the potential for workplace injury and illness.

2.0 Terms and Definitions

2.1 **ANSI** – American National Standards Institute

2.2 **CSA** – Canadian Standards Association

2.3 **PPE** – Personal Protective Equipment

2.4 **SDS** – Safety Data Sheets

2.5 **THA –** Task Hazard Assessment

3.0 References

3.1 S3NA-123-PR1 Respiratory Protection

3.2 S3NA-209-PR1 Risk Assessment & Management

3.3 S3NA-301-PR1 Confined Spaces

3.4 S3NA-304-PR1 Fall Protection

3.5 S3NA-315-PR1 Working On & Near Water

3.6 S3NA-317-PR1 Hand Safety

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Managers** or **Supervisors**

- Confirm the location specific SH&E Plan documents required hazard controls.
- Confirm Task Hazard Assessments (THAs) are conducted and hazards identified are eliminated through substitution, engineering, or administrative controls first before assigning PPE for hazard mitigation.
- Confirm appropriate subject matter experts, manufacturer's specifications, and regulatory requirements are consulted as necessary to assist with proper PPE selection.
- Match the appropriate PPE to those hazards that cannot be eliminated; support employees in exercising Stop Work Authority if the task is too hazardous to be mitigated
- Provide and document employee training on use and care of PPE.
- Determine which staff requires employee-issued PPE.

- If applicable, manage medical monitoring of employees using PPE (e.g. respirators, hearing protection, radiation, etc.).
- Approve the purchase of company-issued PPE.
- Confirm that appropriate PPE is utilized by employees when required or necessary. This may periodically be documented using *S3NA-208-FM2 Personal Protective Equipment Inspection*.
- Exercise Stop Work Authority if PPE is inadequate to address hazards

4.1.2 **SH&E Managers**

- Provide guidance to Managers, Supervisors, and staff on the assessment of hazards and the selection of PPE.
- Provide training materials to Managers and Supervisors for employee training

4.1.3 **Employee**

- Review all relevant SH&E Plans, THAs and applicable SDS prior to commencing work.
- Exercise Stop Work Authority if the task is too hazardous.
- In accordance with training and instructions, utilize appropriate PPE that has been issued when required or necessary.
- Inspect PPE prior to and after use to confirm that it is functional, and maintain PPE in a clean and functional condition.
- Follow instructions and manufacturers' guidance on the care, use, and storage of PPE.
- Replace PPE when worn out, expired or damaged.
- Refrain from wearing PPE outside of the work area for which it is required if doing so would constitute a hazard.

4.2 Hazard Assessment

4.2.1 The location specific SH&E plan and THA shall assess the hazards and identify the necessary control measures. Refer to *S3NA-209-PR1Risk Assessment & Management.*

4.2.2 These control measures shall include direction and guidance concerning the appropriate PPE required as the last line of defense to the anticipated hazards of the specific operations and tasks. A PPE specific assessment may assist in identifying PPE requirements. *S3NA-208-FM1 Personal Protective Equipment Assessment* may be completed and included in the SH&E Plan.

4.2.3 Various tasks and operations, including but not limited to, demolition, remediation, spill response, asbestos abatement, and lead removal, may require additional direction concerning selection, use, care, and disposal of PPE from a subject matter expert (e.g. protector manufacturer, industrial hygienist, asbestos professional, etc.).

- Obtained direction shall be included in the SH&E Plan.
- Consultation with subject matters may be limited to the planning phase or they may be retained to provide technical assistance for a portion of or duration of the project.

4.3 Training

4.3.1 All employees shall be informed of their right to Stop Work if the task is too hazardous to mitigate through use of elimination, substitution, engineering controls, administrative controls, and PPE.

4.3.2 Staff will receive adequate instruction on the correct use, limitations, and assigned maintenance duties for the equipment to be used. The following information, at a minimum, will be covered during PPE training:

- What PPE is required.

- When it is required.
- Why it is required.
- How to properly don, doff, adjust, and wear the PPE described.
- The limitations of the PPE, including its expected useful life.
- How to properly care for, maintain, and dispose of the PPE.

4.3.3 Staff are responsible for confirming that they have reviewed the operation manual/instructions for the PPE before work commences.

4.3.4 All staff will receive a location specific orientation to the hazards on the job site as well as appropriate PPE requirements.

4.4 Determining the Need for PPE

4.4.1 Prior to beginning work, the SH&E plan shall be consulted and THAs developed to identify the PPE requirements.

4.4.2 After the hazard assessments have been completed, the manager and/or employee shall select the appropriate PPE for each job category or task, as necessary. PPE will be provided to each employee appropriate for the hazards present. All PPE selected, purchased and used by AECOM will meet or exceed the appropriate ANSI/CSA standards or other standards as determined by federal, provincial, territorial, or state legislation

4.4.3 If the hazard can be mitigated through using appropriate PPE shall:

- Properly fit the employee's body.
- Be selected and used in accordance with recognized standards and provide effective protection.
- Not in itself create a hazard to the wearer (e.g., scratched safety glasses which could cause impaired vision should be replaced with clear safety glasses).
- Be compatible so that one item of PPE does not interfere with other PPE.
- Be maintained in good working order and in a sanitary condition.
- Not be altered in any way.

4.4.4 Prior to entering any controlled or restricted work area, employees shall review the SH&E plan and corresponding THA(s) to confirm that they are equipped with the applicable ANSI/CSA-approved PPE, appropriate to the specific work area's hazards.

4.5 Eye and Face Protection

4.5.1 AECOM employees shall use appropriate eye and face protection when eye or face hazards are present or potential from flying particles, molten metal, liquid chemicals, acid and caustic liquids, chemical gases or vapors, or injurious light radiation.

4.5.2 Safety glasses with side protection is the minimum eye protection requirement. Additional eye protection shall be suitable to the anticipated hazards (e.g. goggles, safety glasses with a face-shield, welder's helmet, etc.). Refer to *SN3NA-208-ATT1 Eye & Face Protection*.

4.6 Head Protection

4.6.1 Appropriate protective hardhats are required when employees are working in areas where there is any potential for injury to the head.

4.6.2 Head protection shall be suitable to the anticipated hazards (e.g. working near exposed electrical conductors requires hardhats designed to reduce electrical shock). Refer to *S3NA-208-ATT2 Head Protection.*

4.7 Foot Protection

4.7.1 AECOM employees shall use appropriate foot protection when hazards to feet are present or potential; including impact, puncture, cut, electrical, thermal or chemical hazards.

4.7.2 Refer to *S3NA-208-ATT3 Foot Protection.*

4.8 Hand Protection

4.8.1 Appropriate hand protection is required when employee's hands are exposed to hazards such as those from skin absorption of harmful substances, cuts and lacerations, abrasions, punctures, chemical burns, thermal burns, electricity, or harmful temperature extremes.

4.8.2 Refer to *S3NA-208-ATT4 Hand Protection* and *S3NA-317-PR1 Hand Safety*.

4.9 Chemically Resistant Clothing

4.9.1 Chemically resistant clothing is required when there is significant potential for the employee to come in direct contact with the chemicals being handled. Tasks that involve chemical handling will be evaluated for potential splashing or spilling. Refer to *S3NA-208-ATT5 Limb & Body Protection*.

4.9.2 The process for selecting chemical resistant clothing will be similar for the selection of chemical resistant gloves (refer to *S3NA-208-ATT4-Hand Protection* and *S3NA-317-PR1 Hand Safety*).

4.10 High-Visibility Apparel

4.10.1 “High visibility safety apparel” means personal protective safety clothing that is intended to provide conspicuity during both daytime and nighttime usage and that meets the Performance Class II or III requirements of ANSI/CSA standards. Refer to *S3NA-208-ATT6 High Visibility Safety Apparel.*

4.10.2 Color of apparel (orange or lime) may be client/project-specific. If there is a specific need to be visible to the passing public, to machine operators, or to other crew members, high visibility vests shall be worn (and retro-reflective striping on arms and legs at night).

4.10.3 Work conducted at night may require that the minimum level of apparel worn be, at minimum, ANSI/CSA Class III, and in accordance with the governing legislation.

4.11 Personal Clothing

4.11.1 Employees on a project site shall wear full length trousers and shirts that cover shoulders.

4.11.2 For personal safety on the job site, do not wear

- Loose or unsecured clothing or loose fitting cuffs;
- Greasy or oily clothing, gloves, or boots; or
- Torn or ragged clothing.
- Jewelry (e.g. rings, bracelets, neck chains) when working with moving parts or there is a risk or entanglement.

4.11.3 Long hair shall be tied back or otherwise confined when working with moving parts or there is a risk of entanglement.

4.11.4 Clothing made of synthetic fibers can be readily ignited and melted by electric flash or extreme heat sources. Cotton or wool fabrics are recommended for general use.

4.11.5 Footwear shall be suitable for the site conditions and task requirements. No athletic shoes, sandals, flip flops, permitted on active job sites.

4.11.6 It is recommended to use clothing with sun protection properties when working in high sun uv exposure

4.12 Specialized PPE

4.12.1 In addition to basic PPE, additional specialized PPE may be required to provide appropriate protection to the employee. Refer to applicable legislation and related SH&E procedures for additional information on PPE requirements.

- Fall Protection – Only full-body harnesses with shock-absorbing lanyards will be used for personal fall arrest. Refer to *S3NA-304-PR1 Fall Protection*.
- Respiratory Protection – Respiratory protection shall be selected based on the contaminant and concentration to which the employee will be exposed. Refer to *S3NA-123 PR1 Respiratory Protection*, the task- or project-specific hazard assessments and the applicable SDSs for specific requirements.
- Fire Resistant Clothing (FRC) – Approved fire-resistant outer clothing may be required at work locations with flammable or explosive materials or environments. Refer to *S3NA-208-ATT5 Limb & Body Protection.*
- Other Head Protection – Operators and passengers (if trained and permitted) of all-terrain vehicles and snowmobiles will wear approved helmets. Refer to *S3NA-208-ATT2 Head Protection.*
- Protection from Drowning – Appropriate personal floatation devices shall be worn when work working over and near water. Refer to *S3NA-315 Working On & Near Water*.
- Temperature Extremes – Work in cold environments may require additional layers and insulated clothing, gloves, boots and accessories such as balaclavas, hardhat liners. Confirm these items are approved and do not introduce additional unacceptable hazards (e.g. insufficient visibility, conductivity, etc.).
- Hearing Protection – Noise levels in the work environment that cannot be eliminated or reduced to acceptable levels requires worker be protected from exposure. Refer to *S3NA-118-PR1 Hearing Conservation.*
- Traction Devices – Traction devices applied to the base of work boots may be necessary if the employee may be walking on icy surfaces. Refer to *S3NA-208-ATT3 Foot Protection*.
- Rescue – Confined spaces hazards may necessitate the use of specific harnesses attached to retrieval lines to facilitate rescue. Refer to *S3NA-301-PR1 Confined Spaces*.

4.13 Maintaining PPE Supplies

4.13.1 Employees shall inspect their required PPE prior to use. Defective equipment shall be removed from service and replaced.

4.13.2 Each AECOM location will maintain a supply of safety equipment of appropriate types and sizes, including hard hats, high visibility vests, safety glasses, gloves, hearing protection and chemically resistant clothing based on the nature of their field activities. The Manager or designee will be responsible for maintaining this inventory.

4.13.3 Use of PPE by employees and adequacy of protection should be evaluated on a routine basis. This may periodically be documented using *S3NA-208-FM2 Personal Protective Equipment Inspection.*

4.13.4 At a minimum, locations will review their PPE program annually.

4.14 Obtaining Personalized Safety Gear

4.14.1 Employees are not expected to provide their own general PPE. Most basic PPE will be provided to the employee at no charge (e.g. safety glasses, hard hat, gloves, hearing protection, etc.) with the exception of the below personalized safety equipment (prescription safety glasses, safety-toed boots, any washable coveralls).

4.14.2 Certain personalized safety gear such as prescription safety glasses, safety-toed (capped) boots, and any washable coveralls will be ordered and sized specifically by the user. A partial cost reimbursement to the employee may be made if their location provides a specialized PPE purchase program.

4.14.3 All specialized PPE (e.g. fall protection equipment, respirators, helmets, etc.) will be provided by AECOM for employee use at no charge to the employee, with the exception of the above personalized safety equipment (prescription safety glasses, safety-toed boots, any washable coveralls).

5.0 Records

5.1 Completed SH&E plans, THAs documenting PPE requirements, and as applicable, PPE assessments and PPE inspections, will be maintained in the location's safety files.

6.0 Attachments

6.1	S3NA-208-ATT1	Eye & Face Protection
6.2	S3NA-208-ATT2	Head Protection
6.3	S3NA-208-ATT3	Foot Protection
6.4	S3NA-208-ATT4	Hand Protection
6.5	S3NA-208-ATT5	Limb & Body Protection
6.6	S3NA-208-ATT6	High Visibility Safety Apparel
6.7	S3NA-208-FM1	Personal Protective Equipment Assessment
6.8	S3NA-208-FM2	Personal Protective Equipment Inspection

Americas

Hand & Power Tools

S3AM-305-PR1

1.0 Purpose and Scope

1.1 This procedure provides the AECOM requirements for all manually operated hand and power tools and associated use, handling and storage. These requirements apply to tools provided by AECOM for employee use as well as tools provided by employees for use on AECOM work sites.

1.2 This procedure applies to all AECOM Americas-based employees and operations.

2.0 Terms and Definitions

2.1 None

3.0 References

3.1 S3AM-003-PR1 SH&E Training

3.2 S3AM-118-PR1 Hearing Conservation

3.3 S3AM-208-PR1 Personal Protective Equipment

3.4 S3AM-302-PR1 Electrical Safety

3.5 S3AM-325-PR1 Lockout Tagout

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Managers/Supervisors**

- Ensure that all aspects of this procedure are followed and adhered to on all AECOM projects, sites and locations.
- If a specific tool is not included in the work instructions related to this procedure, appropriate guidelines shall be established prior to work associated with that tool, including following manufacturer's recommendations.
- Ensure compliance with applicable client requirements and restrictions regarding hand or power tools.

4.1.2 **Safety, Health and Environment (SH&E) Manager**

- Provide technical guidance and support as to this procedure and associated work instructions.

4.1.3 **Employees**

- Work only with tools for which they are appropriately trained and familiar with.
- Follow manufacturer's recommendations for its use and never modify the equipment without first obtaining authorization from the manufacturer.
- Comply with applicable client requirements and restrictions regarding hand or power tools.

4.2 Requirements

4.2.1 Always conduct a task hazard assessment (THA) prior to work commencing and include the identified hazards associated with the anticipated tool use.

4.2.2 No employee shall use any hand or power tool, unless they are familiar with the use and operation of the equipment or have received specific instruction on its use and operation.

4.2.3 All tools will be used for which they were designed and in accordance with manufacturer's specifications. Do not use tools for jobs they are not intended for. For example, do not use a slot screw driver as a chisel, pry bar, wedge or punch or wrenches as hammers.

4.2.4 Use approved tools only. Never modify or use makeshift tools.

4.2.5 Do not apply excessive force or pressure on tools unless permitted by the manufacturer's specifications. This includes additional force by hammering with body weight, foot or other tools.

4.2.6 Keep surfaces and handles clean and free of excess oil and grease to prevent slipping.

4.2.7 Do not carry sharp tools (e.g. knife, chisel, screwdriver, etc.) in pockets; this practice may cause puncture wounds.

4.2.8 All tools shall be properly maintained. Clean, dry, lubricate and repair tools as applicable, and return to a suitable toolbox, room, rack, or other storage area upon completion of a job.

4.2.9 Ensure proper ergonomics principles are observed when using hand and power tools, such as but not limited to:

- Avoid static and awkward positions when possible.
    - Move at intervals to reduce muscle fatigue.
    - Consider tools with a trigger strip, rather than a trigger button. This strip will allow the exertion of more force over a greater area of the hand that, in turn, will reduce muscle fatigue
- Do not apply excessive force or pressure on tools.
- If possible use tools with comfortable grips that are designed to allow the wrist to stay straight. Avoid using a bent wrist.
- Choose hand tools that have a centre of gravity within or close to the handle.
- Frequently used tools that weigh more than 1 pound (0.45 kilograms) should be counter-balanced.
- Ensure proper body positioning when using a tool to prevent slips or falls in the event of unanticipated tool behaviour (slip, kickback, etc.). Avoid over-reaching.
- Pull on tools such as a wrench or pliers whenever possible. Loss of balance is more likely when pushing if the tool slips. If pushing is necessary, hold the tool with an open palm.
- Hand-arm vibration exposure is associated with the use of hand tools.
    - Reduce power to the lowest setting that can complete the job safely. This action reduces tool vibration at the source.
    - Consider the need for controls such as limiting time of use.
    - If safe to do so, adjust to a looser but stable grip, and use anti-vibration gloves.
- Use of heavy tools such as jackhammers can cause fatigue and strains. Heavy rubber grips can reduce these effects by providing a secure handhold.
- Do not increase a tool's leverage by adding sleeved additions (e.g. a pipe or snipe) to increase tool handle length.

4.2.10 Avoid placing fingers and hands in danger zones:

- Ensure hands and fingers have sufficient clearance in the event the tool slips.
- Ensure stability of the work-piece. Use work-piece holders (e.g. vise, chisel holder, etc.) whenever possible to prevent injury to hands or deflection of tool or work-piece.
- Use push sticks or guides when cutting or machining smaller material.

4.2.11 Secure tools when working from heights to prevent them from falling. Never leave tools on ladders, scaffolds, or overhead work areas when they are not in use.

4.2.12 Utilize good housekeeping practices to ensure tools do not present a tripping hazard.

4.2.13 Ensure no part of a tool extends over the edge of the bench top. Place sharp tools (e.g., saws, chisels, knives) on benches so that sharp points or edges face away from the edge.

4.2.14 When using saw blades, knives, or other tools, if possible direct the tools away from aisle areas and away from other employees working in close proximity.

4.2.15 Do not throw tools from place to place or from person to person, or drop tools from heights. Hand them, handle first, directly to other workers.

4.2.16 Use non-sparking and intrinsically safe tools in atmospheres with flammable or explosive characteristics and where highly volatile liquids, and other explosive substances are stored or used.

- Iron or steel hand tools may produce sparks that can be an ignition source around flammable substances. Where this hazard exists, spark-resistant tools made of non-ferrous materials shall be used.
- Electrical tools shall be identified as intrinsically safe.

4.2.17 If the task presents electrical hazards, worker must be competent and use the appropriate insulated tools to perform work that includes the risk of electrical shock. Cushioned grip handles do not protect against electrical shock.

4.2.18 The fluid used in hydraulic power tools must be an approved fire-resistant fluid and must retain its operating characteristics at the most extreme temperatures to which it will be exposed. The exception to fire-resistant fluid involves all hydraulic fluids used for the insulated sections of derrick trucks, aerial lifts, and hydraulic tools that are used on or around energized lines. This hydraulic fluid shall be of the insulating type.

4.2.19 All tools designed to accommodate guards must have the guard(s) in place when the tool is in use. Do not modify, remove, or disable any machine guards.

4.2.20 Do not allow loose clothing, long hair, loose jewelry, rings, and chains to be worn while working with power tools.

4.2.21 Make provisions to prevent tools from automatically restarting upon restoration of power. Refer to *S3AM-325-PR Lockout Tagout*.

4.3 Training

4.3.1 Instruction in the proper use, safe handling, and maintenance of tools will be provided to employees unfamiliar with the tool.

- Assess the employee's training needs as per *S3AM-003-PR1 SH&E Training* procedure.
- Refer to the applicable work instructions associated with this procedure for any additional training specifics.
- Training shall include applicable manufacturer's recommendations and guidelines.

4.3.2 Employees shall demonstrate knowledge and competency in the use, safe handling and maintenance of the applicable tool prior to operation.

4.4 Personal Protective Equipment (PPE)

4.4.1 Utilize basic PPE appropriate to the task; gloves, safety-toed boots, hard hats and safety glasses with side shields. Refer to *S3AM-208-PR1 Personal Protective Equipment*.

4.4.2 Ensure lockout devices (padlocks, multiple lock hasps, tags) are utilized as necessary. Refer to *S3AM-325-PR Lockout Tagout*.

4.4.3 Ensure PPE is appropriate to the work and use additional PPE as required (e.g. mono-goggles, hearing protection, respiratory protection, etc.).

- Dual eye protection is required to be worn by any employee undertaking or within 3 ½ feet (1 meter) of a task that produces projected particles or material.
- Head and face protection is recommended for employees working with pneumatic tools.
- Noise hazard is associated with pneumatic and many other tools. Working with noisy tools such as jackhammers requires proper, effective use of appropriate hearing protection.

4.4.4 Screens shall also be set up to protect nearby workers from being struck by flying fragments around chippers, riveting guns, staplers, or air drills.

4.4.5 Refer to the applicable work instructions associated with this procedure for any additional specialized PPE.

4.5 Inspections

4.5.1 All tools must be inspected prior to each use.

- Any tool that is defective or has missing parts must not be used.
- Every broken or defective tool must be tagged ‘out of service’ or ‘do not use’ and immediately removed from service.
- Tagged tools will be returned to the supervisor for repair or replacement.

4.5.2 All tools must be inspected to manufacture’s specifications and according to tool rests and guard adjustment tolerances. All tools will be inspected to ascertain that all safety devices are present and functioning properly. Refer to *S3AM-305-FM1 Hand & Power Tool Maintenance Inventory* and *S3AM-305-FM2 Hand & Power Tool Inspection Report*.

5.0 Records

5.1 None

6.0 Attachments

6.1 S3AM-305-ATT1 Chainsaw

6.2 S3AM-305-ATT2 Circular Saw

6.3 S3AM-305-ATT3 Cut Off Saw

6.4 S3AM-305-ATT4 Handheld Grinder

6.5 S3AM-305-ATT5 Impact Wrench

6.6 S3AM-305-ATT6 Nail Gun

6.7 S3AM-305-ATT7 Dustless Vacuum

6.8 S3AM-305-ATT8 Power Drill

6.9 S3AM-305-ATT9 Pressure Washer

6.10 S3AM-305-ATT10 Reciprocating Saw

6.11 S3AM-305-ATT11 Sander

6.12 S3AM-305-ATT12 Knives

6.13 S3AM-305-ATT13 Clearing & Grubbing Equipment

6.14 S3AM-305-ATT14 Pneumatic Tools

6.15 S3AM-305-ATT15 Manual Hand Tools

6.16 S3AM-305-ATT16 Small Engines

6.17 S3AM-305-ATT17 Electric & Battery Hand Tools

6.18 S3AM-305-FM1 Hand & Power Tool Maintenance Inventory

6.19 S3AM-305-FM2 Hand & Power Tool Inspection Report

Wildlife, Plants & Insects

1.0 Purpose and Scope

1.1 Communicates the requirements and precautions to be taken by AECOM employees to protect against the biological hazards associated with insects, arachnids, snakes, poisonous plants, and other animals referred to herein collectively as “biological hazards”.

1.2 This procedure applies to all AECOM Americas-based employees and operations.

2.0 Terms and Definitions

2.1 **Field Work –** Any activity conducted at a site that contains brush, overgrown grass, leaf litter, poisonous plants, or is located near mosquito breeding areas and includes work in structures where animals might exist that harbor fleas or ticks or where spiders and mites could be present. Field work includes, but is not limited to, Phase I, Phase II, Operations Monitoring & Maintenance, biological surveys, and other work that meets the definition of field work.

2.2 **Poisonous** – Capable of harming or killing by or as if by poison; toxic or venomous.

2.3 **Phase I Environmental Site Assessment –** Investigation of real property to determine the possibility of contamination, based on visual observation and property history, but no physical testing. Under new Environmental Protection Agency regulations that went into effect on November 1, 2006, a Phase I, as it is called for short, will be mandatory for all investors who wish to take advantage of Comprehensive Environmental Response, Compensation, and Liability Act defenses that will shield them from liability for future cleanup, should that prove necessary. The new Phase I rules, called “All Appropriate Inquiry” or AAI, also require more investigation than previously mandated. Investors can expect to see dramatic price increases over prior experiences.

2.4 **Phase II Environmental Site Assessment** – Investigation of real property through physical samplings and analyses to determine the nature and extent of contamination and, if indicated, a description of the recommended remediation method.

3.0 References

3.1 RS2-001-PR1 Firearms Standard

3.2 S3AM-004-PR1 Incident Reporting, Notifications & Investigation

3.3 S3AM-008-PR1 Fitness for Duty

3.4 S3AM-113-PR1 Heat Stress

3.5 S3AM-208-PR1 Personal Protective Equipment

3.6 S3AM-209-PR1 Risk Assessment & Management

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Managers / Supervisors**

- Responsible for managing field work.
- Work with employees to see that a Task Hazard Analysis (THA) for the work to be conducted has been performed prior to the beginning of the field work and that it includes an assessment of potential biological hazards.

- Implement control measures at the location to reduce the potential for employees to be exposed to injuries and illnesses from biological hazards while working.
- If the exposures cannot be eliminated or managed with engineering controls, approve the use and cost of Personal Protective Equipment (PPE) and protective repellents and lotions and confirm that exposed employees have and use these products.

4.1.2 **SH&E Manager**

- Confirm training and guidance is provided to employees consistent with this procedure.
- During the performance of site visits, assess the precautions being taken against biological hazards for compliance with this procedure.
- Assist AECOM personnel in identifying hazards and selecting appropriate control measures.
- As applicable, review and approve relevant SH&E Plans for locations that have biological hazards.

4.1.3 **Employees**

- Participate in required training related this procedure.
- Participate in the development of THAs for the task, identify control measures to limit exposure and request PPE, repellents, and protective lotions identified by this procedure.
- Update the applicable THA when a new, unaccounted for biological hazard is identified. Employee shall stop work to identify appropriate elimination or control measures (and obtain any necessary guidance) before continuing work.
- Obtain approval from Managers and/or Supervisors to purchase selected PPE prior to purchasing.
- Implement the precautions appropriate to prevent exposure to the hazardous wildlife, insects and plants.
- Observe requirements for reporting (e.g. tick bites, skin irritations, etc.) as detailed within the procedure and attachments.

4.2 Training

4.2.1 Employees shall be trained to recognize organisms that represent a threat in the regions in which they work – experienced field staff shall provide on the job training to assist staff with hazard recognition.

4.2.2 Employees shall be properly trained to the anticipated tasks and the associated required PPE.

4.3 Overview

4.3.1 The procedures discussed below are detailed because these hazards have historically posed the most significant risk to AECOM employees. Note that this discussion is not a fully encompassing list of hazards. As part of the SH&E Plan and THA developed by the AECOM personnel, in accordance with *S3AM-209-PR1 Risk Assessment & Management*, additional consideration shall be given to other biological hazards.

4.3.2 Departments of Public Health local to the worksite, as well as the Centers for Disease Control (CDC) can serve as a resource for identifying biological hazards not discussed in this procedure.

4.3.3 If additional biological hazards are identified, employees should stop work and contact the SH&E Manager to discuss the hazards and identify effective control measures. Those control measures shall be implemented at the location prior to restarting work.

4.4 Employee Sensitivity

4.4.1 Sensitivity to toxins generated by plants, insects and animals varies according to dosage and the ability of the victim to process the toxin; therefore, it is difficult to predict whether a reaction will

occur, or how severe the reaction will be. Employees should be aware that there are a large number of organisms capable of causing serious irritations and allergic reactions. Some reactions will only erupt if a secondary exposure to sunlight occurs. Depending on the severity of the reaction, the result can be severe scarring, blindness or even death.

4.4.2 Employees also need to consider whether they are sensitive to the use of insect repellents.

4.5 Planning and Hazard Assessment

4.5.1 AECOM personnel shall confirm that the potential for exposure to specific biological hazards are assessed prior to the commencement of work and that the procedures specified by this procedure are integrated into the THA planning process and conveyed to employees conducting the field work. This information shall be communicated in the location-specific SH&E plan, the THA, pre-project kickoff meetings, and tailgate meetings at the location.

4.5.2 It is important to note that the precautions to be taken by employees to decrease the risk of exposure to biological hazards can directly increase the risk of heat-related illness due to thermal stresses. Therefore, heat stress monitoring and precautions shall be included as a critical component of the task-specific THA in accordance with *S3AM-511-PR1 Heat Stress.*

4.5.3 During the preparation of the location-specific SH&E plan and task specific THA, Managers, Supervisors, and employees shall determine what biological hazards might be encountered during the task or operations and shall prescribe the precautions to be taken to reduce the potential for exposure and the severity of resulting illnesses. Consideration will be given to conditions such as weather, proximity to breeding areas, host animals, and published information discussing the presence of the hazards.

4.5.4 It should be assumed that at least one of the biological hazards exists whenever working on undeveloped property. This can include insect activity any time that local temperatures exceed 40 degrees Fahrenheit (4.5 degrees Celsius) for a period of more than 24 hours. The stubble and roots of poisonous plants can be a hazard any time of year, including when some plants are dormant or mown.

4.5.5 The hazard assessments shall also consider the additional hazards posed by vegetative clearing such as the increased risk of coming in contact with poison ivy, oak or sumac and hazards associated with the use of tools and equipment to remove vegetation.

4.5.6 Employees in the field where biological hazards exist shall not enter the hazard areas unless they are wearing the appropriate protective clothing, repellents, and barrier creams specified below. If the hazard is recognized in the field but was not adequately assessed during the THA, the field staff shall stop work and not proceed until the THA has been amended and approved and protective measures implemented.

4.5.7 Employees who have severe allergic reactions are strongly recommended to notify their Manager, field Supervisor and co-workers of the potential for a reaction and demonstrate what medication they might need, where they keep it and how it is administered.

4.5.8 A decision flow chart and table for determining the potential for biological hazards in the Americas has been provided in *S3AM-313-ATT1 Biological Hazard Assessment Flow Chart.*

4.5.9 Restrictions:

- No firearms or weapons are allowed to be used without express permission by the Region Executive and Chief Resilience Officer, refer to the *RS2-001-PR1 Firearms Standard*.
- No weapons related work shall occur without an assessment that includes appropriate hazard control measures and training.
- Staff with life-threatening reactions shall not undertake work in areas infested with the allergen (e.g., wasps, poison ivy), unless precautions are met which satisfy a medical practitioner's requirements. Refer to *S3AM-008-PR1 Fitness for Duty*.

4.5.10 Precautions

- Be aware of the potential irritants in your area and know how to recognize them.
- Modify activities to avoid encounters (diurnal rhythms, seasonal rhythms).
- Avoid wearing perfume and cologne and strong smelling deodorants, lotions, soaps, and shampoos.
- When working in areas where there may be small insects that "hitchhike" (e.g., ticks, spiders, scorpions), it is recommended that clothes are turned inside out and shaken at the end of day; do not wear same clothes two days in a row.
- Staff should always be aware of where they are placing their hands, or where they are sitting in order to avoid contact with potential toxins. Avoid reaching into areas where visibility is limited.

4.6 Wildlife Hazards (Wild Animals, Reptiles and Birds)

4.6.1 Employees shall not work alone in areas where the risk of an encounter with dangerous wildlife is high. Wildlife handling shall only be completed under direct supervision of an experienced individual. Refer to the following work instructions for more specifics:

- *S3AM-313-ATT13 Alligators*
- *S3AM-313-ATT9 Large Carnivores & Ungulates*
- *S3AM-313-ATT10 Bear Safety*
- *S3AM-313-ATT11 Small Mammals*
- *S3AM-313-ATT12 Snakes & Scorpions*

4.7 Ticks, Spiders and other Insects

4.7.1 Insects for which precautionary measures should be taken include but are not limited to: mosquitoes (potential carriers of disease aside from dermatitis), black flies, wasps, bees, ticks, fire ants and European fire ants.

4.7.2 Employees with known allergies to insect stings should consult their personal physician for advice on any immediate medications that they should carry with them. Epi-pens[1] shall be carried at all times in the field by employees who are aware that anaphylactic shock is a possibility for them AECOM highly recommends that employees with known allergies inform their co-workers of the allergy and the location of the medications they might carry for the allergy.

4.7.3 Habitat Avoidance, Elimination and/or Control

- The most effective method to manage worker safety and health is to eliminate, avoid and/or control hazards. Clearing the location of brush, high grass and foliage reduces the potential for exposure to biological hazards. Clearing will not eliminate the exposure to flying insects and there might be an increased exposure to ticks and spiders during the clearing process.
- Projects such as subsurface environmental assessment or remediation are often candidates for brush and overgrown grass to be cleared. In these instances, the Manager shall either request that the client eliminate vegetation, or request approval from the client to have vegetation clearing added to the scope of work.
    - o It should be noted that vegetation clearance may unintentionally serve to spread noxious and poisonous plant materials around the site.
    - o As applicable, measures should be taken to prevent spread, such as but not limited to, confirming equipment and materials are not placed on affected areas, and equipment is decontaminated after use and before removal from site.

[1] *Epi-pens must be prescribed by a personal physician. Renew epi-pens on a regular schedule to ensure effectiveness and make sure your field companions know where it is and how to use it if you cannot self-administer the dose.*

- When work shall be conducted in areas that cannot or may not be cleared of foliage, personal precautions and protective measures shall be prescribed.
- Mosquitoes breed in stagnant water and typically only travel a quarter mile (less than half a kilometer) from their breeding site. Whenever possible, stagnant water should be drained to eliminate breeding areas. Managers and client site managers should be contacted to determine whether water can be drained and the most appropriate method for draining containers, containment areas, and other objects of standing water.
- If water cannot be drained, products similar to Mosquito Dunks® can be placed in the water to control mosquitoes. Once wet, the Mosquito Dunks® kill the immature, aquatic stage of the mosquito. The active ingredient is a beneficial organism that is lethal to mosquito larvae, but harmless to fish, humans, and other animals. Mosquito Dunks® provide long-term protection for 30 days or more.

4.7.4 Ticks

- Ticks can be encountered when walking in tall grass or shrubs. They crawl up clothing searching for exposed skin where they will attach themselves. The most serious concern is a possibility of contracting a disease.
- Data from the CDC indicates that tick-borne diseases have become increasingly prevalent. At the same time, tick repellents have become both safe and effective so it is possible to prevent the vast majority of bites and, therefore, most related illnesses. The use of permethrin is strongly advised.
- The most common and severe tick-borne illnesses in the U.S. are Lyme disease, Ehrlichiosis, and Rocky Mountain spotted fever. A summary table listing CDC informational resources for these diseases is provided in *S3AM-313-ATT2 Ticks* along with a listing of CDC information resources and maps showing the distribution of common tick-borne diseases in the U.S.
- When working in areas where ticks may occur, it is recommended that clothes are turned inside out and shaken at the end of day; do not wear the same clothes two days in a row.
- To remove ticks that are embedded in skin, utilize a tick key. Alternatively use tweezers or fingers to carefully grasp the tick as close to the skin as possible and pull slowly upward, avoiding twisting or crushing the tick. Do not try to burn or smother the tick. Cleanse the bite area with soap and water, alcohol, or household antiseptic. Note the date and location of the bite and save the tick in a secure container such as an empty pill vial or film canister. A bit of moistened paper towel placed inside the container will keep ticks from drying out. Follow AECOM incident reporting guidelines to report the tick bite within 4 hours and notify the Manager or Supervisor.
- Familiarize yourself with the characteristic bulls-eye pattern of Lyme disease infection surrounding the bite. If you notice this type of pattern or rash resulting from a tick bite, immediately report the issue to your supervisor and follow the incident reporting requirements for your business group.
- If you experience symptoms such as fever, headache, fatigue, and a skin rash, you should immediately visit a medical practitioner as Lyme disease is treated easily with antibiotics in the early stages, but can spread to the heart, joints, and nervous system if left untreated.

4.7.5 Chiggers

- Chiggers are mite larvae, approximately ½ millimeter in size, and typically invisible to the naked eye. While chiggers are not known to carry infectious diseases, their bites and resulting rashes and itching can lead to dermatitis and a secondary infection.
- Chiggers are typically active from the last hard freeze in the winter or spring to the first hard freeze. They are active all year in the Gulf Coast and tropical areas.

4.7.6 Spiders

- Spiders can be found in derelict buildings, sheltered areas, basements, storage areas, well heads and even on open ground. Spiders can be found year round in sheltered areas and are often present in well heads and valve boxes.
- Most spider bites produce wounds with localized inflammation and swelling. The Black Widow and Brown Recluse spiders in the U.S. and others outside the U.S. inject a toxin that causes extensive tissue damage and intense pain.
- Additional information on spider identification can be found in attachment *S3AM-313-ATT3 Poisonous Spider Identification*.

4.7.7 Mosquitoes

- When a mosquito bites, it injects an enzyme that breaks down blood capillaries and acts as an anticoagulant. The enzymes induce an immune response in the host that results in itching and local inflammation. The tendency to scratch the bite sites can lead to secondary infections.
- CDC data indicates that mosquito-borne illnesses, including the strains of encephalitis, are a health risk. At least one of the Encephalitis strains listed below is known to exist in every area of the U.S. and in many other countries as well:
    - Eastern Equine encephalitis
    - Western Equine encephalitis
    - West Nile Virus
    - St. Louis encephalitis
    - La Crosse encephalitis
- Mosquitoes can transmit the West Nile Virus and other forms of encephalitis after becoming infected by feeding on the blood of birds which carry the virus.
- Most people infected with the virus experience no symptoms or they have flu-like symptoms. Sometimes though, the virus can cause severe illness, resulting in hospitalization and even death, so proper precautions should be taken. Consult a medical practitioner if you suspect you have West Nile Virus. Other diseases including Dengue Fever and Malaria are spread by mosquitoes in the sub-tropic and tropical parts of the world. See *S3AM-313-ATT4 Mosquito Borne Diseases* for information on the locations where mosquito borne diseases are known to be present.

4.7.8 Bees, Wasps and Hornets

- Wasps and bees will cause a painful sting to anyone if they are harassed. They are of most concern for individuals with allergic reactions who can go into anaphylactic shock. Also, instances where an individual is exposed to multiple stings can cause a serious health concern for anyone. These insects are most likely to sting when their hive or nest is threatened.
- Bees, hornets, and wasps may be found in derelict buildings, sheltered areas, behind covers or lids and even on open ground. Other protective measures are not normally effective against aggressive, flying insects. Be aware of the potential areas for these types of insects, approach these locations cautiously. Avoid reaching into areas where visibility is limited.
- If you see a nest in the area you are working in stop work. Contact the Manager or Site Supervisor for procedures to have the nest removed.
- If stung by a wasp, bee or hornet, notify a co-worker or someone who can help should you have an allergic reaction. Stay calm and treat the area with ice or cold water. Follow AECOM incident reporting guidelines to report the sting within 4 hours and notify the Manager or Supervisor immediately. Seek medical attention if you have any reactions to the sting such as developing a rash, excessive swelling or pain at the site of the bite or sting, or any swelling or numbness beyond the site of the bite or sting.

4.7.9 Fire Ants

- The fire ant (southern and western U.S.) and the European fire ant (northeastern U.S. and eastern Canada) is often very abundant where it is established. It is very aggressive and commonly climbs up clothing and stings unprovoked when it comes into contact with skin. Painful irritations will persist for an hour or more.

4.7.10 Personal Protective Equipment (PPE)

- Chemically-treated field clothing, full-length clothing, or Tyvek® coveralls.
- Gloves shall also be worn consistent with the recommendations of the site-specific SWP and/or THA to minimize hand exposure.
- Where ticks, chiggers, and spiders are presumed to exist, the Tyvek® or chemically treated clothing will be taped to the work boots.
- See *S3AM-313-ATT2 Ticks* for configuration of clothing for protection against ticks and insects.
- Application of insect repellent to clothing and/or exposed skin. Oil of lemon eucalyptus, DEET, and Permethrin have been recommended by the CDC for effective protection against mosquitoes that may carry the West Nile virus and related diseases.
- Note that DEET will reduce the effectiveness of Fire Resistance Clothing (FRC) and should not be applied to this clothing. If working in FRC, employees can use Permethrin as it has been shown not to reduce the effectiveness of FRC. Permethrin will need to be applied to FRC well in advance of the planned work. If permethrin is unavailable employees can apply DEET to their skin and let dry prior to putting FRC on.
    - Oil of Lemon Eucalyptus is a plant-based insect repellent on the market as Repel Lemon Eucalyptus. The products have been proven to be effective against mosquitoes, deer ticks, and no-see-ums for up to six hours. Derived from Oil of Lemon Eucalyptus, this non-greasy lotion or spray has a pleasant scent and is not known to be toxic to humans. The spray or lotions will be effective for approximately two to six hours and should be reapplied every two hours to sustain protection. Lemon Eucalyptus products cannot be applied to fire retardant clothing.
    - Permethrin is an insecticide with repellent properties registered with the Environmental Protection Agency and recommended by the CDC.
        - Permethrin is highly effective in preventing tick bites when applied to clothing, but is not effective when applied directly to the skin. Two options are available for Permethrin treatment of clothing worn during field work: 1) pre-treatment of fabric by the clothing manufacturer; or 2) manual treatment of their personal clothing using Permethrin spray in accordance with recommendations manufacturers recommendations. This will likely require treatment at home or the office prior to field mobilization. Caution should be used when applying Permethrin as it is highly toxic to fish and house cats. AECOM strongly recommends the first option (employees obtaining pre-treated clothing) to avoid the time required, potential risk, and housekeeping issues involved with manually treating the clothing with spray. Purchase pre-treated clothing in accordance with *S3AM-208-PR1 Personal Protective Equipment* and with the approval of your Supervisor or Manager.
        - The Permethrin pre-treatment is odorless and retains its effectiveness for approximately 25 washings. After 25 washings, the pre-treated clothing will be considered no longer effective and removed from service. Clothing that has been manually treated by employees will be considered effective for five wash cycles.
        - Also, use of clothing that has been pre-treated with Permethrin offers a reduction in the use and application of other insect repellents that shall be applied directly to the skin. Supervisor or Manager approval is required prior to purchase.

- If the employee opts not to utilize chemically pre-treated clothing while potentially exposed to insects, spiders and/or ticks, they shall either: 1) wear Tyvek® coveralls taped to the boots, or 2) wear full-length clothing consisting of long-legged pants and long-sleeved shirts treated with an insect repellent containing Permethrin, DEET, or an oil of lemon eucalyptus to their work clothing.
- Safety Data Sheets (SDS) for the repellents, lotions, and cleansers discussed in this Procedure are not required because the repellents, lotion, and clothing are consumer products used in the manner intended for the general public. Although not required, a SDS should be obtained for the products used and placed into the office SDS library and site-specific safety plan.

4.8 Poisonous Plants

4.8.1 Habitat Avoidance, Elimination and/or Control

- If poisonous plants are identified in the work area, employees will mark the plants using either flags or marking paint, and discuss what the specific indicator will be to signal to other employees to avoid the designated area. If employees decide to use ground-marking paint to identify poisonous plants, they should discuss this tactic with the Manager (and Client as appropriate) for approval.
- If removal of the plants is considered, it should be subcontracted to a professional landscaping service that is capable and experienced in removing the plant. If herbicides are considered for use, a discussion shall need to occur with the Manager (and Client as appropriate) to determine whether it is acceptable to apply herbicides at the work site. Application of herbicides may require a license.
- Employees shall not attempt to physically remove poisonous plants from the work area unless a clearing procedure, including PPE, is prepared in advance and approved by the SH&E Manager. The clearing procedure should be included in the SH&E Plan and THA and the required PPE specified.

4.8.2 Poisonous plants that employees should recognize and take precautions to avoid include: poison sumac, poison ivy (terrestrial and climbing), poison oak, giant hogweed[2] (or giant cow parsnip), wild parsnip, devil's club and stinging nettle. Many others are extremely poisonous to eat (e.g., poison hemlock; water parsnip) – do not eat anything that has not been identified. Refer to *S3AM-313-ATT5 Plants of Concern* for information on locations where some of these poisonous plants are found in the U.S.

- Of the toxic plants in the cashew family, poison ivy (*Rhus radicans*) is most widespread. It grows in a variety of forms such as a low sprawling shrub, dense ground cover, or a thick woody vine that grows high into the tree canopy. Poison oak (*Rhus diversiloba*) is typically a low shrub in drier soils. Both of these plants have leaves of three and white berries. Poison sumac (*Rhus vernix*) is a tall shrub that is less prolific in distribution. It grows in wet areas, has a compound leaf with a red leaf stem (rachis), and white berries. All of these plants possess urushiol oils in all parts of the plant. Touching the plant causes an itchy skin rash that can show up within 4-72 hours following contact. People have a wide range of reactions including swelling, itching, rash and bumps, patches or blisters.
- Uroshiol oil can also transfer onto clothing and equipment. The oil can remain active on surfaces for up to 5 years and can be transferred to your skin.
- Wild parsnip is found throughout the U.S. and contains a poison that produces a rash similar to poison oak and ivy. Unlike poison oak and ivy, the active oil will not be present on unbroken leaves. See *S3AM-313-ATT6 Wild Parsnip Identification* for additional information and photos of wild parsnip.

[2] Phytodermatisi producer: keep skin covered and wash well after exposure

- Several plants in the carrot family contain toxic sap that causes severe dermatitis if it comes into contact with skin that is then exposed to sunlight. The most serious reaction is caused by the giant hogweed (*Heracleum mantegazzianum*), a plant that is spreading in southern Ontario and is also present in southwestern British Columbia. The plant is enormous, attaining up to 16 feet (5 meters) in height, which it does in one growing season. Contact causes painful blistering that can cause permanent disfigurement. It is to be avoided. Similar but less serious reactions can be caused by meadow parsnip (*Pastinaca sativa*) and cow parsnip (*Heracleum lanatum*). Meadow parsnip can be very abundant on disturbed sites.
- Nettles, particularly stinging nettle (*Urtica dioica*) and wood nettle (*Laportea canadensis*) contain urticating hairs on the leaves and stems that cause sharp pain or itchiness on contact with skin. The irritation is immediate and normally lasts no more than an hour and there are no lasting consequences.
- Some plants contain abundant stiff spines that can present a safety hazard, particularly if one is to fall into them. These include the cactus (*Opuntia spp.*), devils club (*Oplopanax horridum*), and prickly-ash (*Zanthoxylon americanum*).

4.8.3 A large number of plants are not harmful to touch but may contain poisonous berries or foliage that could cause serious complications or death if they are ingested. It goes without saying to not eat any berries or plants if you are unsure of their identity.

- Remember that in the fall and winter the hazard still exists in the form of stubble and roots.

4.8.4 Personal Protective Equipment (PPE)

- Employees conducting clearing, grubbing, or similarly disturbing work activities in areas where poisonous plants exist shall wear long-sleeve clothing or Tyvek® coveralls, and disposable cotton, leather or synthetic gloves. Employees shall not touch exposed skin (neck and face) with potentially contaminated gloves. Tyvek® and gloves worn to protect from exposure to poisonous plants shall be treated as contaminated, removed from the body in a manner that the contamination is not spread, and placed in plastic bags for disposal.
- Personal clothing that has been exposed to poisonous plants shall be decontaminated with a poisonous plant cleanser such as Tecnu® or removed in a careful manner, bagged and washed separately from other clothing to remove urushiol.
- Work boots will be decontaminated with either soap and water or a cleansing agent such as Tecnu® cleanser.
- If foliage is being cleared and includes poisonous plants, exposed skin shall be treated with a dermal barrier cream such as Tecnu®'s Oak 'n Ivy Armor or Enviroderm's Ivy Block and either a full-face respirator or a half-face respirator (with goggles) fitted with a P-100 (HEPA) dust filter.

4.9 Bird Droppings and Biological Soil Hazards

4.9.1 Work in any area where pigeons or other flying animals (e.g. bats) may nest requires a written statement from the client which states the potential for, and extent of, accumulation of excrement on/in the structure from pigeons or other winged animals.

4.9.2 Substantial accumulations of droppings can pose physical and health risks as slippery surfaces (if wet) and if the material is disturbed and becomes airborne, it can be inhaled or ingested if personal hygiene practices are not implemented. Inhalation of airborne droppings can cause diseases such as histoplasmosis. Exposure to surfaces with bird droppings shall be safeguarded by implementing proper work practices, training employees for awareness and using PPE. See *S3AM-313-ATT8 Bird Droppings*.

4.9.3 Tularemia is a problem with contaminated soil in some locations. Tularemia is a disease of animals and humans caused by the bacterium *Francisella tularensis*. Rabbits, hares, and rodents are especially susceptible and often die in large numbers during outbreaks. Workers can contract Tularemia through tick and deer fly bites, but also through inhalation of contaminated aerosols or

agricultural dusts. Check work areas for carcasses before disturbing the ground (e.g. mowing, brushing, grubbing, excavation, etc.).

4.10 Personal Hygiene and Body Checks

4.10.1 Tick-borne diseases typically require that the tick be imbedded for four hours to begin disease transfer. The oils from poisonous plants can take up to 4 hours after exposure to penetrate the skin and react with the live proteins under the skin.

4.10.2 It is recommended that exposed skin be checked frequently for the presence of ticks, insects, rashes, or discolorations. External clothing should also be checked for the presence of ticks and insects; these should be retained for identification and to determine if medical treatment is needed.

4.10.3 Employees shall shower as soon as practical after working in the field and examine their bodies for the presence of ticks, insect bites, rashes, or swollen areas. If imbedded ticks are found, they should be removed using the technique described in *S3AM-313-ATT2 Ticks*.

4.11 Employees shall immediately notify their Manager or Supervisor of the presence of an imbedded tick, bee, wasp or hornet sting, other insect bite, rash, or any abnormal reaction. Reporting shall occur within 4 hours for a significant incident and 24 hours for all other SH&E incidents, and in accordance with *S3AM-004-PR Incident Reporting, Notifications & Investigation.*

4.12 The Manager or Supervisor shall forward the report to the SH&E Manager for follow up.

5.0 Records

None

6.0 Attachments

6.1 S3AM-313-ATT1 Biological Hazard Assessment Flow Chart

6.2 S3AM-313-ATT2 Ticks

6.3 S3AM-313-ATT3 Poisonous Spider Identification

6.4 S3AM-313-ATT4 Mosquito Borne Diseases

6.5 S3AM-313-ATT5 Plants of Concern

6.6 S3AM-313-ATT6 Wild Parsnip Identification

6.7 S3AM-313-ATT7 Alligators

6.8 S3AM-313-ATT8 Bird Droppings

6.9 S3AM-313-ATT9 Large Carnivores & Ungulates

6.10 S3AM-313-ATT10 Bear Safety

6.11 S3AM-313-ATT11 Small Mammals

6.12 S3AM-313-ATT12 Snakes & Scorpions

1.0 Purpose and Scope

1.1 This procedure applies to all AECOM Americas based employees and operations where the potential for hand injuries is present.

1.2 This procedure is intended to protect employees from activities that may expose them to hand injury. This procedure provides information on recognizing those conditions that require personal protective equipment (PPE) or specific work practices to reduce the risk of hand injury.

1.3 All personnel shall have gloves in their immediate possession 100% of the time when in a shop or on a work site. Appropriate gloves shall be worn when employees work with or near any materials or equipment that present the potential for hand injury due to sharp edges, corrosives, flammable and irritating materials, extreme temperatures, splinters, etc.

2.0 Terms and Definitions

2.1 None

3.0 References

3.1 S3NA-003-PR1 SH&E Training

3.2 S3NA-208-PR1 – Personal Protective Equipment

3.3 S3NA-209-PR1 – Risk Assessment & Management

3.4 S3NA-325-PR1 – Lockout Tagout

4.0 Procedure

4.1 Roles and Responsibilities

4.1.1 **Manager / Supervisor**

- Implementation of this standard for the applicable facility, site, or project location.
- Confirm employees are familiar with this procedure and have appropriate training.
- Confirm the appropriate hand protection is available on site as necessary.

4.1.2 **Employees**

- Recognize hazards to hands.
- Comply with this procedure as well as client or work location requirements.

4.1.3 **SH&E Manager**

- Advise supervisors and site personnel on matters relating to hand safety.
- Work with the manager / supervisor to confirm that sufficient PPE and equipment are available.
- Maintain contact with manager / supervisor to regularly evaluate site conditions and new information that might require modifications to this procedure.
- Conduct training or briefings, when necessary, and to explain the content of this procedure and site hazards to employees.
- Assist in investigation of incidents that resulted or could have resulted in an injury.

4.2 Hazard Assessment

4.2.1 Perform hazard assessments for those work activities likely to require Personal Protective Equipment (PPE).

- Use the Task Hazard Assessment (THA) to perform the hazard assessment (in accordance with *S3NA-209-PR1 Risk Assessment & Management*). The THA will accompany AECOM personnel at jobsites for use in the event of a job or task change, or
- Use the *Gloves Needs Assessment – S3NA-317-FM1* or equivalent to perform the assessment.
- Re-evaluate completed hazard assessments when the job or task changes.

4.2.2 The hierarchy of controls should be considered during the THA process to minimize or eliminate the need for hand protection PPE or material handling tools. Examples of controls are chemical substitution, machine guarding, and use of different tools.

4.2.3 Select PPE that will protect employees if hazards cannot be eliminated.

- Review Safety Data Sheets for project or task-specific chemicals to determine appropriate PPE. If needed, consult with a SH&E Manager for assistance.
- Review glove manufacturer recommendations for both physical and chemical protection.
- Obtain gloves of the correct size for the employees.
- When both chemical and physical protection is of concern, wear the chemical protection gloves (e.g., nitrile) inside the physical protection gloves (e.g., leather, Kevlar®).
- Nitrile gloves or equivalent chemical resistant shall always be used for protection from hazardous fluids or non-corrosive chemicals.
- Do not wear metal or metal-reinforced gloves when working with electrical equipment or on electrical services. Proper leather and/or rubber gloves designed and tested for this purpose shall be used.
- Refer to *S3NA-208-PR1 – Personal Protective Equipment* for additional information.

4.2.4 Follow glove requirements in the applicable SH&E plan.

4.3 Guidelines for Working With and Around Equipment (Hand Tools, Portable Powered Equipment)

4.3.1 General

- As applicable, employees shall be trained in the use of all tools. Refer to *S3NA-003-PR1 SH&E Training*.
- Keep hand and power tools in good repair and use them only for the task for which they were designed.
- Inspect tools before use and remove damaged or defective tools from service.
- Operate tools in accordance with manufacturer's instructions.
- Do not remove or bypass a guarding device for any reason.
- Keep surfaces and handles clean and free of excess oil to prevent slipping.
- Do not carry sharp tools in pockets.
- Clean tools and return to the toolbox or storage area upon completion of a job.
- Confirm that the wrench is in full contact (fully seated, "flat", not tilted) with the nut or bolt before applying pressure.

- Place the body in the proper position for optimal balance and bracing to prevent falls if the tool slips.
- Make sure hands and fingers have sufficient clearance in the event the tool slips.
- Whenever possible, pull on a wrench and avoid pushing.

- When working with tools overhead, place tools in a holding receptacle when not in use.
- Do not throw tools from place to place or from person to person, or drop tools from heights.
- Inspect all tools prior to start-up or use to identify any defects.
- Powered hand tools shall not be capable of being locked in the ON position.
- Require that all power-fastening devices be equipped with a safety interlock capable of activation only when in contact with the work surface.
- Do not allow loose clothing, long hair, loose jewelry, rings, and chains to be worn while working with power tools or rotating equipment.
- Do not increase the leverage by adding sleeved additions (e.g. a pipe or snipe) to increase tool handle length.
- Make provisions to prevent machines from restarting through proper lockout/tagout (refer to *S3NA-325-PR1 – Lockout Tagout*).

4.3.2 Cutting Tools

- Always use the specific tool designed for the task. Tubing cutters, snips, self-retracting knives, concealed blade cutters, and related tools are task specific and minimize the risk of hand injury. For more information about cutting tools, see *S3NA-317-ATT1 Safe Alternative Tools.*
- Fixed open-blade knives (FOBK) are prohibited from use during the course of AECOM work.
  - Examples of fixed open-blade knives include pocket knives, multi-tools, hunting knives, and standard utility knives.
  - Any exception to this requirement shall require approval of the Manager / Supervisor and SH&E Manager.
- When utilizing cutting tools, personnel will observe the following precautions to the fullest extent possible:
  - Use the correct tool and correct size tool for the job.
  - Cut in a direction away from yourself and not toward other workers in the area.
  - Maintain the noncutting hand and arm toward the body and out of the direction of the cutting tool if it were to slip out of the material being cut.
  - Ensure that the tool is sharp and clean; dirty and dull tools typically cause poor cuts and more hazard than a sharp, clean cutting tool.
  - Store these tools correctly with covers in place or blades retracted, as provided by the manufacturer.
  - On tasks where cutting may be very frequent or last all day (e.g., liner samples), consider Kevlar® gloves in the PPE evaluation for the project.
  - Do not remove guards on paper cutters.
  - In office locations, paper cutters must always be kept in a locked position when not in use.

4.3.3 Moving/Rotating Equipment

- General Requirements for Rotating Equipment (feed augers, chippers, conveyors, etc.)
  - Never place hands, fingers, or extremities near hoppers and operational areas of machinery.

- When the equipment is rotating, stay clear of the rotating components and only operate equipment with proper machine guarding in place.
- Never clean a jammed piece of equipment unless the transmission is in neutral and the power source or the engine is off, locked out, and the moving parts of the equipment have stopped rotating. Refer to *S3NA-325-PR1 – Lockout Tagout*.

4.3.4 Other Physical Hazards

- Activities such as drum handling, fencing, work near razor wire, manhole cover removal, and demolition also pose hazards to hands. Use tools instead of hands for high hazard tasks whenever possible.
- Plan work to avoid pinch points for hands when moving drums, moving manhole covers into position, and handling other heavy objects.
- Work handling scrap metal, glass or other sharp edges requires proper hand PPE (Kevlar® or leather gloves).
- Activities involving hoisting, lifting and landing of a load shall be done "hands-free" when possible. Refer to *S3NA-317-ATT2 – Safe Hands-Free Lifting Guidelines*.

4.4 Ergonomics – Hand and Wrist Care

4.4.1 Keep your wrist in neutral. Avoid using your wrist in a bent (flexed), extended, or twisted position for long periods of time. Instead try to maintain a neutral (straight) wrist position. Ergonomic tools may be needed for long-term work.

4.4.2 Watch your grip. Gripping, grasping, or lifting with the thumb and index finger can put stress on your wrist. When practical, use the whole hand and all the fingers to grasp an object.

4.4.3 Minimize repetition. Even simple, light tasks may eventually cause injury. If possible, avoid repetitive movements or holding an object in the same way for extended periods of time.

4.4.4 Reduce speed and force. Reducing the speed with which you do a forceful, repetitive movement gives your wrist time to recover from the effort. Using power tools helps reduce the force.

4.4.5 Rest your hands. Periodically give your hands a break by letting them rest briefly. Or you may be able to alternate easy and hard tasks, switch hands, or rotate work activities.

4.4.6 Consider low vibration or anti- vibration hand power tools when possible.

4.5 Cleaning Hands

4.5.1 Avoid contamination of hands by proper use of gloves when contact with physical, chemical, or biological hazards is possible.

4.5.2 Use soap and water for normal hand cleaning. Do not use solvents for cleaning as they remove essential oils in the skin and may cause dermatitis. Do not use pressure washers for hand cleaning.

4.5.3 If the hands contact a corrosive (e.g., nitric acid), wash the area with water for fifteen minutes and then seek medical attention.

4.5.4 Use antibiotic ointment and skin protection on minor breaks/scratches of the skin.

4.5.5 In some cases barrier creams may be used to provide limited protection for hands exposed to greases and oils.

4.6 Safe Hands Observation Tool

4.6.1 The *Safe Hand Task Review Card S3NA-317-FM2* may be used to supplement and reinforce safe work practices and the requirements of this procedure.

4.6.2 The observer's responsibilities include:

- Two-way conversation with the employees being observed.
- Completing the card and mark the applicable fields on the back of the card.
- Submitting the completed cards to the supervisor.

4.6.3 The supervisor's responsibilities include:

- Reviewing the completed cards.
- Identifying best work practices and any improvements.
- Communicating any changes back the employee(s).

5.0 Records

The following documentation will be maintained:

5.1 Hand tool training records, as applicable.

6.0 Attachments

6.1	S3NA-317-FM1	Glove Needs Assessment
6.2	S3NA-317-FM2	Safe Hands Task Review Card
6.3	S3NA-317-ATT1	Safe Alternative Tools
6.4	S3NA-317-ATT2	Safe Hands-Free Lifting Guidelines

Appendix C

Right-of-Entry for Remedial Investigation

DEPARTMENT OF THE ARMY
RIGHT-OF-ENTRY FOR REMEDIAL INVESTIGATION
ON
NON-FEDERAL PUBLIC LANDS

Site-AEDB-R #: NYHQ-007-R-01
Project: Camp Blauvelt Maneuver Area
Property I.D. No: Assessor Parcel Number (APN) 70.07-1-8; 70.07-1-9

The undersigned, herein referred to as the "Local Government," in consideration for the mutual benefits of the work described below, hereby grants the UNITED STATES OF AMERICA, hereinafter called the "Federal Government," a right-of-entry upon the following terms and conditions:

1. The Local Government hereby grants to the Federal Government an irrevocable and assignable right to enter in, on, over and across the land described below in (APN) 70.07-1-8; 70.07-1-9, *for a period not to exceed twenty-four (24) months,* commencing with the execution of the instrument by the Federal Government, and terminating with either the completion of the inspection or the expiration of the twenty-four (24) month term, whichever should occur first in time, for use by the Federal Government, its representatives, agents, contractors and assigns, as a work area for a Military Munitions Response Program (MMRP) Remedial Investigation, including the right to investigate, collect samples and perform any other such work which may be necessary and incident to the Federal Government's use for the investigation and response on said lands.

2. The Local Government also grants the right to enter and exit over and across any other lands of the Local Government as necessary to use the described lands for the purposes referenced above.

3. If any action of the Federal Government's employees, agents, contractors or assigns, in the exercise of this right-of-entry result in damage to the real property, the Federal Government shall, at its sole discretion, either repair such damage or make an appropriate settlement with the Local Government. In no event shall such repair or settlement exceed the fair market value of the fee title to the real property at the time immediately preceding such damage. The Federal Government's liability under this clause is subject to the availability of appropriations for such payment, and nothing contained in this agreement may be considered as implying that Congress will at a later date appropriate funds sufficient to meet deficiencies. The provisions of this clause are without prejudice to any rights the Local Government may have to make a claim under any applicable laws for any damages other than those provided for herein.

4. The land affected by this right-of-entry is located in Camp Blauvelt, Rockland County, NY, and is described as follows: APN(s) 70.07-1-8; 70.07-1-9, as shown on EXHIBIT "A" attached hereto.

We will attempt to telephone you at 845-786-2701 no less than ten (10) days prior to commencing any activities.

Dated this 9th day of September, 2018.

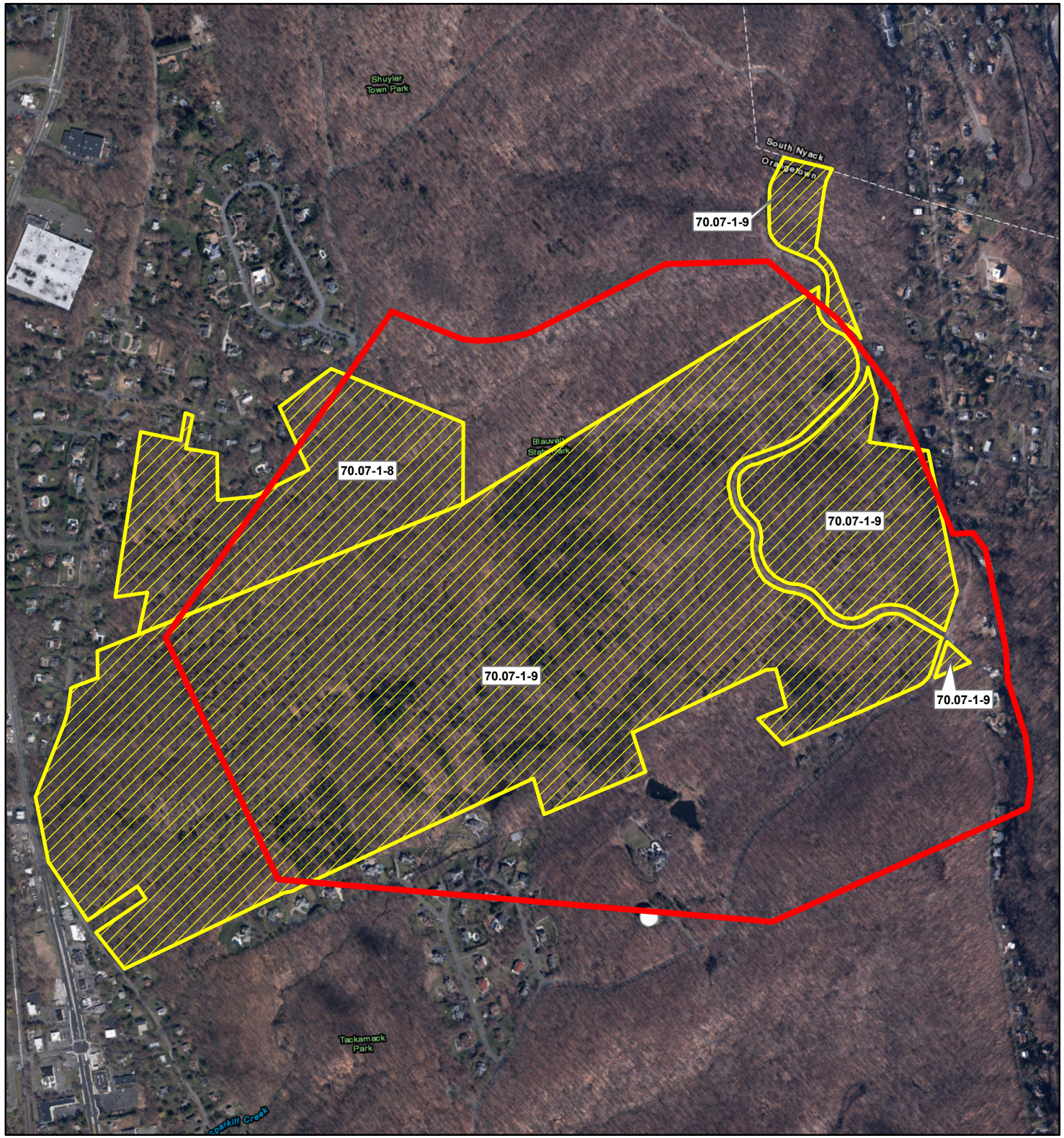
Local Government:

Mr. Jim Hall, Executive Director
Palisades Interstate Parkway Commission

THE UNITED STATES OF AMERICA:
(Federal Government)

By:
Real Estate Contracting Officer
U.S. Army Corps of Engineers

Camp Blauvelt



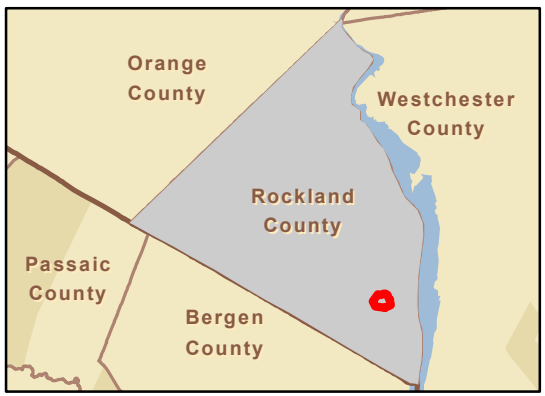
Legend

- MRS Boundary
- Palisades Park Parcel Owner Boundary

0 5 10 20 Miles

N

US Army Corps of Engineers
Omaha District



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DERP-FUDS Project No. D01MA123401
ROE#____

WITNESS MY HAND AND SEAL this 24th day of September, 20 18.

Owner/Agency Name: Palisades Interstate Park Commission
Parcel Address: Camp Blauvelt Maneuver Area
Mailing Address if different from above: PO Box 427, Bear Mt, NY 10911
Owner/Agency Phone #: 845-786-7911
Year Round Phone # or cell phone #:
Email: Jim.Hall@Parks.NY.Gov

Signature[1]: [signature]

Title: Exec. Director

UNITED STATES OF AMERICA

By: _____

Chief, Real Estate Division
U.S. Army Corps of Engineers

[1] Owner or Agency representative needs to sign this page. If signing on behalf of owner or an agency, The certificate of authority signature is also required on the next page.
2 For Gov't use only: Projected ROE Expiration Date _____

DERP-FUDS Project No. D01MA123401
ROE#____

CERTIFICATE OF AUTHORITY

I, James Hall (Name) certify that I am Exec. Director (Title) of Palisades Interstate Park Comm and that James Hall (name of person who signed above), who signed (name of corporation, agency, etc.)

the foregoing instrument on behalf of the grantee, was then the Exec. Director (title of person who signed above) of

the Palisades Interstate Park Comm I further certify that the said James Hall (name of person who signed above) (name of corporation, agency, etc.)

was acting within the scope of powers delegated to him/her in executing said instrument.

Date: 9/26/18

Signature[1]: [signature]

CERTIFICATE OF TRUSTEE

[1] Certificate of authority is required if owner is a corporation, company, agency, etc. to verify that the person who signed the preceding page has the proper authority to sign on owner or agency's behalf.