SCS ENGINEERS

Analysis for Brownfields Cleanup Alternatives (ABCA) and Remediation Work Plan

Old Fort Lowell Restoration Project
5460 East Fort Lowell Road
Tucson, Arizona

Presented to:

City of Tucson

Environmental Services
PO Box 27210
Tucson, AZ 85726-7210
(520) 791-3175

Presented by:

SCS ENGINEERS
2410 West Ruthrauff Road, Suite 110
Tucson, Arizona 85705
(520) 696-1617

October 14, 2011
File No. 10.204058.26

Offices Nationwide
www.scsengineers.com

Environmental Consultants
and Contractors

2410 W. Ruthrauff Road
Suite 110
Tucson, AZ 85705

520 696-1617
FAX 520 696-1618
www.scsengineers.com

SCS ENGINEERS

October 14, 2011
File No. 10204058.26

Ms. Lynne Birkinbine
City of Tucson Environmental Services
PO Box 27210
Tucson, AZ 85726-7210
(520) 791-3175

Subject: Analysis for Brownfields Cleanup Alternatives (ABCA) and Remediation Work Plan
Old Fort Lowell Restoration Project
5460 East Fort Lowell Road
Tucson, Arizona

Dear Lynne:

Attached please find a copy of the Analysis for Brownfields Cleanup Alternatives (ABCA) and Remediation Work Plan for the site. It has been prepared by SCS Engineers (SCS) for use by the City of Tucson in preparation for remedial activities at the site.

SCS appreciates the opportunity to be of service to the City on this project. If you have any questions, please contact Pat Hartshorne at (520) 696-1617.

Sincerely,

Patricia M. Hartshorne, RG
Project Manager
SCS ENGINEERS

David F. Laney, CHMM
Project Director
SCS ENGINEERS

PMH/DFL:pmh
C:\Documents and Settings\Pat Hartshorne\My Documents\SCS Data\Projects\204058.26 COT Old Ft Lowell Work Plan\Work Plan\Work Plan\FINAL WP\Ft Lowell ABCA & Work Plan text v1.0.doc

Attachment

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1.0 INTRODUCTION

This Analysis for Brownfields Cleanup Alternatives (ABCA) and Remediation Work Plan (Work Plan) for the Old Fort Lowell Restoration Project describes the site conditions, results of past investigations of the site, and identifies and evaluates a variety of cleanup alternatives to determine the best cleanup technique for the site. Included in the appendices of this document are the Sampling and Analysis Plan (SAP; Appendix A), Health and Safety Plan (HASP; Appendix B) and the Archaeological Monitoring Plan (Appendix C) for the site remedial activities.

This Work Plan has been prepared by SCS Engineers (SCS) for the City of Tucson Environmental Services (COT ES). The Archaeological Monitoring Plan was prepared by Desert Archaeology. These documents were prepared using funding from a Brownfields Cleanup Grant provided by the United States Environmental Protection Agency (EPA), Region IX. The project will be performed under the Arizona Department of Environmental Quality (ADEQ) Voluntary Remediation Program (VRP). In addition, due to the prehistoric and historic features present on the site and listing of the site on the National Register of Historic Places, the Arizona State Historic Preservation Office (SHPO) will approve planned site activities and the Archaeological Monitoring Plan.

2.0 SITE DESCRIPTION

The Old Fort Lowell Restoration Project property (the site) consists of approximately 5.2 acres of land located at the southwest corner of East Fort Lowell Road and North Craycroft Road in Tucson, Pima County, Arizona. A Site Location Map is included as Figure 1. The address currently used for the site is 5460 East Fort Lowell Road and the Pima County Assessor's Parcel Numbers (APNs) for the five parcels that make up the site are 110-09-032A, 110-09-032B, 110-09-0330, 110-09-0340, and 110-09-0350. The site is located within the northeast quarter of Section 35, Township 13 South, Range 14 East of the Gila and Salt River Base Line and Meridian.

The site is unoccupied and contains two former residential structures, adobe ruins, three dry groundwater wells, septic tanks, and a water tower. The site is secured with fencing, lighting, and a caretaker that lives across the street from the site. Former structures and features on the site that were demolished in September 2010 included a work shop, windmill frame, concrete water tank, stormwater drainage feature, and concrete pads. The site contains mostly native vegetation. The topography on the site slopes gently toward the north and northwest, with a change in elevation of approximately 8 feet from the southeast corner to the north boundary of the site. Maps showing features on the site in 2011, 2008, and 2005 are provided as Figures 2, 3, and 4.

The site is bounded on the east by Craycroft Road and to the north by Fort Lowell Road. Properties that adjoin the site include residences to the west and north, a stormwater detention basin for a homeowners association to the south, and Fort Lowell Park to the east. A Site and Vicinity Map is included as Figure 5.

3.0 SITE HISTORY

3.1 PREHISTORIC OCCUPATION

The site is located within the area known as the prehistoric Hardy Site, which dates to the Hohokam period. Archaeological features were noted at Fort Lowell in 1884 and archaeological excavations were performed at Fort Lowell Park beginning in the 1960s. Dating of the archaeological features indicated that the prehistoric occupation occurred between 650-750 AD and 1000-1300 AD, and probably in the intervening years. Various artifacts and other features have been observed throughout the park area (Poster Frost 2009; Thiel 2009; Thiel et. al. 2008). Numerous potsherds and stone flakes have been observed on the ground surface and in adobe bricks making up building walls at the site. Additional discussion of the archaeological history of the site area is included in the archaeological monitoring plan in Appendix C.

3.2 HISTORIC OCCUPATION

The site is part of an area formerly occupied by Fort Lowell, a United States Army supply base that operated between 1873 and 1891 following relocation to this area from the downtown Tucson area. The portion of Fort Lowell that was located on the site included Cottonwood Lane, parade grounds, a guardhouse, bake house, adjutant's office, and three officers' quarters and associated kitchens and privies. After the fort was abandoned in 1891, the site portion of the former fort was subsequently used for residential purposes through 2006. From 1908 to at least 1950, a tuberculosis sanatorium/rest home occupied the former fort officers' quarters. The Adkins family purchased the site in 1928 and began operating a trucking and steel manufacturing business on the site in 1934, manufacturing steel buildings and tanks. By the 1950s, the business made primarily steel tanks; this business operated on the site until 2006 (Thiel 2009; Thiel et. al. 2008). Additional discussion of the recent history of the site is included in the archaeological monitoring plan in Appendix C.

Because of the presence of significant historic and prehistoric features located on the site, the COT acquired the site in 2006 through a complex land exchange and sale with a private developer as part of the Old Fort Lowell Restoration Project. Pima County will maintain a Conservation Easement on the site. (Poster Frost 2009; Thiel 2009; Thiel et. al. 2008)

3.3 PHYSICAL SETTING

3.3.1 Geologic Setting

The site is within the Basin and Range Physiographic Province, which is characterized by broad alluvial-filled basins bounded by steep, fault-block mountains. The Tucson Basin is a structural depression within the Basin and Range Physiographic Province. The Tucson Basin fill deposits are characterized by three stratigraphic units (from top to bottom): the Fort Lowell Formation, the Tinaja beds, and the Pantano Formation. The Fort Lowell Formation is generally 300 to 400 feet thick, and consists of unconsolidated to moderately consolidated sediments grading from silty gravel at the basin margins to a sandy silt and clayey silt in the center of the basin. Overlying the Fort Lowell Formation are younger, well-preserved surficial alluvium terrace

deposits. The surficial alluvium terrace sediments are generally thin (averaging 30 to 70 feet in thickness) and silty, and become younger and lower in relief closer to the Santa Cruz River. (Anderson 1987; McKittrick 1988; Murphy & Hedley 1984)

3.3.2 Hydrogeology

The site is located within the Tucson sub-area of the Upper Santa Cruz Basin area, within the Tucson Active Management Area. The primary source of groundwater in the Tucson sub-area is the Fort Lowell Formation, which is described above in Section 3.3.1 (Murphy & Hedley 1984). The site is located approximately 0.5 mile south of the ephemeral Rillito River and 0.4 mile west of the ephemeral Pantano Wash.

Regional groundwater flow in the vicinity of the site was shown on the Arizona Department of Water Resources (ADWR) map to be generally toward the northwest (Murphy & Hedley 1984). Groundwater flow direction and gradient may be significantly influenced by localized sources of withdrawal and recharge, such as irrigation wells and unlined channels, respectively.

Recent groundwater level information for the site area was obtained from ADWR online databases. Based on information included in the databases for the quarter-section containing the site and the quarter-section adjoining the site to the east, water levels that have been measured in wells from 2000 through 2011 ranged from approximately 122 to 248 feet below ground surface (bgs). Water levels dropped significantly from the earliest recorded measurements in the database, which were collected in the 1950s, when water levels in the same area ranged from 45 to 63 feet bgs.

A registered well was identified on the on-line ADWR Fortis Well 55 database for the site address 5460 East Fort Lowell Road (ADWR well ID #55-636570). Based on historical records (Thiel et. al. 2008), the address given for this well corresponds to the house located on the northeast site parcel; therefore, it is assumed that this well registration refers to the well in the northeast portion of the site, which adjoined a windmill and water tank. According to the on-line ADWR file for registered well #55-636570, it was installed in 1948, was registered to Marion H. Adkins in 1982, and was used for domestic purposes. ADWR records show that the depth of the well and casing are 140 feet bgs and the steel casing is 8 inches diameter. At the time of the well registration (1982), the depth to water was reported as 120 feet bgs.

No records were found to indicate that the two other groundwater wells present at the site have been registered with ADWR. These wells are about 4 feet in diameter and the upper approximately 40 feet were hand dug according to the former site owner. When the wells went dry, steel well casings were reportedly placed in the center of the old wells to bottom depths of about 100 feet bgs.

Prior to sale of the site to the COT in 2006, owner Mr. Harry Adkins (son of Marion H. Adkins) stated that the three wells on the site had been dry for many years. According to Tucson Water, the site was connected to the municipal water service in 1975. Videos of the three wells were attempted in 2007; however, due to the presence of well equipment in the casing of the northeast well and lumber blocking the casings of the two other wells, the camera was not able to be placed down the well casings.

4.0 PREVIOUS ENVIRONMENTAL INVESTIGATIONS

4.1 PHASE I ENVIRONMENTAL SITE ASSESSMENTS

Features observed on the site by SCS during Phase I Environmental Site Assessments (ESAs) and site cleanup activities (SCS 1991, 2008) included a former shop building, three former residences, adobe ruins, and a few sheds. Concrete pads and a concrete steel sheet roller trench containing a stormwater drainage feature were located south of the shop building. Soil piles containing broken asphalt, rocks, and gravel were located in the south portion of the site. It was estimated that there are approximately five or six septic systems or wastewater disposal features located on the site. An elevated water tank, old windmill tower, and water well were located in the northeast portion of the site. Two other water wells were located in the south and west portions of the site.

There were significant amounts of debris, equipment, and material stockpiles stored on the site, including vehicles, vehicle parts, appliances, metal tanks, miscellaneous steel, scrap metal, buckets, containers, and other materials. A diesel fuel aboveground storage tank (AST), a 3,000-gallon gasoline underground storage tank (UST), a 450-gallon diesel fuel UST, numerous 55-gallon drums, and other containers were located on the site. Soil staining, metal debris, and granular materials that were likely associated with metal grinding, sanding, and cutting activities were observed in many locations, particularly in the vicinity of the shop building, 55-gallon drum storage areas, adjacent to the concrete pad and work areas, beneath the AST, and at other locations. In 1990, a “cesspool” was observed in the southeast portion of the site, consisting of an approximately 10-foot diameter by 4-foot deep hole. The cesspool contained oily liquids and was adjoined by stained soil and used oil filters; according to Mr. Harry Adkins, a septic tank was later placed at this location. Currently there is no surface evidence of this former cesspool.

Properties adjoining the site have consisted of vacant desert, a park, a church, and residences. Adjoining properties do not appear to represent recognized environmental conditions for the site.

The site was designated as a Resource Conservation and Recovery Act (RCRA) large quantity generator for one year beginning in 2006 as a result of the removal and disposal of hazardous materials during site cleanup activities. Other environmental regulatory database listings identified in the vicinity of the site included fifteen registered wells. None of the identified environmental regulatory database listings appeared to represent recognized environmental conditions for the site.

SCS recommended investigation of the nature and extent of potential impacts to surface soils at the site in areas of stained soil; areas where vehicle batteries, drums, ASTs, or other containers of petroleum hydrocarbons or hazardous materials were stored; and other areas of potential impacts observed at the site, including locations that exceeded the Arizona Residential Soil Remediation Levels (RSRLs) for arsenic, lead, and polynuclear aromatic hydrocarbons (PAHs). It was also recommended that the nature and extent of potential impacts to subsurface soils should be investigated at the septic systems, the former cesspool, and the stormwater drainage feature in the concrete-lined trench; the two inactive water wells should be registered with ADWR and all

three inactive wells abandoned following ADWR guidelines; and the septic tank systems should be removed or properly abandoned.

4.2 UST INVESTIGATIONS

In December 1990, SCS supervised the drilling of two soil borings next to the gasoline UST west of the shop building (SCS 1991). The two borings were drilled at a 10 degree angle adjacent to the west side of the UST. No evidence of impacts to soil from petroleum hydrocarbons was observed in the cuttings from the two borings. Two soil samples collected from each boring at depths of 20 and 30 feet bgs were analyzed for total petroleum hydrocarbons (TPH) using EPA Method 8015. No TPHs were detected in any of the four soil samples.

The gasoline and diesel fuel USTs and piping to a former dispenser were removed in August 2007 under the direction of SCS (SCS 2007). SCS collected ten soil samples from beneath the two USTs, the UST piping, and the former dispenser location, and from the two excavated soil stockpiles. Faint petroleum odors were observed at the east end of the excavated piping area; however, no soil staining was observed. Hydrocarbons and benzene, toluene, ethylbenzene, and xylenes (BTEX) were not detected at concentrations exceeding the laboratory reporting limits in the soil samples except for the sample of stockpiled soil from the east UST excavation, which contained 2,000 milligrams per kilogram (mg/kg) of total C_{10}-C_{32} hydrocarbons. However, there are currently no Arizona Soil Remediation Levels (SRLs) for hydrocarbons and based on visual observations, laboratory results, and historical information, there did not appear to have been a release from either of the two UST systems. ADEQ closed out this UST case file in August 2007.

4.3 PHASE II ENVIRONMENTAL SITE ASSESSMENTS

4.3.1 Previous Limited Soil Sampling Investigation

Twelve soil samples were collected in 1990 by SCS during a limited soil sampling investigation in areas of staining and at other locations, including a diesel fuel AST, battery and drum storage areas, black granular material area, and the cesspool (SCS 1991). All the samples were from a maximum depth of 0.5 feet bgs, except for AS11-7, which was from below the bottom of the cesspool at 7 feet bgs.

The analyses identified detectable concentrations of hydrocarbons in the 10 analyzed samples; the highest concentration of hydrocarbons was detected in the sample from below the bottom of the cesspool. Hydrocarbons are not currently regulated under the current SRLs. Detected metal concentrations did not exceed the current Arizona SRLs or minimum Groundwater Protection Levels (GPLs; ADEQ 1996), except for arsenic and lead in the sample from the black granular material, which exceeded the Non-Residential Soil Remediation Level (NRSRL) for arsenic and the RSRL for lead. The four samples analyzed for volatile organic compounds (VOCs) did not contain detectable compounds except for acetone, toluene, 4 methyl-2-pentanone (aka methyl isobutyl ketone), and m- and p-xylenes; however, concentrations of these VOCs did not exceed the current SRLs or minimum GPLs.

A summary of the constituents detected in the above samples is shown in the table below and is included in the attached Table 1. The sample location map from the 1991 report is included as Figure 6.

LIMITED SOIL SAMPLING INVESTIGATION RESULTS – 1991 REPORT													
Sample ID	HC (418.1)	METALS (6010B/7471A)							VOCs (8240)				
		As	Ba	Cd	Cr	Pb	Se	Hg	Acetone	4-M-2-p	Toluene	Xylenes	
												m,p-	o-
AS1-0.5	1,600	na	na	na	na	na	na	na	0.140	ND	ND	ND	ND
AS2-0.5	2,460	na	na	na	na	na	na	na	na	na	na	na	na
AS3-0.5	29,600	na	na	na	na	na	na	na	0.190	0.140	0.011	0.011	ND
AS4-0.5	2,630	na	na	na	na	na	na	na	0.120	ND	0.010	ND	ND
AS5-0.5	6,630	na	na	na	na	na	na	na	na	na	na	na	na
AS6-0.5	13,000	na	na	na	na	na	na	na	na	na	na	na	na
AS7-0.5	na	na	na	na	na	150	na	na	na	na	na	na	na
AS8-0.5	38,500	na	na	na	na	na	na	na	na	na	na	na	na
AS9-0.5	168	na	na	na	na	na	na	na	0.075	ND	ND	ND	ND
AS10-0.5	na	155	131	7	69	610	1.0	0.410	na	na	na	na	na
AS11-7	78,900	na	na	na	na	na	na	na	na	na	na	na	na
AS12-0.5	42,200	na	na	na	na	na	na	na	na	na	na	na	na
RSRL (10^{-5} Risk)	none	10	none	none	none	none	none	none	none	none	none	none	
RSRL (NC)	none	10	15,000	39	none	400	390	23	14000	5,300	650	270	
NRSRL	none	10	170,000	510	65	800	5,100	310	54,000	17,000	650	420	
Minimum GPL	none	290	12,000	29	590	290	290	12	none	none	400	2200	
Alternative GPL	none	73	none	none	none	4,540	none	TBD	none	none	none	none	

NOTES: HC=Hydrocarbon, As=Arsenic, Ba=Barium, Cd=Cadmium, Cr=Chromium, Pb=Lead, Se=Selenium, Hg=Mercury, 4-M-2-p=4-Methyl-2-pentanone or Methyl Isobutyl Ketone, na=Not Analyzed, ND = Not detected, NC=Non-carcinogen, TBD=To be determined. There are no SRLs for Total Chromium; the NRSRL shown is for Chromium VI. There are no SRLs for individual Xylenes, those shown are for Total Xylenes.

4.3.2 Site Characterization Investigation

From 2007 through 2009, SCS performed several phases of soil sampling as part of site characterization activities (SCS 2009). Soil sampling was performed to identify impacts to soil above RSRLs, NRSRLs, and minimum GPLs and the extent of identified impacts. Soil sample locations were selected based on observations of staining or other visible impacts, knowledge of hazardous material storage at the site, and analytical results from preceding soil samples.

Samples of surface soil were collected at 132 locations on the site; samples were also collected at 10 of these locations at depths of up to 1.5 feet bgs. Three subsurface soil samples were collected from two push-probe borings near the location of the former cesspool at depths of 5 and 10 feet bgs. In addition, two samples were collected from the stormwater drainage feature located in the east end of the concrete trench that had contained the steel sheet roller equipment. The stormwater drainage feature consisted of an approximately 1-foot diameter steel cylinder placed into the ground at the base of the trench. The top of the cylinder was a couple inches above the base of the trench and soil in the settling chamber was about 1 foot below the base of the trench. No standpipe or other features were present in the settling chamber of the cylinder. Only runoff

from within the trench could enter the cylinder. The two soil samples were collected from the settling chamber of the cylinder at 1.0 and 1.5 feet below the base of the trench.

A total of 21 surface sample locations contained constituents that exceed the 10^{-5} risk level RSRLs, non-carcinogen RSRLs, NRSRLs, or minimum GPLs, including the PAHs benz[a]anthracene, benzo[a]pyrene, and indeno[1,2,3-cd]pyrene and the metals arsenic and lead. The only constituent that exceeded the minimum GPLs for these samples was lead. Two samples collected north of the shop building from a depth of approximately 0.5 foot bgs contained constituents that exceed the RSRLs or minimum GPLs, including benzo[a]pyrene and lead. One sample from the push-probe borings contained benzo[a]pyrene above the 10^{-5} risk level RSRL and mercury at a concentration that exceeded the minimum GPL. None of the constituents detected in the two samples from the stormwater drainage feature exceeded the RSRLs, NRSRLs, or minimum GPLs; this stormwater drainage feature was removed during demolition activities along with the concrete for the steel roller trench.

The attached Table 1 lists the analytical results for samples collected during the site characterization investigation performed on the site. The table below summarizes those samples with detected constituents that exceeded the respective RSRLs, NRSRLs, and GPLs. For a discussion of the minimum and alternative GPLs, see Section 6.1.2. Surface soil sample locations are shown on Figure 7, subsurface soil sample locations are shown on Figure 8, and soil boring locations and samples are shown on Figure 9.

SUMMARY OF SITE CHARACTERIZATION SAMPLES EXCEEDING SRLs AND GPLs							
Sample ID	Sample Depth	PAHs (8310)			METALS (6010B/7471A)		
		Benz[a] anthracene	Benzo[a] pyrene	Indeno[1,2,3-cd]pyrene	Arsenic	Lead	Mercury
AD-1-S	S	**1.5**	**1.4**	**1.2**	**25**	**870**	**0.11**
AD-1B-S	~0.5 ft	ND	**0.95**	**1.5**	**8.4**	**530**	ND
AD-3-S	S	ND	**0.64**	**0.84**	**34**	**470**	**0.75**
AD-4-S	S	ND	ND	ND	**7.2**	**300**	ND
AD-5-S	S	ND	ND	ND	**8.5**	**380**	**0.30**
AD-16-S	S	ND	**0.037**	**0.050**	**40**	**310**	ND
AD-19-S	S	**1.6**	**4.8**	**6.1**	**15**	**410**	**0.20**
AD-19A-S	~0.5 ft	ND	**0.010**	ND	**7.7**	**340**	**0.19**
AD-21-S	S	ND	**0.14**	ND	**5.2**	**860**	ND
AD-22-S	S	ND	**0.19**	ND	**9.5**	**320**	**0.59**
AD-40-S	S	ND	**0.58**	**0.66**	**21**	**210**	ND
AD-46-S	S	ND	**0.27**	**0.34**	**6.0**	**330**	**0.12**
AD-48-S	S	ND	ND	**0.32**	**8.3**	**300**	**0.12**
AD-52-S	S	ND	ND	ND	**98**	**310**	**0.11**
AD-66-S	S	ND	**0.11**	ND	**34**	**160**	**0.42**
AD-85-S	S	ND	ND	ND	**11**	**66**	**0.092**
AD-86-S	S	ND	ND	ND	**22**	**290**	**0.24**
AD-92-S	S	**2.0**	**2.4**	**2.7**	na	na	na
AD-107-S	S	ND	ND	ND	**20**	**180**	**0.14**
AD-108-S	S	ND	ND	ND	**28**	**100**	ND
AD-115-S	S	**1.9**	**2.0**	**1.6**	**14**	**400**	ND
AD-122-S	S	**9.6**	**10**	**7.8**	ND	**66**	ND

SUMMARY OF SITE CHARACTERIZATION SAMPLES EXCEEDING SRLs AND GPLs							
Sample ID	Sample Depth	PAHs (8310)			METALS (6010B/7471A)		
		Benz[a] anthracene	Benzo[a] pyrene	Indeno[1,2,3-cd]pyrene	Arsenic	Lead	Mercury
AD-126-S	S	**0.88**	**1.0**	**0.90**	na	na	na
B9-10	10 ft	ND	**0.80**	**3.8**	**10**	**280**	**17**
RSRL (10^{-5} Risk)		**6.9**	**0.69**	**6.9**	**10**	none	none
RSRL (Non-carcinogen)		none	none	none	**10**	**400**	**23**
NRSRL		**21**	**2.1**	**21**	**10**	**800**	**310**
Minimum GPL		none	none	none	**290**	**290**	**12**
Alternative GPL		none	none	none	**73**	**4,540**	TBD

NOTES: S=Surface, ND=Not detected, na=Not analyzed, TBD=To be determined.

Two locations that had the highest detected concentrations of arsenic (98 mg/kg) and lead (870 mg/kg) were selected to be sampled and analyzed using the toxicity characteristic leaching procedure (TCLP). Neither of these samples contained detectable concentrations of arsenic or lead using the TCLP, and therefore did not exceed the EPA toxicity characteristic levels.

The areas of highest contamination (above NRSRLs or minimum GPLs) were concentrated around the former shop building and in former work and storage areas through the central portion of the site. Areas of lower concentrations (above RSRLs) extend through the central portion of the site from north to south. The areas of surface soil containing PAHs, arsenic, and/or lead concentrations that exceed applicable RSRLs at the site encompass between approximately 0.3 to 1.2 acres to a depth of less than 1 foot, and probably less than 0.5 foot in most areas.

5.0 PROSPECTIVE SITE USE

The Fort Lowell Multiple Resource Area was placed on the National Register of Historic Places in 1978. The site was included within the Fort Lowell Multiple Resource Area at that time. The proposed plan for the site is to incorporate the area into the COT's larger Fort Lowell Historic Park. The Intergovernmental Agreement between the COT and Pima County implements the historic preservation project through a master planning process that includes opportunities for public participation, interpretation of the existing cultural resources, and recreational opportunities for the entire 78-acre park. (COT 2008)

The existing Fort Lowell Park is a large regional recreational center featuring swimming pools, ballfields, tennis and racquetball courts, picnic areas, a pecan orchard, a wetland, riparian areas, a fitness trail, and the Fort Lowell Museum, which is operated by the Arizona Historical Society. The historic buildings at the park are listed individually on the National Register of Historic Places. The historic buildings and the underlying prehistoric site are identified by Pima County as Priority Cultural Resources. (COT 2008)

The Preservation Plan, prepared as part of the Master Plan for Fort Lowell Park (Poster Frost 2009), discusses the plans for the site, which has the best preserved examples of the former officers' quarters from the fort era and previously contained other important features and buildings for the fort. Some of the structures and features dating from the Adkins period, including the work shop, one former residence, the windmill base, concrete water tank, and various concrete slabs, were documented by archaeologists and demolished because it was determined that the main focus of the preservation effort should be Fort Lowell.

Following remediation of soil contamination at the site, the remaining former features of Fort Lowell will be preserved. The former Officer's Quarters #3 will be rehabilitated, Officer's Quarters #2 and kitchen ruins will be protected with a roof, and Officer's Quarters #1 ruins will be preserved. The former Cottonwood Lane will be reestablished on the site and cottonwood trees replanted. A new structure containing self-guided exhibits, restrooms, office, and storage will be placed at the location of the former Adjutant's Office. The former Adkins residence in the northeast corner of the site will be stabilized pending future decisions on its use or disposition. Various former buildings will be represented by interpretive ghosting to show former outlines and/or floor plans. A parking area will be added to the west portion of the site. Access between the site and the portion of Fort Lowell Park east of Craycroft Road will likely be assisted with the installation of a pedestrian activated traffic signal. The former parade grounds at the site will be used informally, and may be planted with turf or native drought tolerant grasses. A copy of a drawing showing the Final Concept Plan for the Fort Lowell Park Master Plan, which includes the site area, is included as Figure 10 (Poster Frost and Sage 2009).

6.0 REMEDIAL ACTION OBJECTIVES

Remedial action objectives consist of media-specific goals for protecting human health and the environment. The remedial action objectives generally specify:

- The contaminants of concern
- Exposure routes and receptors
- An acceptable contaminant level or range of levels for each exposure route
- Documentation and preservation of archaeological features

6.1 SOIL AND GROUNDWATER

6.1.1 Soil Remediation Levels (SRLs)

The Arizona non-carcinogen RSRLs and 1 x 10^{-5} risk level RSRLs for carcinogens will be used for soil remediation at the site, as discussed below. As mentioned earlier, the contaminants at the site exceeding the 10^{-5} risk level and non-carcinogen RSRLs in soil include the PAHs benz[a]anthracene, benzo[a]pyrene, and indeno[1,2,3-cd]pyrene and the metals arsenic and lead. The selected cleanup levels to be used at the site are based on the following rationales:

- PAHs are *possible* carcinogens (cancer-causing chemicals); therefore, the 1 x 10^{-5} and 1 x 10^{-6} risk level RSRLs are applicable. However, because the PAHs are not *known* carcinogens, the 1 x 10^{-6} risk level RSRLs are only applicable if the site will be used for a school, day care, or other such use.

- Plans for future land use do not include utilization of the site for a school, day care center, or other such sensitive use. Therefore the 1 x 10^{-5} risk level RSRLs are to be used for PAHs rather than the 1 x 10^{-6} risk level RSRLs.

- Lead is non-carcinogenic (non-cancer causing); therefore, there are no 1 x 10^{-5} and 1 x 10^{-6} risk level RSRLs for lead.

- Arsenic has one cleanup level that is the same for the carcinogenic and non-carcinogenic RSRLs, as well as for the NRSRL.

Therefore, the cleanup levels to be used at the site will be the 1 x 10^{-5} risk level RSRLs for PAHs and the non-carcinogenic RSRL for lead, as shown in the table below. Arsenic has the same RSRL for both the 1 x 10^{-5} risk level and non-carcinogenic RSRL, as shown in the table below

RSRLs FOR CONTAMINANTS OF CONCERN		
Contaminant	**10^{-5} Risk Level RSRL (Carcinogens) (mg/kg)**	**RSRL (Non-Carcinogens) (mg/kg)**
Benz[a]anthracene	6.9	not applicable
Benzo[a]pyrene	0.69	not applicable
Indeno[1,2,3-cd]pyrene	6.9	not applicable

RSRLs FOR CONTAMINANTS OF CONCERN		
Contaminant	**10^{-5} Risk Level RSRL (Carcinogens) (mg/kg)**	**RSRL (Non-Carcinogens) (mg/kg)**
Arsenic	10	10
Lead	not applicable	400

6.1.2 Groundwater Protection Levels (GPLs)

Based on groundwater information obtained from ADWR and discussed in Section 3.3.2, groundwater is not considered to be a medium of concern due to its depth below ground surface (at least 122 feet and possibly as deep as 250 feet bgs) and is not believed to have been impacted by site activities. However, Arizona regulations (R18-7-203B1) require that contaminant concentrations be compared to GPLs based on the worst case assumption that "all metal leaches to groundwater regardless of the depth to groundwater" (ADEQ 1996). Therefore, concentrations of constituents detected in soil will also be compared to GPLs.

Based on the site soil sample results, the only constituents with minimum GPLs (ADEQ 1996) that were detected in site samples are the various metals, toluene, and xylenes. Lead was the only constituent that exceeded the minimum GPL in site samples, except for one subsurface sample from the push-probe borings at the former cesspool that had a concentration of mercury that exceeded the minimum GPL of 12 mg/kg; the highest detected concentration in the other site samples analyzed for mercury was 0.75 mg/kg. The minimum GPLs for site contaminants of concern are shown on the table below.

MINIMUM GPLs FOR CONTAMINANTS OF CONCERN	
Contaminant	**Minimum GPL**
Benz[a]anthracene	None
Benzo[a]pyrene	None
Indeno[1,2,3-cd]pyrene	None
Arsenic	290
Lead	290
Mercury	12

The minimum GPLs for metals provided in the 1996 ADEQ document were derived using the conservative theoretical correlation between total metals in soil and their leachability of 20:1. Because some fraction of the metal is typically not readily leachable, ADEQ allows the use of alternative GPLs for metals that are derived from site-specific leachability data. This data is attained by performing the Toxicity Characteristic Leaching Procedure (TCLP) analysis to determine the relationship between the concentration of the total metal in site soil versus the leached TCLP concentration using the following equation:

$$X_S = (292.9)RC_W$$

X_S = Maximum allowable metals concentration in soil to protect groundwater (mg/kg)
R = Ratio between total metals content in a soil and the TCLP leachate result
C_W = Groundwater concentration in mixing cell (milligrams per liter [mg/l]), equivalent to the Aquifer Water Quality Standard (AWQS)

As discussed in Section 4.3.2, two locations on the site that had the highest detected concentrations of arsenic and lead were selected to be sampled and analyzed using the TCLP. Neither of these samples contained detectable concentrations of arsenic or lead using the TCLP. From this data alternative GPLs were calculated, as shown below.

ALTERNATIVE GPL CALCULATIONS					
Sample ID and Contaminant of Concern	**Total Concentration (mg/kg)**	**TCLP Concentration (mg/l)**	**Ratio of Total Concentration to TCLP Concentration (R)**	**Maximum Groundwater Concentration (C_W) in mg/l**	**Alternative GPL (X_S) in mg/kg**
AD-1-S/AD-1A-S					
Arsenic	25	<1.0	25:1 = 25	0.01	73
Lead	870	<1.0	870:1 = 870	0.05	12,741
AD-52-S/AD-52A-S					
Arsenic	98	<1.0	98:1 = 98	0.01	287
Lead	310	<1.0	310:1 = 310	0.05	4,540

Based on the above calculations, the alternative GPLs for arsenic and lead are well above the RSRLs discussed in Section 6.1.1; therefore, the RSRLs will be the cleanup levels used for the site soils for arsenic and lead.

One subsurface sample from a push-probe boring near the former cesspool on the site contained a concentration of mercury that exceeded the minimum GPL. Therefore, mercury will only be considered a contaminant of concern at the former cesspool location. A TCLP analysis was not performed for this sample; therefore, if mercury concentrations are detected in samples from the former cesspool area that exceed the minimum GPL, these samples will be analyzed using the TCLP to determine if an alternative GPL can be applied.

6.1.3 Selected Action Levels for Verification Soil Samples

Based on the discussions provided above, the selected remedial action levels for the site verification soil samples are shown in the table below. The RSRLs for PAHs are shown in Table 2 in Attachment 2; there are no GPLs for PAHs.

ACTION LEVELS FOR VERIFICATION SOIL SAMPLES		
Contaminant	**Remediation Level (mg/kg)**	**RSRL or GPL**
Benz[a]anthracene	6.9	10^{-5} Risk Level RSRL (Carcinogens)
Benzo[a]pyrene	0.69	
Indeno[1,2,3-cd]pyrene	6.9	
Arsenic	10	10^{-5} Risk Level RSRL (Carcinogens) and RSRL (non-carcinogenic)
Lead	400	RSRL (Non-Carcinogens)
Mercury	12	Minimum GPL
	To be determined – If sample results exceed the Minimum GPL, an Alternative GPL will be calculated using TCLP results. If the Alternative GPL is greater than the Minimum GPL, the Action Level will be whichever is lower, the RSRL or the Alternative GPL.	Alternative GPL
	23	RSRL (Non-Carcinogens)

6.2 AIRBORNE DUST AND SURFACE WATER RUNOFF

Airborne contamination (except for dust) is not of concern because PAHs, lead, and arsenic are not volatile. Surface water is not a medium of concern for protection of human health; however, sediment in stormwater runoff must be controlled on the site to prevent contaminants from being carried off site. Following completion of remediation at the site, there will no longer be a potential for contaminants of concern to be present in dust and stormwater at the site.

6.3 ARCHAEOLOGICAL FEATURES

Due to the presence of historic and prehistoric features on the site, all subsurface activities at the site will be monitored by an archaeologist. The preferred outcome is to document archaeological and historical resources that are found and leave them in place. However, it is assumed that a small number of features or artifacts may need to be excavated to achieve the cleanup goals; these features or artifacts will be removed and/or sampled to address research questions about prehistoric and historic period use of the area. The methodology used will be determined on a case by case basis in accordance with the Archaeological Monitoring Plan in Appendix C.

If necessary, historic structures or features will be fenced as protection from excavation activities. Sampling of soil will be performed adjacent to artifacts and/or wipe samples will be collected from artifacts that are excavated and removed in order to evaluate whether the artifact has been impacted by contaminates of concern and to determine proper cleaning and/or handling procedures.

7.0 DETAILED ANALYSIS OF ALTERNATIVES

7.1 GENERAL CLEANUP EVALUATION APPROACH

The potential remedial alternatives were evaluated using criteria consistent with those included in EPA guidance documents (EPA 1988), including:

- Ability to Meet Remedial Action Objectives
- Long-term Effectiveness
- Implementability
- Short-term Risks
- Cost
- Community Acceptance
- Preservation of Historical and Archaeological Artifacts

The objective of the detailed analysis that follows is to determine which of the alternatives satisfies these criteria best. This is the alternative that will be selected as the preferred alternative for the site.

7.2 OVERVIEW OF EVALUATION CRITERIA

7.2.1 Ability to Achieve Remedial Action Objectives

Ideally, all of the alternatives that are identified for possible implementation will meet remedial action objectives. This criterion is designed to evaluate how well and how completely the alternatives meet the remedial action objectives established for the site as identified in Section 6.0. Failure to meet remedial action objectives or failure to meet them fully adversely affects the ability of an alternative to be selected as the preferred alternative.

7.2.2 Long-Term Effectiveness

EPA defines long-term effectiveness of remediation in terms of the risk remaining at the site after the remedial objectives have been met. The primary focus when evaluating long-term effectiveness is the ability of each alternative to maintain the desired level of protection of human health and the environment over time. One measure of the long-term effectiveness of an alternative is the extent and effectiveness of controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes after the alternative has been implemented.

7.2.3 Implementability

The criterion of implementability considers both the technical and the administrative feasibility of a given alternative. Technical feasibility includes the technical difficulties and unknowns associated with an alternative, the reliability of technologies that make up an alternative, the ease of undertaking additional remedial actions, if necessary, and the ability to monitor the effectiveness of the alternative. Administrative feasibility includes those activities needed to coordinate with state and federal agencies, the ease of obtaining needed permits and approvals,

etc. Implementability also includes consideration of the availability of services and materials including the availability of adequate offsite treatment, storage or disposal facilities, the availability of necessary equipment and specialists, and the ease of being able to obtain competitive bids for the remediation services needed.

7.2.4 Short-Term Risks

This criterion addresses the effects of each alternative during construction and implementation (i.e., the time between the start of remediation and the time that remedial objectives are met). It is designed to evaluate the effects on human health and the environment during remediation. Some questions to be considered during evaluation of the short-term effectiveness of alternatives include:

- What are the risks to the community and workers that will occur during remediation?
- How will the risks to the community and workers be addressed and mitigated?
- What risks remain to the community and workers that cannot be readily controlled?
- What environmental impacts are expected with the construction and implementation of the alternative?
- What are the available mitigation measures to be used and what is their reliability to minimize potential impacts?
- What are the impacts that cannot be avoided should the alternative be implemented?

In addition, short-term effectiveness considers how long until protection against the risks being addressed by each alternative can be achieved, how long until any remaining risks are addressed, and how long until remedial action objectives are achieved.

7.2.5 Cost

The costs to be considered for each alternative include capital costs and operation and maintenance (O&M) costs. Capital costs consist of direct and indirect cost. Direct costs are construction costs and include expenditures for equipment, labor, and material. Indirect costs are non-construction and overhead costs and include engineering, license and permit fees, startup and shakedown costs, and contingency costs to cover unforeseen circumstances.

Annual O&M costs are post-construction costs necessary to ensure the continued effectiveness of an alternative. They include operating labor costs, maintenance materials and labor costs, auxiliary materials and energy, disposal of treatment residuals, sampling costs, laboratory fees, administrative costs, insurance, taxes and licensing fees, contingency funds, costs for maintaining or replacing equipment or structures that wear out over time, and costs to perform periodic reviews of the site remedy if any residual risk remains.

Specific cost estimates for alternatives were not performed. The alternatives were compared using relative costs compared to other alternatives, with cost rating levels being reported as low, medium, and high.

7.2.6 Community Acceptance

This criterion is designed to provide for an evaluation of the issues and concerns the public may have regarding each of the alternatives. It is generally considered after one or more public involvement events (meetings, newsletters, flyers, etc.) have occurred. The purpose of holding these events is to solicit public input in the decision making process and consider community feelings and concerns during selection of the preferred alternative for remediation.

7.2.7 Preservation of Historical and Archaeological Features and Artifacts

In addition to the above criteria, the alternatives were evaluated with respect to the ability to document and/or preserve any historical and archaeological features and artifacts that may be encountered during the remedial activities. This criterion is specific to this site with regard to the known and suspected prehistoric and historic features and artifacts present at the site. Site activities will need to be coordinated with archaeological oversight and the Archaeological Monitoring Plan (see Appendix C) will need approval from the Arizona SHPO.

7.3 DESCRIPTION OF REMEDIATION ALTERNATIVES AND ABILITY TO SATISFY EVALUATION CRITERIA

Evaluation of alternatives for site remediation typically includes: (1) identification and (2) detailed analysis of a technology or combination of technologies that are capable of achieving remedial action objectives.

In the case of Old Fort Lowell Restoration Project, the following alternatives were identified for consideration:

- Alternative 1 – No Action
- Alternative 2 – Excavation and Offsite Disposal
- Alternative 3 – Capping of Contaminated Soil
- Other Alternatives

7.3.1 Alternative 1: No Action

Description

No Action was identified as an alternative that should be carried forward to represent the base case against which the other alternatives can be compared. If the No Action alternative was selected as the preferred alternative, conditions at the site would remain unchanged for the foreseeable future. There would be no reduction in the toxicity, mobility, or volume of contamination. This alternative would not provide any improvement in the protection of human

health or the environment compared to that currently afforded by the site. The following sections discuss the ability of the No Action alternative to satisfy the evaluation criteria.

Ability to Achieve Remedial Action Objectives

The No Action alternative would not achieve remedial action objectives. It would not remove soil with contaminant concentrations above the applicable RSRLs or GPLs, it would not restrict exposure to chemicals of concern via ingestion or inhalation, and it would not protect environmental receptors from exposure to chemicals of concern via surface water runoff.

Long-Term Effectiveness

The long-term effectiveness of the No Action alternative would be poor. This alternative would not reduce the toxicity, mobility, or volume of contamination at the site through treatment or excavation. Furthermore, the risk of residual contamination that is left behind after implementation of this alternative would be the same as the risk that is present before implementation of the alternative.

Implementability

The implementability of the No Action alternative would be poor. Although the technical feasibility of this alternative is good, the administrative feasibility is poor.

There are no technical difficulties or unknowns associated with this alternative and it would be relatively easy to monitor its effectiveness. The availability of services and materials needed to implement this alternative are good. It would not require offsite treatment, storage, or disposal facilities, nor would it require any equipment or specialists.

This alternative would leave contaminants in place above NRSRLs and thus would not be able to receive ADEQ approval in the form of a Declaration of Environmental Use Restriction (DEUR). As a result, the ability to develop the property in accordance with the Master Plan or in the future would be poor. Thus its administrative feasibility would be poor.

Short-Term Risk

The short-term effectiveness of the No Action alternative would be good. There would be no excess risks to the community, workers, or the environment that would occur during its implementation. There would be no impacts to human health or the environment that would have to be avoided because of implementation of this alternative.

However, because this alternative is included in this document as a baseline only, and is not designed to reduce long-term risks, questions about how long it would take until the alternative provides protection against risks are not applicable. Likewise, it is unknown how long it would be until any remaining risks are addressed. Finally, this alternative would not achieve remedial action objectives.

Cost

The relative cost of the No Action alternative would be low. This is because it includes no cleanup or remediation, and would not include preparation of a DEUR application or long-term monitoring.

Community Acceptance

The community acceptance of the No Action alternative would be poor based on the public meetings that have already been held, the high local community interest in the site, and expectations for cleanup and inclusion of the site as an addition to Fort Lowell Park.

Preservation of Historical and Prehistoric Artifacts

The No Action alternative would not cause disturbance of potential historic and prehistoric artifacts. However, this alternative would eventually cause long-term permanent damage because the existing historic structures and ruins would continue to deteriorate.

7.3.2 Alternative 2: Excavation and Offsite Disposal

Description

Excavation and Offsite Disposal would include removal of soil contaminant concentrations greater than the applicable RSRLs and GPLs discussed in Section 6.1. Excavation of contaminated soil would be performed using an excavator or backhoe. The equipment operator would need to have experience performing precision cuts that are typically used for archaeological excavations. The excavations would be monitored for signs of visible contamination and for the presence of prehistoric and historic artifacts. Contaminated soil would be stockpiled and transported off site for disposal.

Once soil has been excavated to the appropriate depth and the lateral extent of the excavation is considered sufficient to remove chemicals of concern verification samples would be collected from the floor and perimeter of the excavation to determine if remedial action objectives have been met. Verification samples would be analyzed for PAHs, lead, and arsenic in the surface soil remediation areas; PAHs, lead, arsenic, and mercury at the four residential septic system areas; and PAHs, lead, arsenic, mercury, and volatile organic compounds (VOCs) at the two non-residential septic system areas (work shop and former cesspool area).

If any surface sample verification samples indicate that PAHs, lead, or arsenic are present above applicable RSRLs, additional soil excavation and verification sampling would be performed until remedial action objectives have been met. If verification samples at the septic tanks contain mercury above minimum GPLs, TCLP analyses would be performed to determine whether alternative GPLs can be applied. If any VOCs are identified in the verification samples at the two non-residential septic tanks, they will be compared to applicable RSRLs and GPLs.

If locations in the surface soil remediation areas are found that exceed applicable RSRLs at 5 feet bgs, or in the case of the septic tanks, if they exceed applicable RSRLs or GPLs at 12 feet bgs, excavation would be halted and the results for that location evaluated to determine if excavation

should continue or if a DEUR would be a feasible alternative. Any backfilling necessary for safety issues or for archaeological preservation would be evaluated on a case by case basis.

The following sections discuss the ability of the Excavation and Offsite Disposal alternative to satisfy the evaluation criteria.

Ability to Achieve Remedial Action Objectives

The ability of the Excavation and Offsite Disposal alternative to achieve remedial action objectives would be good. It would remove soil contaminant concentrations greater than the applicable RSRLs and GPLs discussed in Section 6.1, it would restrict future exposure to chemicals of concern via ingestion or inhalation, and it would protect environmental receptors from exposure to chemicals of concern via surface water runoff. If a DEUR is used for isolated areas of contamination that are left in place due to excessive depth or for preservation of archaeological features or artifacts, these areas will be covered with soil or other cap to protect workers, visitors, and the community from exposure to the contaminants.

Long-Term Effectiveness

The long-term effectiveness of the Excavation and Offsite Disposal alternative would be good. This alternative would reduce the toxicity, mobility, or volume of contamination at the site through excavation. If applicable, any potential isolated DEUR areas resulting from isolated areas of contamination that are left in place due to excessive depth or for preservation of archaeological features or artifacts will be covered with soil or other cap to protect workers, visitors, and the community from exposure to the contaminants. The risk of residual contamination that is left behind after implementation of this alternative would be low.

Implementability

The implementability of the Excavation and Offsite Disposal alternative would be good. There are no technical difficulties or unknowns associated with this alternative, other than as discussed below under the archaeological criterion. In addition, there is the potential for isolated areas of contamination that would be left in place due to excessive depth; these areas will be covered with soil or other cap to protect workers, visitors, and the community from exposure to the contaminants. It would be relatively easy to monitor the effectiveness of this alternative. The availability of services and materials needed to implement this alternative would be good. The time needed to perform this alternative is estimated to be less than one month. The offsite treatment, storage, or disposal facilities required by this alternative would be readily available. Equipment and personnel required to implement this alternative would also be readily available. The ability of this alternative to receive required permits and approvals from state and federal agencies would be good.

Short-Term Risk

The short-term effectiveness of the Excavation and Offsite Disposal alternative would be fair. There would be some risks to the community, workers, and the environment that would occur during its implementation, which is estimated to be less than one month, but it is expected that

these risks could be mitigated through dust and stormwater controls (such as covering bins and stockpiles) and appropriate health and safety procedures, including air monitoring, as necessary.

If a DEUR is used for this alternative, long-term risks would be reduced, but monitoring and maintenance would be required. This alternative would also restrict some types of potential future uses.

Cost

The relative cost of the Excavation and Offsite Disposal alternative would be medium to high due to the need for soil removal and disposal. This alternative would include preparation and approval of several documents prior to beginning work. These include a Work Plan, SAP, HASP, and archaeological monitoring plan. In addition, prior to initiation of fieldwork, it would be necessary to perform public and private utility surveys.

Direct costs would include excavation, staging, transportation, and disposal of contaminated soil; verification sampling and backfilling (if necessary); archaeological monitoring; and project management. Following completion of remediation activities, there would be costs for preparation of reports documenting the fieldwork. No O&M costs would be required for this alternative unless isolated areas of contamination are left in place due to excessive depth or for preservation of archaeological features or artifacts. These areas would require preparation of a DEUR application for submittal to ADEQ and a one-time fee for ADEQ review and approval of the application. Engineering controls used to protect the remaining contamination from disturbance, such as a soil cover or cap, would require preparation of an Engineering Control Plan as part of the DEUR application, and would incur future costs for performance of an annual site inspection, preparation of a letter report of findings and recommendations, and submittal of the report to ADEQ.

Community Acceptance

Several public meetings have been held by the COT regarding activities at the site. Based on public comments voiced during these meetings, it is expected that community acceptance of the Excavation and Offsite Disposal alternative would be good.

Preservation of Historical and Archaeological Artifacts

Excavation and Offsite Disposal would cause disturbance of potential historic and prehistoric artifacts. However, an archaeological monitoring plan would be submitted to SHPO prior to implementation of the remedial action and remediation activities would be continuously monitored by an archaeologist. If the discovery of artifacts were to occur, they would be documented and, if necessary, collected and cleaned for preservation. Significant features or artifacts may also be left in place and buried to preserve them. Once the site is remediated, existing historic structures and ruins would be preserved, rehabilitated, and/or protected so that they do not continue to deteriorate.

7.3.3 Alternative 3: Capping of Contaminated Soil

Description

Capping of Contaminated Soil would require design and installation of a suitable cap, such as asphalt or soil, over contaminated soil. This alternative would need to be coordinated with the Master Plan for the site. A DEUR would need to be obtained in order to leave soil contamination above applicable RSRLs on the site. However, in order to qualify for a DEUR, areas of soil that exceed applicable NRSRLs and GPLs would need to be excavated for offsite disposal and verification samples collected and analyzed as discussed under Alternative 2. In addition, some excavation and grading, including staging, transportation, and offsite disposal of contaminated soil, could be required to achieve proper grades. There would be some reduction in the toxicity and volume of contamination. The remaining contaminated soil would be immobilized and protected from disturbance, but long term maintenance of the cap would be required to assure that no unplanned breach occurs.

The following sections discuss the ability of the Capping of Contaminated Soil alternative to satisfy the evaluation criteria.

Ability to Achieve Remedial Action Objectives

Capping of Contaminated Soil would not achieve some of the remedial action objectives. Although it would restrict exposure to chemicals of concern via ingestion or inhalation and it would protect environmental receptors from exposure to chemicals of concern via surface water runoff, it would leave in place soil contaminant concentrations greater than the applicable RSRLs and less than the applicable NRSRLs and GPLs discussed in Section 6.1. Fewer archaeological features would potentially be disturbed by this alternative.

Long-Term Effectiveness

The long-term effectiveness of the Capping of Contaminated Soil alternative would be fair. The risk of residual contamination left behind after implementation of this alternative would be reduced because it would be isolated and inaccessible. However, there would be future risks to workers during future projects or if projects are performed by personnel that are unaware of the presence of the cap and contaminated soil. In addition, long-term monitoring would be required. This alternative would reduce the toxicity and volume of contamination at the site through excavation of areas of soil contamination that exceed applicable NRSRLs or GPLs.

Implementability

The implementability of the Capping of Contaminated Soil alternative would be fair. The technical feasibility of this alternative would be good; the administrative feasibility would be fair to good.

Technical difficulties or unknowns associated with this alternative consist of the potential for the cap to be in conflict with the design and goals of the Master Plan for the site. It would be relatively easy to monitor the effectiveness of this alternative. However, the availability of services and materials needed to implement this alternative would be good. The offsite treatment,

storage, or disposal facilities required to implement this alternative would be readily available. The equipment and personnel required for this alternative would also be readily available.

This alternative would leave contaminants in place above applicable RSRLs but not above applicable NRSRLs or GPLs. Thus it would be possible for it to receive ADEQ approval in the form of a DEUR. For this reason, its administrative feasibility would be fair to good.

Short-Term Risk

Disturbance of contaminated soil would be required with this alternative; therefore, the short-term effectiveness of the Capping of Contaminated Soil alternative would be fair. There are some risks to the community, workers, and the environment that would occur during its implementation, which would be expected to take more than one month, but it is expected that these risks could be mitigated through dust and stormwater controls (such as covering bins and stockpiles) and appropriate health and safety procedures, including air monitoring, as necessary.

This alternative would reduce long-term risks, but monitoring and maintenance would be required. This alternative would also restrict some types of potential future uses. This alternative would not achieve remedial action objectives.

Cost

The relative cost of the Capping of Contaminated Soil alternative would be medium to high. Costs would include the work required to remove contaminated soil above applicable NRSRLs or GPLs and stage, transport, and dispose of this soil. This alternative would include preparation and approval of several documents prior to beginning work. These include a Work Plan, SAP, HASP, and archaeological monitoring plan. In addition, prior to initiation of fieldwork, it would be necessary to perform public and private utility surveys.

Costs of this alternative would also include the cost to design and install a suitable cap over the remaining contaminated areas of the site above applicable RSRLs or GPLs. In addition, there would be costs to prepare a DEUR application and Engineering Control Plan for submittal to ADEQ and a one-time fee for ADEQ review and approval of the application and annual site inspection reports. There would also be future costs for performance of an annual site inspection, preparation of a letter report of findings and recommendation, and submittal of the report to ADEQ.

It should be noted that the majority of the identified contaminated soil on the site exceeds applicable NRSRLs or GPLs, not RSRLs, meaning areas that would require excavation under this alternative are likely not significantly different than those that would be excavated under Alternative 2. Therefore, capping areas that exceed RSRLs would probably not result in significant cost savings over Alternative 2 due to the need for design and construction of a cap and resulting long-term maintenance costs, and would probably cost more.

Community Acceptance

Several public meetings have been held by the COT regarding activities at the site. Based on the results of these meetings, it is expected that the community acceptance of the Capping of

Contaminated Soil alternative would be poor. This is due to significant local community interest in the site and expectations for cleanup of the site and its inclusion in the Fort Lowell Park.

Preservation of Historical and Archaeological Artifacts

The Capping of Contaminated Soil alternative, which includes excavation of contaminated soil above applicable NRSRLs or GPLs, would cause disturbance of potential historic and prehistoric artifacts. However, an archaeological monitoring plan would be submitted to SHPO prior to implementation of the remedial action and remediation activities would be continuously monitored by an archaeologist. If the discovery of artifacts were to occur, they would be documented and, if necessary, collected and cleaned for preservation. Significant features or artifacts may also be left in place and buried to preserve them. Once the site is remediated and capped, existing historic structures and ruins would be preserved, rehabilitated, and/or protected so that they do not continue to deteriorate. There would be restrictions included in the DEUR with regard to any future archaeological investigations that would disturb the engineering control (the cap).

7.3.4 Other Alternatives

Several other remedial alternatives were researched to determine if they would be feasible for this site. These alternatives included vacuum soil removal, solidifying or stabilizing impacted soil, soil washing, electrokinetics, and in-place activation/phytostabilization. Expected problems with these alternatives that were determined to be fatal flaws for the remediation action objectives include:

1) No removal of contaminants from the site (solidifying or stabilization);

2) Dust emissions that would be difficult to control (vacuum soil removal);

3) Inability to monitor for archaeological artifacts (in-place inactivation/phytostabilization);

4) Mandatory performance of bench scale and/or pilot tests to determine whether the alternative would be effective at the site (soil washing, electrokinetics, in-place activation/phytostabilization), which would add a significant amount of time to the project, but would not guarantee a favorable outcome;

5) Interference from the large amount of metallic materials in site soil, especially around the shop building, and poor conductance caused by low soil moisture content (electrokinetics);

6) Potentially much longer time frame for implementation relative to Alternatives 1 through 3 (vacuum soil removal, soil washing, electrokinetics, in-place activation/ phytostabilization);

7) Long-term monitoring (sample collection) extending beyond the length of the grant period would be required for some methods to prove that the cleanup was effective (electrokinetics, in-place activation/ phytostabilization); and

8) Higher costs per volume of soil remediated (soil washing, electrokinetics, in-place activation/phytostabilization).

An additional consideration is that by themselves, none of these technologies could achieve remedial action objectives. A combination of these technologies would likely be required to achieve effective cleanup of the various chemicals of concern (PAHs, metals) contamination in soil.

7.4 COMPARATIVE ANALYSIS OF ALTERNATIVES

Using the results of the detailed analysis presented in Section 7.0, a comparative analysis was performed to provide a relative ranking of the alternatives. Each alternative was assigned a score for each of the seven criteria. In general, the alternative with the best performance for each criterion was assigned a "2". The second best alternative was assigned a "1". The alternative that appears to be least able to satisfy the criteria relative to the other two was assigned a "0". The alternative with the highest total score is the preferred alternative. The following table summarizes the results of the comparative analysis.

Criteria	Alternative 1 No Action	Alternative 2 Excavation and Offsite Disposal	Alternative 3 Capping of Contaminated Soil
Achievement of Remedial Action Objectives	Poor (0)	Good (2)	Fair (1)
Long-Term Effectiveness	Poor (0)	Good (2)	Fair (1)
Implementability	Poor (0)	Good (2)	Fair (1)
Short-Term Risks	Fair (2)	Fair (1)	Fair (1)
Cost	Low (2)	Medium to High (1)	Medium to High (0)
Community Acceptance	Poor (0)	Good (2)	Poor (1)
Preservation of Historical and Prehistoric Artifacts	Fair (0)	Fair (1)	Fair (2)
TOTAL SCORE	4	11	7

With respect to ***achievement of remedial action objectives***, the ability of the alternatives to satisfy this criterion from best to worst included Alternative 2, Alternative 3, and Alternative 1. Only Alternative 2 (Excavation and Offsite Disposal) would remove most, if not all, of the contamination above applicable RSRLs and GPLs.

With respect to ***long-term effectiveness***, the ability of the alternatives to satisfy this criterion from best to worst included Alternative 2, Alternative 3, and Alternative 1. Because Alternative 1 (No Action) would not remove any contamination, and Alternative 3 (Capping of Contaminated Soil) would leave contamination above RSRLs, Alternative 2 (Excavation and Offsite Disposal) had the highest long-term effectiveness.

The ability of the alternatives to satisfy the criterion of ***implementability*** from best to worst included Alternative 2, Alternative 3, and Alternative 1. Alternative 1 (No Action) was given the lowest score because it would not be able to obtain a DEUR from ADEQ, which would be required in order to leave contamination in place. Alternative 3 (Capping of Contaminated Soil) was given the next lowest score because of expected conflicts with the Master Plan.

The ability of the alternatives to satisfy the criterion of ***short-term risk*** from best to worst included Alternative 1, with Alternatives 2 and Alternative 3 tied. Because there would be no disturbance of contaminated soil and no dust or noise, Alternative 1 (No Action) was given the highest score. Alternative 3 (Capping of Contaminated Soil) and Alternative 2 (Excavation and Offsite Disposal) would both result in disturbance of site soils during the remedial activities.

With respect to ***cost***, the ability of the alternatives to satisfy this criterion from best to worst included Alternative 1, Alternative 2, and Alternative 3. The highest score was given to Alternative 1 (No Action) because it would have the lowest costs. The lowest score was given to Alternative 3 (Capping of Contaminated Soil) because areas that would require excavation under this alternative are not significantly different than those that would be excavated under Alternative 2 (Excavation and Offsite Disposal), and Alternative 3 would also require a DEUR and costs for design and construction of a cap and subsequent O&M. Although Alternative 2 could potentially also require a DEUR and soil cover for isolated areas of contamination, these areas would be smaller than the cap discussed under Alternative 3.

With respect to ***community acceptance***, the ability of the alternatives to satisfy this criterion from best to worst included Alternative 2, Alternative 3, and Alternative 1. The local community expects contamination to be removed in the most effective way possible, while protecting public safety and health. Alternative 1 (No Action) received the lowest score because it does not result in the removal of contaminants. Alternative 3 (Capping of Contaminated Soil) received a lower score than Alternative 2 (Excavation and Offsite Disposal) because it would not remove soil contamination above applicable RSRLs, but less than applicable NRSRLs and GPLs, from the site.

The ability of the alternatives to satisfy the criterion of ***preservation of historical and prehistoric artifacts*** from best to worst included Alternative 3, Alternative 2, and Alternative 1. Although there would be no disturbance of soil for Alternative 1 (No Action), this alternative would allow existing historic structures and ruins to continue to deteriorate, causing permanent long-term damage; therefore this alternative was given the lowest score. Alternative 3 (Capping of Contaminated Soil) was given the highest score because potentially less disturbance of soil would occur than with Alternative 2 (Excavation and Offsite Disposal). Although Alternatives 2 and 3 would both potentially disturb artifacts and features, this would be mitigated by archaeological monitoring, documentation, and preservation.

Based on this analysis, Alternative 2 (Excavation and Offsite Disposal) received the highest total score and is the preferred alternative. The remainder of this document includes discussion of the Work Plan for this alternative. A Sampling and Analysis Plan (SAP) has also been prepared for this alternative and is included in Appendix A.

8.0 REMEDIATION WORK PLAN

Excavation and Offsite Disposal will include the activities listed below.

- Soil located in areas containing contaminants at concentrations greater than applicable RSRLs and GPLs will be removed (approximately 0.3 to 1.2 acres) through excavation methods. Archaeologists will monitor activities to ensure preservation/documentation of prehistoric and historic artifacts and features.
- Areas disturbed by the remediation activities will not be backfilled, unless necessary for safety or for preservation of archaeological features and artifacts. This will be determined on a case by case basis. As needed, excavated areas will be recontoured.
- Stormwater controls will be installed to reduce potential transport of contaminants.
- Soil samples will be collected to verify that remediation to applicable RSRLs and GPLs has been met.
- If locations in the remediation area are found that exceed applicable RSRLs at 5 feet bgs, or in the case of the septic tanks, if applicable RSRLs and GPLs are exceeded at 12 feet bgs, excavation will be halted and the results for that location evaluated to determine if excavation should continue or if a DEUR would be a feasible alternative.

In addition, the project is subject to on-going review and consultation with the Arizona SHPO, and impacts on cultural resources from environmental remediation will be mitigated through SHPO-approved archaeological treatment and monitoring.

Additional discussion about pre-field activities, field activities, and reporting are included in the following sections.

8.1 TASK 1 – PRE-FIELD ACTIVITIES

8.1.1 Planning and Coordination Meetings

The purpose of planning activities is to methodically and logically prepare the design of remediation activities, provide regulatory agencies an opportunity to review and approve the remediation design, and to solicit and consider input from the community. Regular monthly planning meetings are held by the COT and Pima County to discuss planned site activities and any issues that require resolution. Quarterly Advisory Committee meetings are held to provide input from the advisory committee and interested general public, and emails are sent to key representatives to keep them informed on upcoming activities. SCS will provide project updates, if requested, at these meetings. Field planning meetings will be held as needed before fieldwork begins to coordinate field activities.

8.1.2 Document Preparation

Planning activities include the preparation of various documents. These include:

- This Remediation Work Plan document;
- A Sampling and Analysis Plan (SAP), which combines elements of a Field Sampling Plan and a Quality Assurance Project Plan (QAPP) – included in Appendix A;
- The site-specific Health and Safety Plan (HASP) – included in Appendix B;
- An Archaeological Monitoring Plan – included in Appendix C;
- Fugitive Dust Activity Permit; and
- Stormwater Pollution Prevention Plan (SWPPP).

The SAP provides detailed descriptions of sampling activities to be performed during remediation activities and quality assurance/quality control (QA/QC) procedures. The site-specific HASP describes potential site hazards and mitigation of these hazards for SCS workers. Each contractor working on site will need their own HASP that will be applicable to their workers. Desert Archaeology prepared the Archaeological Monitoring Plan for the site that describes the archaeological oversight, documentation, and preservation activities that will be performed during remediation activities. Desert Archaeology will also prepare a HASP for their workers.

This Work Plan and associated documents will be submitted to the EPA and ADEQ VRP for approval. The Archaeological Monitoring Plan will be submitted to SHPO for approval.

Because the area of the site to be stripped of soil may exceed one acre, prior to field work SCS will prepare a Fugitive Dust Activity Permit Application for submittal to Pima County Department of Environmental Quality (PDEQ). In addition, SCS will prepare a SWPPP in accordance with the 2008 Arizona Pollutant Discharge Elimination System (AZPDES) General Permit for Stormwater Discharges from Construction Activities (AZG2008-01), also called the Construction General Permit (CGP). The purpose of the SWPPP is to identify potential pollution sources that may affect the quality of stormwater discharges and to describe the implementation of practices to minimize and control pollutants in stormwater discharges associated with construction activities. This document will serve as a guide to prevent or control the discharge of pollution in stormwater discharge associated with remediation activities at the site. In addition, a Notice of Intent will be submitted to ADEQ at least 32 days prior to the start of excavation fieldwork and a copy will also be provided to ADEQ VRP.

8.1.3 Training

Workers at the site involved with excavation in areas of contaminated soil will be required to have received the 40-hour Hazardous Waste Worker (HAZWOPER) training and have annual 8-hour refresher training that is current.

8.1.4 Structure Demolition

Asbestos surveys were performed on the site structures planned for demolition. Structures and features on the site that were demolished in September 2010 included a former work shop,

windmill frame, concrete water tank, and concrete pads, including the concrete steel sheet roller trench containing the stormwater drainage feature. SCS and Desert Archaeology observed the demolition activities to ensure that contaminated areas were avoided as much as possible and archaeological features were not impacted.

8.1.5 Utility Surveys

Prior to the start of active excavation all underground utilities will be surveyed and their location marked. To ensure proper survey of public utilities, Arizona Blue Stake will be contacted. Arizona Blue Stake will notify public utility companies of the location of planned excavation activities and request that they mark the known location of any of their utilities that are present at the site. SCS will retain a utility survey company to locate and mark private utilities on the site in the planned excavation areas. The purpose of the utility surveys is to avoid impacting utilities whenever possible, and to implement special procedures to protect utilities whenever potential impacts appear to be unavoidable.

8.1.6 Scheduling and Coordination of Fieldwork

SCS field personnel will review the Work Plan, SAP, and HASP; gather equipment needed to perform the fieldwork; and contact the laboratory to schedule delivery of sample containers, sample drop-off, and sample analyses.

Fieldwork will be scheduled following receipt of necessary approvals and permits. Fieldwork will be coordinated with the COT, Pima County, Desert Archaeology, and all subcontractors. Key public representatives will be notified of the dates and times of fieldwork to be performed. Signs will be placed at the site to notify passers-by of activities being performed at the site.

8.2 TASK 2 – FIELD ACTIVITIES

8.2.1 Site Management

SCS will serve as the overall site manager and will determine where excavations will occur. Desert Archaeology will monitor excavations and will have authority to stop excavation work if archaeological features are encountered.

8.2.2 Remediation Activities

8.2.2.1 Excavation of Contaminated Soil – Surface Soil Locations

SCS prepared a map of surface conditions that shows the initial areas that will be excavated, as shown in Figure 11. The map was prepared using data from previous site characterization work. Contaminated soil will be excavated to an initial depth of approximately 6 inches using an excavator. These areas will be marked by SCS prior to excavation. Excavated soil will be stockpiled on plastic sheeting next to the excavation and then transferred into roll-off containers placed near the excavation area. City of Tucson personnel will bring empty roll-off containers to the site, place in designated areas, and remove any full containers.

After excavation of each area is complete, SCS will collect verification soil samples for analysis for PAHs, lead, and arsenic. Surface samples will also be collected within the area of potential maximum excavation to ensure that the area between the limits of the minimum and maximum areas of excavation meet cleanup goals. If any verification sample exceeds the applicable RSRLs, additional soil will be excavated horizontally and/or vertically, as necessary. After the additional excavation is complete, verification samples will be collected once more. This process will continue until the full extent of contamination has been removed and verified. If locations in the remediation area are found that exceed applicable RSRLs at 5 feet bgs, excavation will be halted and the results for that location evaluated to determine if excavation should continue or if a DEUR would be a feasible alternative.

8.2.2.2 Verification Sampling

Sampling methodology is described in Sections 4.0, 6.0, and 7.0 of the SAP and the estimated locations of verification samples are shown on Figure 11. The locations of any additional verification samples will be determined based on the results of the initial samples and subsequent additional excavation locations. Soil sample locations will be identified with nail and whisker markers and recorded in the field notebook as sampling is completed. A sketch of the sample location will be entered into the notebook and any physical reference points will be labeled. The sample locations and excavation boundaries will be surveyed using a differentially-corrected global positioning system (GPS).

Grab soil samples will be collected from the floor of the initial excavations from a depth of 6 to 12 inches bgs and from the ground surface around the excavations from a depth of 0 to 6 inches bgs. The samples will be analyzed for contaminants of concern (PAHs, arsenic, and lead) and the results will be compared to applicable RSRLs.

8.2.2.3 Excavation of Septic Tank Areas

Approximately six septic systems and related features (tanks, piping, leach fields, etc.) will be excavated and removed from the site. These include four residential septic systems for the two residences in the northern portion of the site, a former trailer location, and a wastewater drainage feature apparently connected to the kitchen of the northeast residence. A non-residential septic system is associated with the restroom of the work shop and the another non-residential septic system is located in the southeast portion of the site and is associated with a residence and the former cesspool. During excavation, the septic systems will be observed for evidence of contamination, such as staining or odors, and will be investigated by the collection and analysis of soil samples.

Sampling methodology is described in Sections 4.0, 6.0, and 7.0 of the SAP. Soil samples will be collected from below the septic tank, any perforated piping, and the leach field. If samples are collected in excavations that are more than 4 feet deep, the backhoe bucket will be used to collect the soil for the sample. Soil samples from the residential septic system areas will be analyzed for PAHs, arsenic, lead, and mercury. Soil samples from the non-residential septic systems will also be analyzed for VOCs.

If a verification sample at a septic system does not exceed applicable RSRLs, but contains mercury above the minimum GPL, the TCLP analysis will be performed for mercury to determine whether an alternative GPL can be applied. If a soil sample collected from the excavations exceeds the applicable RSRLs or GPLs, additional soil will be excavated horizontally and/or vertically, as necessary. After the additional excavation is complete, verification samples will be collected once more. This process will continue until the full extent of contamination has been removed and verified.

If septic tank sample locations are found that exceed applicable RSRLs or GPLs at 12 feet bgs, excavation will be halted and the results for that location evaluated to determine if excavation should continue, if other methods of investigation should be used, or if a DEUR would be a feasible alternative.

8.2.2.4 Waste Characterization Sampling

Two samples of in-situ soil were previously collected at the site by SCS from areas with the highest identified concentrations of arsenic and lead. These samples were analyzed for arsenic and lead using the TCLP for waste characterization purposes. The samples were not analyzed for PAHs because these compounds are not regulated for toxicity. The results for these samples indicate that contaminated soil on the site will not be a characteristic hazardous waste and can be disposed as a non-hazardous waste. The results for these TCLP samples were also used to determine alternative GPLs for arsenic and lead, as described in Section 6.1.2.

If additional samples of soil are needed by the landfill for waste characterization purposes, at the beginning of the excavation fieldwork, two locations will be selected that represent high levels of arsenic and lead. These areas will be excavated in the same manner as planned for the remediation activities and the soil placed into two roll-off containers. SCS will collect a composite soil sample from each of the two roll-offs and will submit them to the analytical laboratory. The samples will be analyzed for arsenic and lead using the TCLP and compared to the TCLP threshold levels to confirm that the soil may be disposed at Los Reales Landfill.

In addition, TCLP analyses may be used to establish alternative GPLs for additional constituents on a case by case basis, as discussed under Section 8.2.2.3 above.

8.2.2.5 Soil Transportation, Disposal, and Backfill

Excavated soil will be initially be placed in stockpiles on plastic sheeting during excavation. The soil will be then be transferred into roll-off containers placed near the excavation area. City of Tucson personnel will bring empty roll-off containers to the site, place in designated areas, and remove any full containers. The soil will be moisture conditioned to prevent blowing dust. The roll-off containers will be covered when filled and during transportation by truck to the disposal facility. Based on the results for two preliminary waste characterization samples previously analyzed (as discussed in Section 8.2.2.3), it is assumed that the soil will be disposed as a non-hazardous waste at the City-owned Los Reales Landfill.

Backfilling is not planned unless there are safety issues with deeper excavations or in areas where archaeological features or artifacts were preserved in place. If backfill is required, to ensure that it is free of contaminants of concern up to 6 samples of backfill material will be

collected for laboratory analysis. The samples will be collected at the borrow or source area prior to loading any material on trucks for transport to the site. The soil that is considered for backfill will also need to be screened for invasive plant seeds.

8.2.3 Well Abandonment

Three inactive dry groundwater wells are located in the northeast, south, and west portions of the site. The wells have reportedly been dry for many years, and will be abandoned as one of the project tasks. In 2007, SCS spoke with several subcontractors regarding the procedures and costs required to remove the debris from the wells. Due to the high estimated costs to perform this removal, the health and safety risks, and the potential risk to archaeological features, the COT discussed abandoning the wells with the debris in place with Mr. Mike Ball of ADWR; it was agreed that the debris could be left in place during abandonment. Notices of Intent (NOIs) to Abandon Well forms were submitted to ADWR, but the abandonment project was temporarily halted due to lack of funds. The windmill tower at the northeast well and the concrete water tank at the south well were removed during demolition activities in September 2010.

For the current project, prior to abandonment, the two unregistered wells will be registered with ADWR. The NOIs previously filed with ADWR will be reviewed to make sure the information is current and accurate, and any necessary changes will be made. Permits to abandon the wells will be obtained by the selected subcontractor. The three water wells will be abandoned in accordance with ADWR requirements by filling with approved soil and/or grout. No groundwater or soil sampling is planned because the wells are reported to be dry, equipment and lumber are blocking access to the interior of the well casings, and there is no evidence contaminants extend significantly into the subsurface at the site.

8.2.4 Archaeology

Desert Archaeology will monitor excavation activities during remediation. The Archaeological Monitoring Plan is included in Appendix C.

8.2.5 Health and Safety Considerations

The primary health and safety concern with regard to the contaminants present in soil on the site during remediation activities is control of dust. Water will be used to moisture condition in-place soil and soil that is being excavated and placed in stockpiles or into roll-off containers. Inactive stockpiles will be covered with plastic sheeting to control dust and bermed to prevent migration of sediment during stormwater runoff. All roll-off containers will be covered when filled and during transport. Proper personal protection equipment (PPE), including chemical resistant gloves, safety boots, etc. will be worn as discussed in the SCS site-specific HASP (see Appendix B).

During remediation, it may be necessary to perform monitoring at and/or near the site. The purpose of monitoring would be to evaluate whether contingency measures are necessary to keep potential impacts to the community within acceptable parameters. If necessary, several locations may be selected around the perimeter of the site for ambient air monitoring stations. If this type of monitored is needed, high volume air samplers would be operated at these stations to monitor particulate matter less than 10 microns in size (PM_{10}) and PAHs to evaluate whether it is possible

that chemicals of concern from excavation operations could be carried to offsite areas. If monitoring data indicate that the potential for exposure to airborne contaminants is likely, contingency measures could be implemented. These might include increased dust suppression via application of water or foam, or reduction in the size of the working face of the excavation. The excavation contractor might also be required to cease onsite activities any time wind speed exceeds a predetermined value.

Working hours at the site will be limited to predetermined daytime hours so that noise and onsite operations do not occur during the quietest times of the day. Portable toilets will be provided for workers on the site.

8.3 TASK 3 – REPORTING

Analytical data and field results from remediation activities will be compiled into a final report prepared by a professional geologist registered in the State of Arizona. The report will describe the work that was performed to excavate, transport, and dispose of contaminated soil. The results of any monitoring will be discussed. The report will also discuss the procedures used for collection and analysis of verification samples performed in accordance with the SAP, and the source, quality, and volume of backfill, if applicable. Photographs, lab reports, and monitoring data (if any) will be incorporated into the report as appendices. Any deviations from the Work Plan and SAP will also be discussed. Desert Archaeology will prepare a separate report documenting the archaeological monitoring activities and findings from the investigation.

Upon approval by the COT, the report will be submitted to the EPA and ADEQ VRP for review. A final summary report for submittal to the EPA that discusses the highlights of the project will also be prepared upon completion of remediation. A request for project closure will be submitted to ADEQ VRP.

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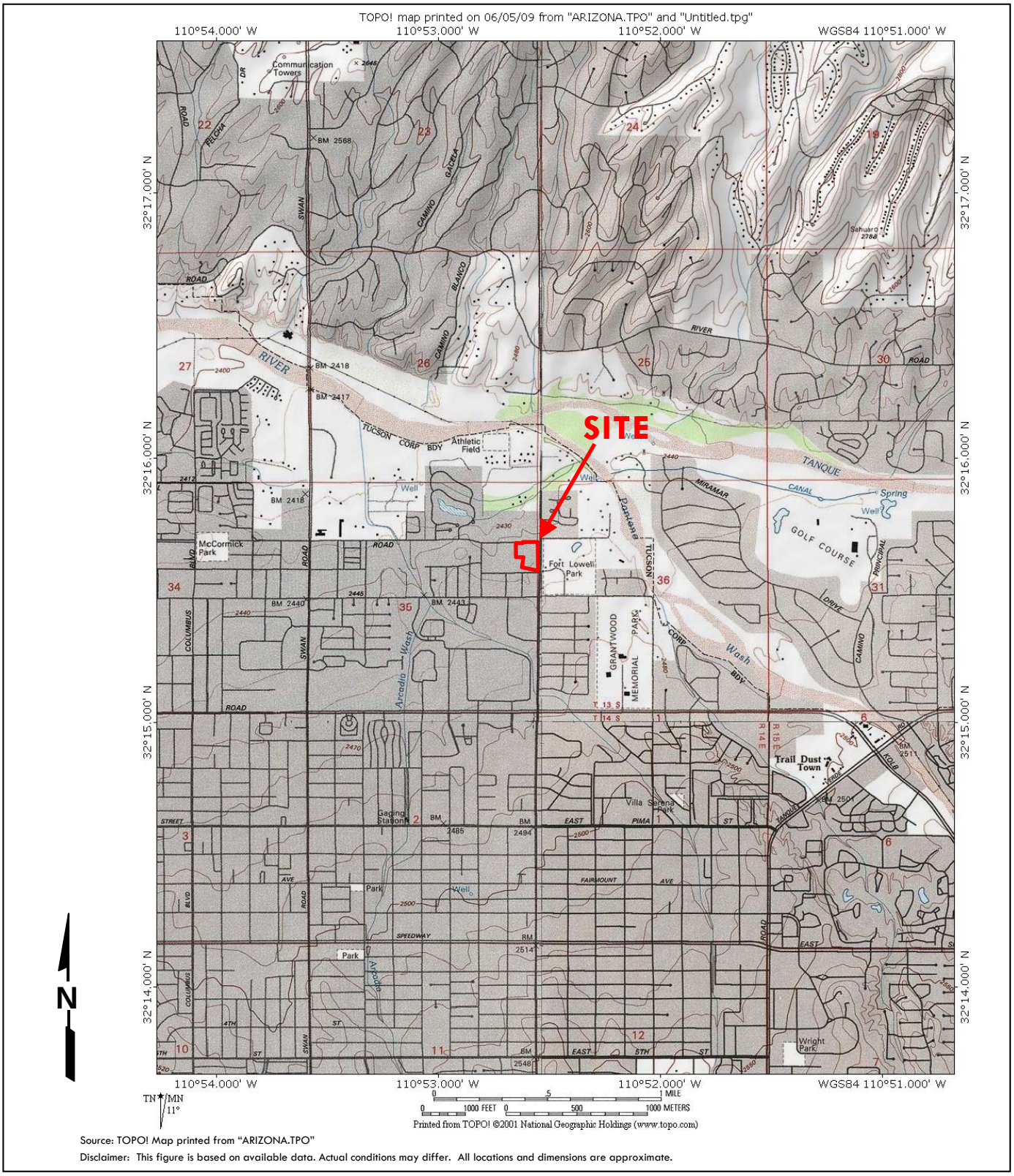
FIGURES



Source: TOPO! Map printed from "ARIZONA.TPO"

Disclaimer: This figure is based on available data. Actual conditions may differ. All locations and dimensions are approximate.

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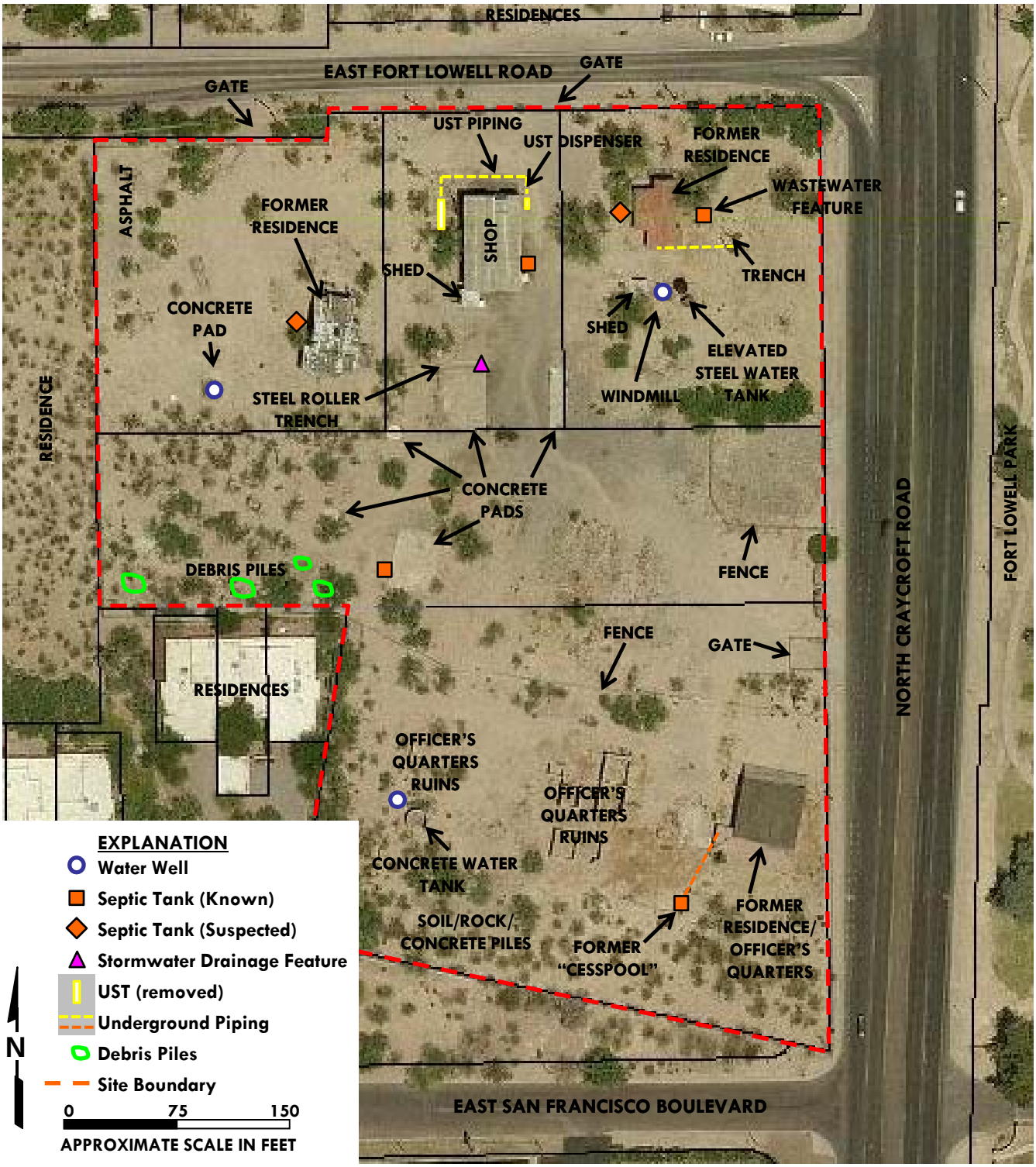
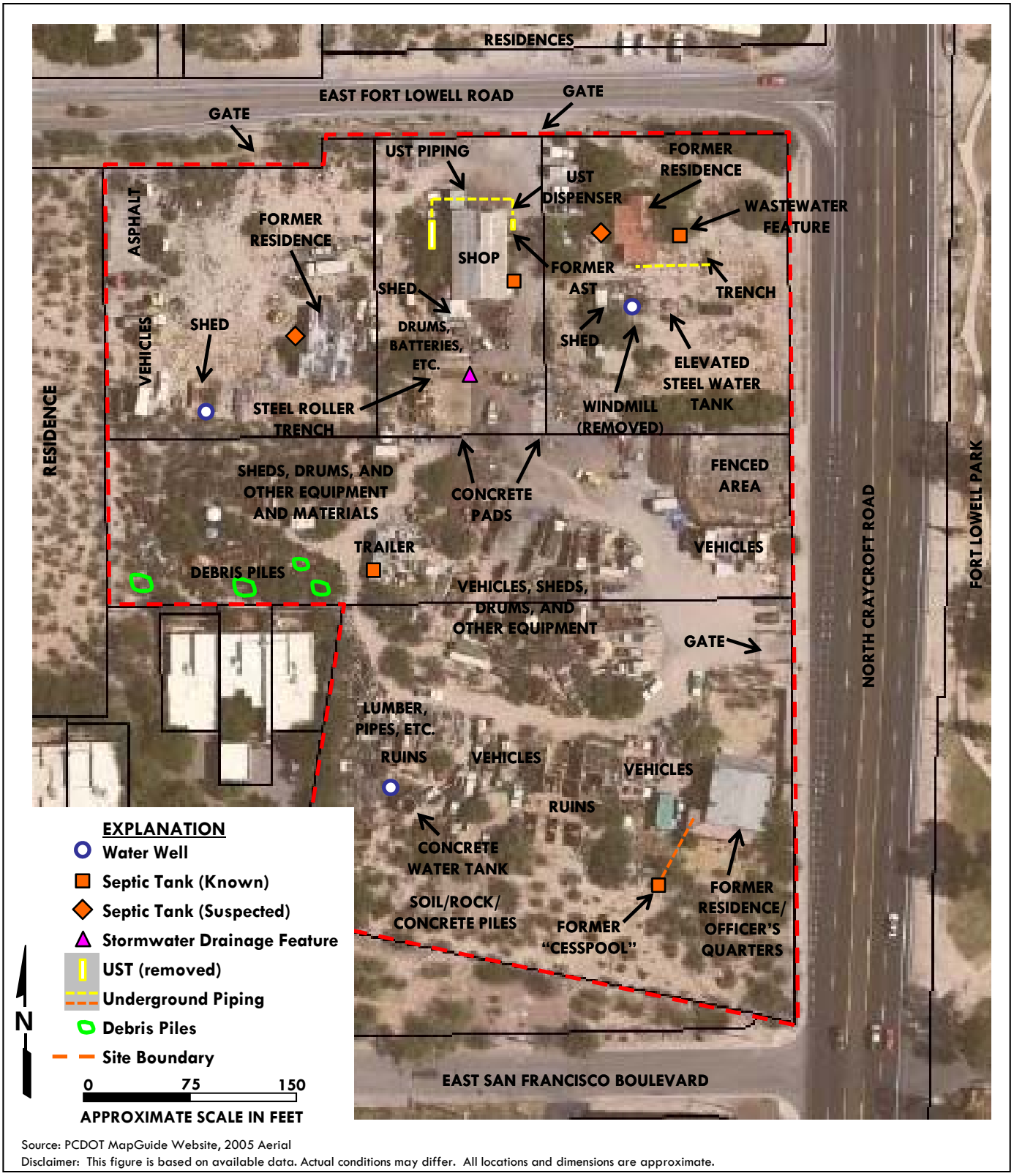
ABCA and Remediation Work Plan
Old Fort Lowell Restoration Project
5460 East Fort Lowell Road
Tucson, Arizona

Figure 1
Site Location Map

Source: Google Earth, March 2011 Aerial
Disclaimer: This figure is based on available data. Actual conditions may differ. All locations and dimensions are approximate.



Source: PCDOT MapGuide Website, 2008 Aerial
Disclaimer: This figure is based on available data. Actual conditions may differ. All locations and dimensions are approximate.



Source: PCDOT MapGuide Website, 2005 Aerial
Disclaimer: This figure is based on available data. Actual conditions may differ. All locations and dimensions are approximate.

APPROXIMATE BOUNDARY OF SITE

N

0 100 300

APPROXIMATE SCALE IN FEET

Source: Live Search maps website, MicroSoft Virtual Earth, 2007 or 2008

Disclaimer: This figure is based on available data. Actual conditions may differ. All locations and dimensions are approximate.

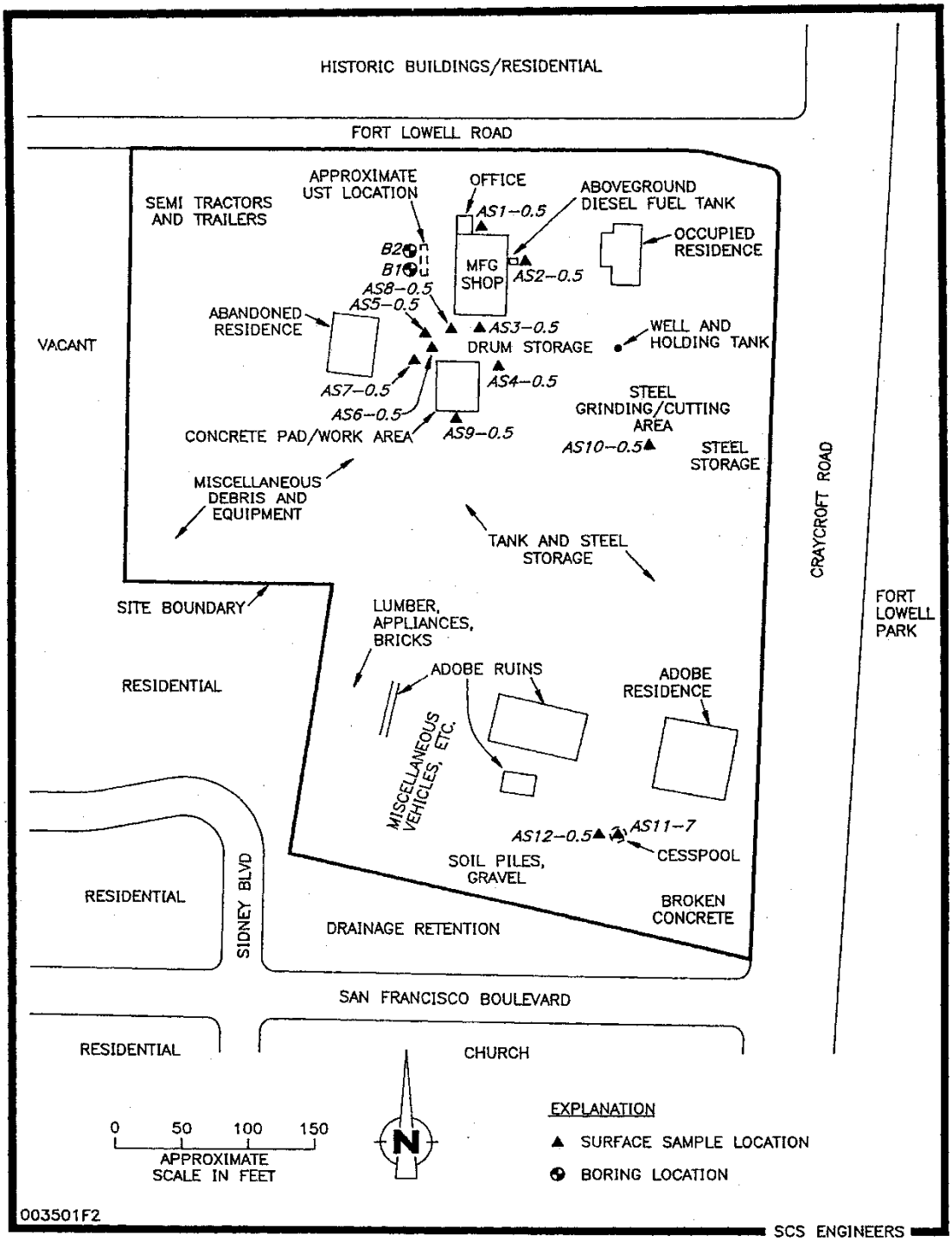


FIGURE 2. SITE AND VICINITY MAP

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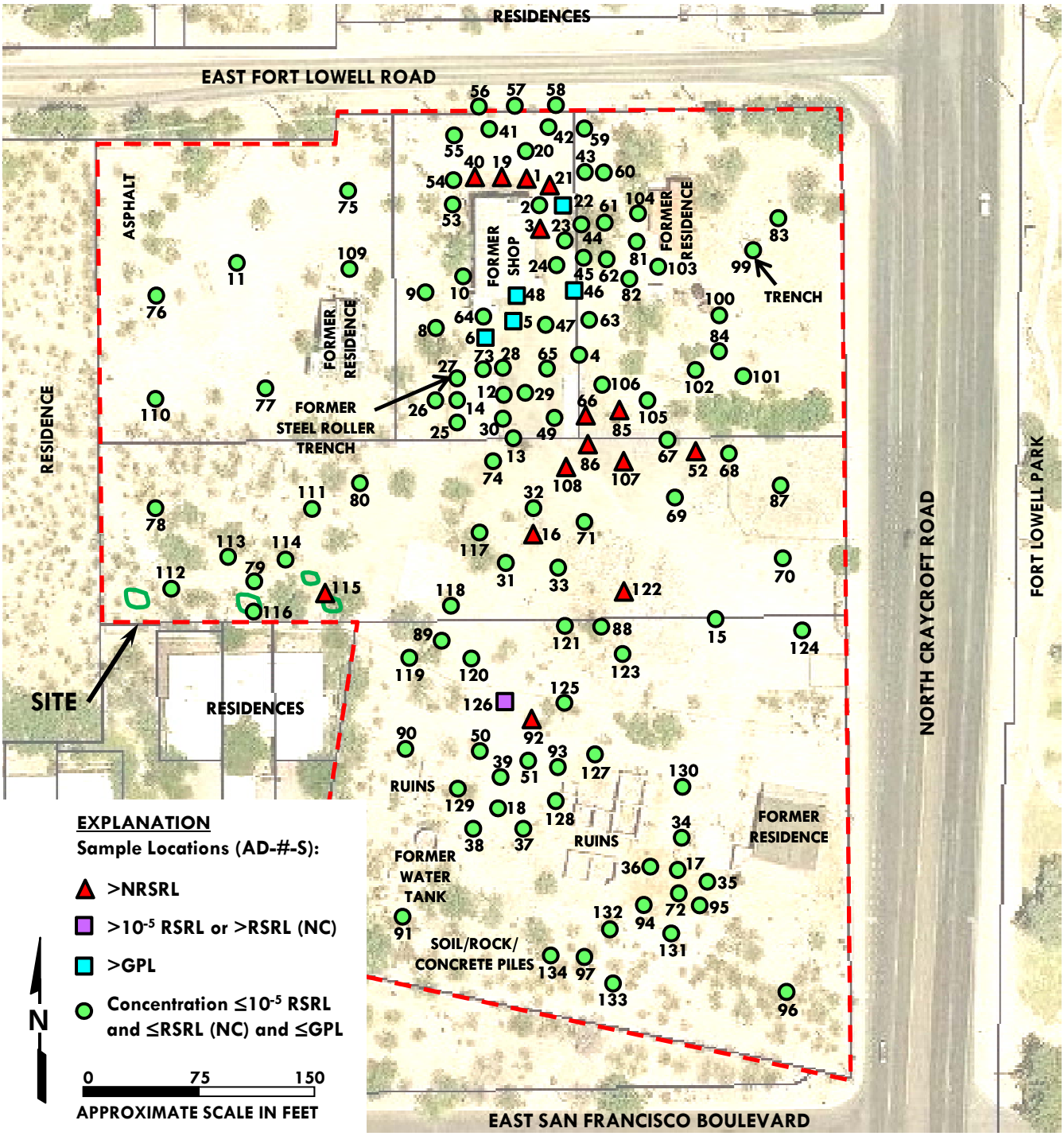
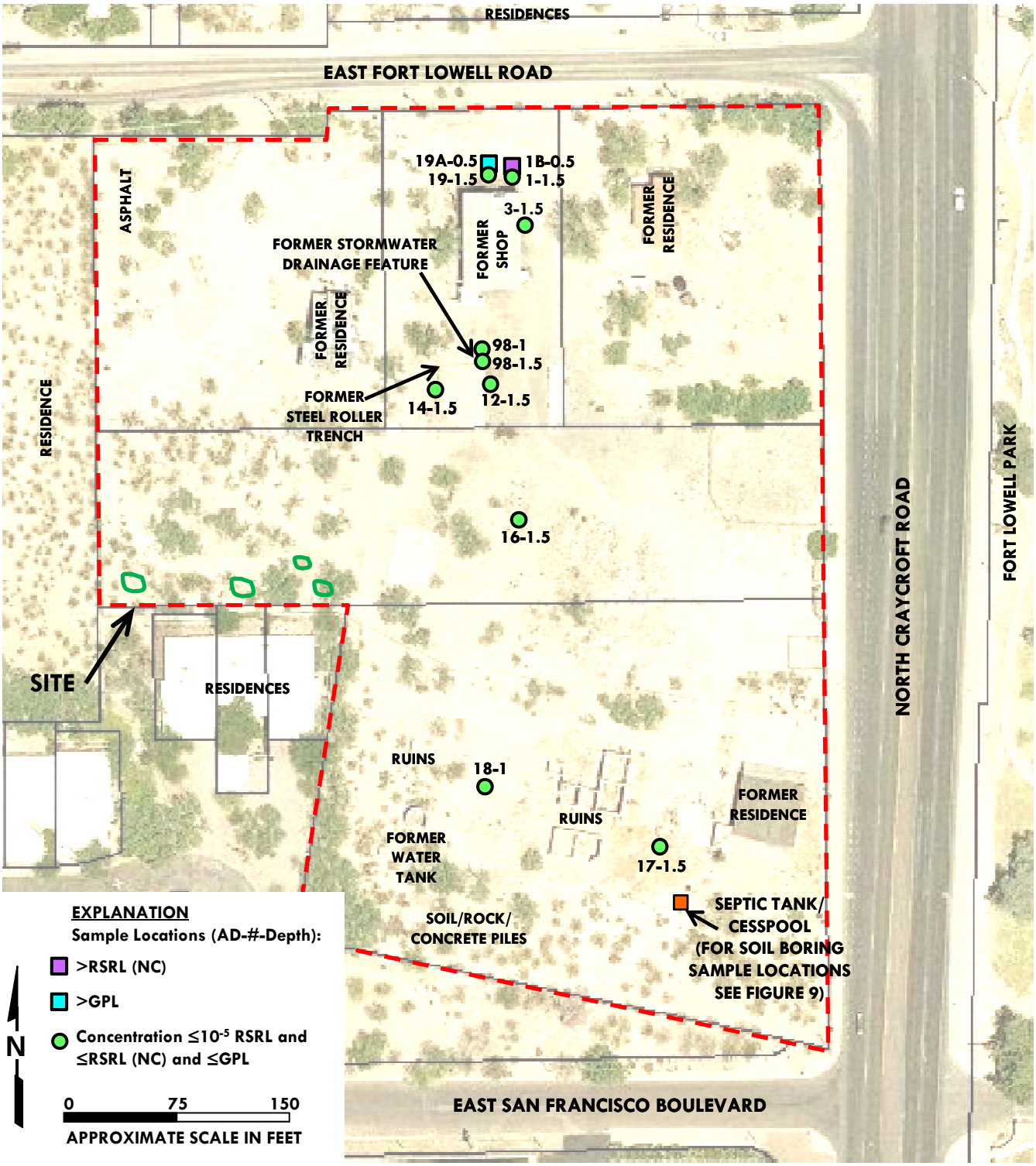
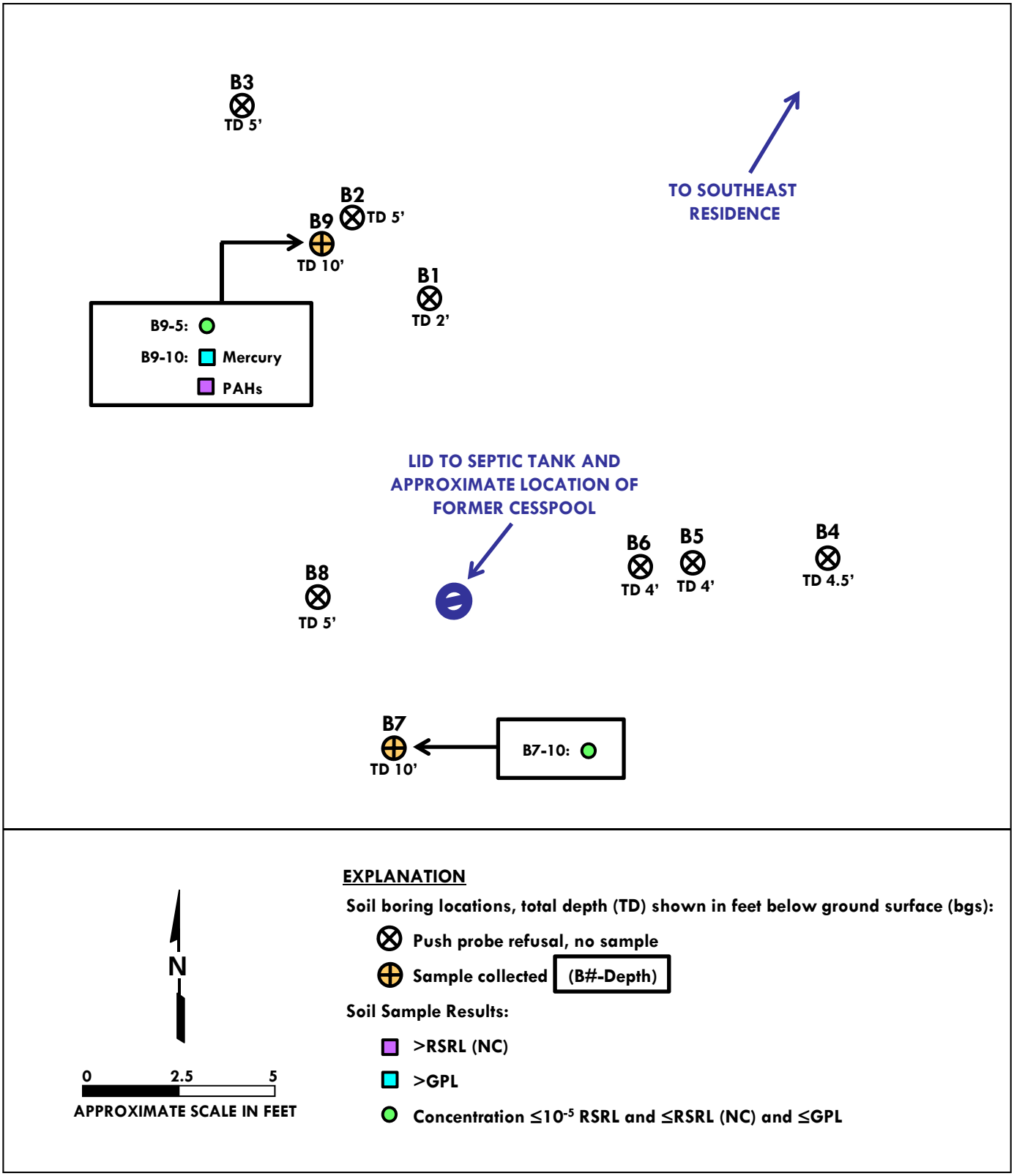
Source: SCS Engineers (SCS). February 11, 1991. *Environmental Site Assessment for Adkins Steel Property, 5460 East Fort Lowell Road, Tucson, Arizona.*

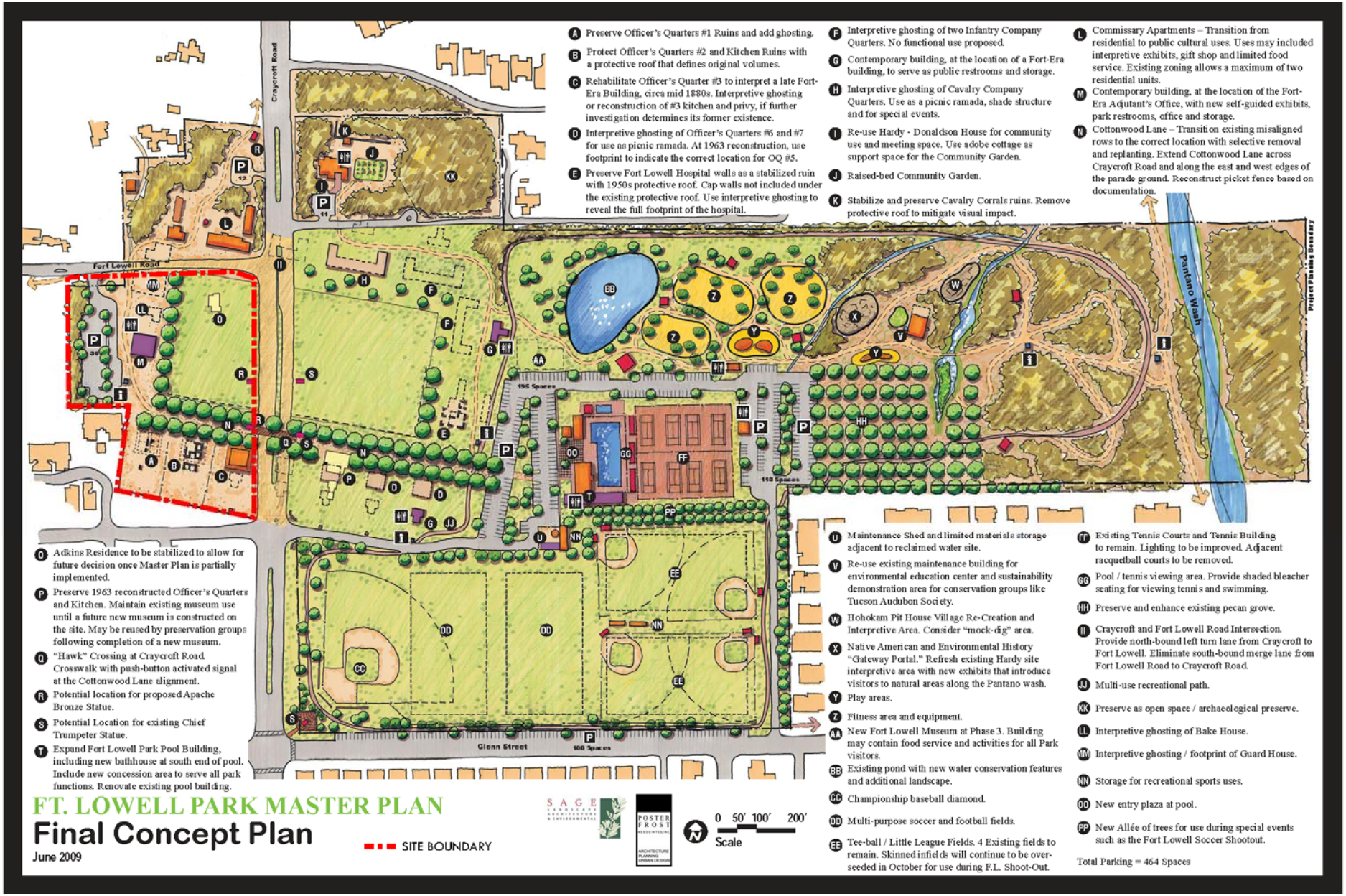


Source: PCDOT MapGuide Website, 2008 Aerial
Disclaimer: This figure is based on available data. Actual conditions may differ. All locations and dimensions are approximate.



Source: PCDOT MapGuide Website, 2008 Aerial
Disclaimer: This figure is based on available data. Actual conditions may differ. All locations and dimensions are approximate.


B3
TD 5'
B2
TD 5'
B9
TD 10'
B1
TD 2'
TO SOUTHEAST RESIDENCE
B9-5:
B9-10:
Mercury
PAHs
LID TO SEPTIC TANK AND APPROXIMATE LOCATION OF FORMER CESSPOOL
B8
TD 5'
B6
TD 4'
B5
TD 4'
B4
TD 4.5'
B7
TD 10'
B7-10:
N
0
2.5
5
APPROXIMATE SCALE IN FEET
EXPLANATION
Soil boring locations, total depth (TD) shown in feet below ground surface (bgs):
Push probe refusal, no sample
Sample collected
(B#-Depth)
Soil Sample Results:
>RSRL (NC)
>GPL
Concentration ≤10-5 RSRL and ≤RSRL (NC) and ≤GPL

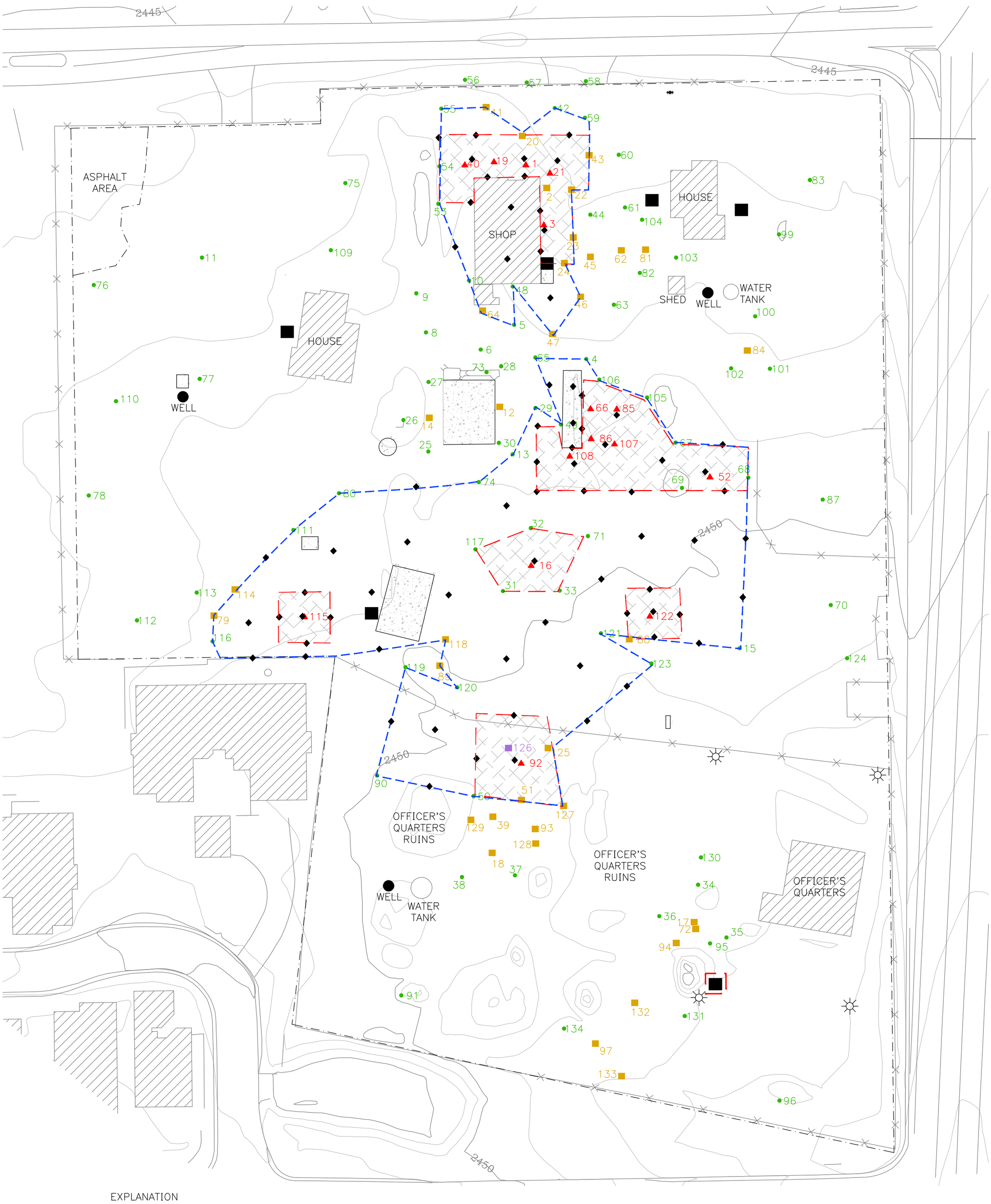


Source: Poster Frost Associates, Inc. and Sage Landscape Architecture & Environment, June 2009

10204058.26

ABCA and Remediation Work Plan
Old Fort Lowell Restoration Project
5460 East Fort Lowell Road
Tucson, Arizona

Figure 10
Fort Lowell Park Master Plan



EXPLANATION

- Estimated Minimum Area of Excavation
- Estimated Maximum Area of Excavation
- ▲ 86 Exceeds Non–Residential Soil Remediation Level (NRSRL)
- ■ 126 Exceeds Residential Soil Remediation Level (RSRL;10^{-5} Risk)
- ■ 41 Exceeds RSRL (10^{-6} Risk)
- • 13 Less Than RSRLs and NRSRLs
- ◆ Estimated Verification Sample Location
- ■ Estimated Septic Tank Location

BASE MAP PROVIDED BY POSTER FROST ASSOCIATES, INC.

N

0 40' 80'
SCALE IN FEET
1"=40'

10204058.26

ABCA and Remediation Work Plan
Old Fort Lowell Restoration Project
5460 East Fort Lowell Road
Tucson, Arizona

Figure 11
Planned Excavation Areas and Sample Locations

TABLE

TABLE 1. SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL RESULTS

SAMPLE ID	SAMPLE DATE	SAMPLE DEPTH	HC (418.1)	HYDROCARBONS (8015AZ)				PAH (8310)												METALS (6010B/7471A)									TCLP		VOCs (8260)	VOCs (8240)	SVOCs (8270)	PCBs (8082)
				C_6-C_{10} GRO	C_{10}-C_{22} DRO	C_{22}-C_{32} ORO	C_{10}-C_{32} SRL	Anthr	B[a]a	B[a]p	B[b]f	B[g,h,i]p	B[k]f	Chry	Flt	I[1,2,3-cd]p	N	Ph	Py	As	Ba	Cd	Cr[1]	Cr[2]	Pb	Se	Ag	Hg	As	Pb				
AS1-0.5	12/6/90	0.5	1,600	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	+++	na	na
AS2-0.5	12/6/90	0.5	2,460	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AS3-0.5	12/6/90	0.5	29,600	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	+++	na	na
AS4-0.5	12/6/90	0.5	2,630	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	+++	na	na
AS5-0.5	12/6/90	0.5	6,630	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AS6-0.5	12/6/90	0.5	13,000	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AS7-0.5	12/6/90	0.5	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	150	na	na	na	na	na	na	na	na	na
AS8-0.5	12/6/90	0.5	38,500	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AS9-0.5	12/6/90	0.5	168	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	+++	na	na
AS10-0.5	12/6/90	0.5	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	155	131	7	69	na	610	1.0	<1	0.410	na	na	na	na	na	na
AS11-7	12/6/90	7	78,900	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AS12-0.5	12/6/90	0.5	42,200	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-1-S*	11/13/07	S	na	<20	48	300	348	<0.80	1.5	1.4	1.4	1.0	<0.80	1.6	3.1	1.2	<1.0	<1.6	3.1	25	140	8.8	160	<0.50	870	<5.0	<5.0	0.11	na	na	ND	na	na	na
AD-1A-S	9/23/08	S	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	<1.0	<1.0	na	na	na	na
AD-1B-S+	9/23/08	~0.5 ft	na	na	na	na	na	<0.40	<0.40	0.95	0.45	2.0	<0.40	<0.60	1.6	1.5	<1.0	<4.0	2.0	8.4	120	3.3	18	na	530	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-1-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	150	<1.0	8.8	na	<5.0	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-2-S*	11/13/07	S	na	20	67	280	347	<0.40	<0.40	0.23	<0.40	<0.40	<0.40	<0.40	<0.40	0.38	<2.0	<0.80	<0.40	6.3	160	3.1	22	na	180	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-3-S*	11/13/07	S	na	<20	<30	<100	<130	<0.80	<0.80	0.64	<0.80	<0.80	<0.80	<0.80	1.3	0.84	<1.0	<1.6	<0.80	34	320	11	170	<0.50	470	<5.0	<5.0	0.75	na	na	ND	na	na	na
AD-3-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	270	<1.0	10	na	<5.0	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-4-S*	11/13/07	S	na	<20	33	<100	<130	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.20	<1.0	<0.80	<0.40	7.2	180	1.1	22	na	300	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-5-S*	11/13/07	S	na	<20	<30	<100	<130	<0.80	<0.80	<0.20	<0.80	<0.80	<0.80	<0.80	<0.80	<0.40	<2.0	<1.6	<0.80	8.5	280	2.8	67	<0.50	380	<5.0	<5.0	0.30	na	na	ND	na	na	na
AD-6A-S	11/14/07	S	na	<20	93	380	473	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	0.025	<0.10	<0.080	<0.040	6.0	120	<1.0	23	na	140	<5.0	<5.0	0.65	na	na	na	na	na	na
AD-8-S*	11/13/07	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	0.022	<0.10	<0.080	<0.040	5.2	150	<1.0	8.0	na	63	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-9-S*	11/13/07	S	na	<1,000	1,800	17,000	18,800	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.50	<0.40	<0.20	<5.0	110	<1.0	5.9	na	12	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-10-S*	11/13/07	S	na	27	100	590	690	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.40	<0.40	0.22	<1.0	<0.80	<0.40	<5.0	120	15	28	na	230	<5.0	<5.0	0.21	na	na	ND	na	na	na
AD-11-S*	11/13/07	S	na	23	37	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	5.0	130	<1.0	6.6	na	10	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-12-S*	11/13/07	S	na	<20	630	7,200	8,300	<0.40	<0.40	0.12	<0.40	<0.40	<0.40	<0.40	<0.40	<0.20	<1.0	<0.80	<0.40	5.8	180	<1.0	56	<0.50	160	<5.0	<5.0	0.31	na	na	ND	na	na	na
AD-12-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	180	<1.0	11	na	5.6	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-13-S	11/14/07	S	na	<1,000	7,400	41,000	48,400	<0.080	<0.080	<0.020	<0.080	<0.080	<0.080	<0.080	<0.080	<0.040	<0.20	<0.16	<0.080	<5.0	31	1.5	<5.0	na	20	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-13A-S	9/23/08	S	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	ND
AD-14-S	11/14/07	S	na	<20	39	300	339	<0.040	0.085	0.12	0.11	0.12	0.056	0.096	0.086	0.14	<0.10	0.11	0.10	<5.0	110	1.2	14	na	160	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-14-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	150	<1.0	9.6	na	<5.0	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-15-S	11/14/07	S	na	<400	1,100	19,000	20,100	<0.80	<0.80	<0.20	<0.80	<0.80	<0.80	<0.80	<0.80	0.54	<2.0	<1.6	<0.80	<5.0	110	<1.0	5.7	na	37	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-16-S	11/14/07	S	na	<20	30	140	170	<0.040	<0.040	0.037	<0.040	<0.040	<0.040	<0.040	<0.040	0.050	<0.10	<0.080	0.049	40	91	3.1	17	na	310	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-16-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	250	<1.0	8.6	na	<5.0	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-17-S*	11/14/07	S	na	<1,000	2,700	28,000	30,700	<0.80	<0.80	0.28	0.86	<0.80	<0.80	<0.80	<0.80	<0.40	<2.0	<1.6	<0.80	<5.0	140	<1.0	6.9	na	170	<5.0	<5.0	0.084	na	na	ND	na	na	na
AD-17-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	190	<1.0	7.3	na	6.1	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-18-S*	11/14/07	S	na	<100	<150	<500	<650	<0.40	<0.40	0.32	<0.40	<0.40	<0.40	<0.40	0.56	0.37	<1.0	<0.80	0.57	<5.0	190	1.6	9.6	na	130	<5.0	<5.0	0.092	na	na	ND	na	na	na
AD-18-1	7/7/08	1 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	5.7	330	<1.0	8.3	na	6.5	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-19-S	4/10/08	S	na	20	250	3,000	3,250	<0.80	1.6	4.8	3.4	6.8	1.2	2.2	12	6.1	2.3	7.6	12	15	410	6.2	35	<0.50	410	<5.0	<5.0	0.20	na	na	ND	na	na	na
AD-19A-S+	9/23/08	~0.5 ft	na	na	na	na	na	<0.040	<0.040	0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	7.7	160	3.0	11	na	340	<5.0	32	0.19	na	na	na	na	na	na
AD-19-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	170	<1.0	7.7	na	5.8	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-20-S	4/10/08	S	na	<20	<30	<130	<130	<0.20	<0.20	0.17	<0.20	<0.20	<0.20	<0.20	0.39	0.18	<.050	<0.40	0.34	6.8	120	<1.0	13	na	100	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-21-S	4/10/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.14	<0.40	<0.40	<0.40	<0.40	<0.40	<0.20	<1.0	<0.80	<0.40	5.2	280	1.3	25	na	860	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-22-S	4/10/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.19	<0.40	<0.40	<0.40	<04.0	<0.40	<0.20	<1.0	<0.80	<0.40	9.5	140	2.6	43	<0.50	320	<5.0	<5.0	0.59	na	na	ND	na	na	na
AD-23-S	4/10/08	S	na	<20	<30	<100	<130	<0.40	0.44	0.40	<0.40	0.40	<0.40	<0.40	1.1	0.36	<1.0	<0.80	0.87	<5.0	130	1.6	13	na	70	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-24-S	4/10/08	S	na	<20	<30	<100	<130	<0.40	0.54	0.56	0.52	0.54	<0.40	0.42	1.3	0.56	<1.0	<0.80	0.97	7.0	170	1.9	22	na	190	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-25-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.041	0.040	0.053	<0.040	<0.060	0.070	0.050	<0.10	<0.40	<0.10	<5.0	110	<1.0	8.3	na	47	<5.0	<5.0	0.085	na	na	ND	na	na	na
AD-26-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	<5.0	120	<1.0	6.4	na	56	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-27-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	140	<1.0	7.1	na	26	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-28-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.011	<0.040	<0.040	<0.040	<0.060	<0.040	0.021	<0.10	<0.40	<0.10	<5.0	160	<1.0	10	na	42	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-29-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.012	<0.040	<0.040	<0.040	<0.060	<0.040	0.030	<0.10	<0.10	<0.10	5.3	200	<1.0	12	na	95	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-30-S	4/10/08	S	na	21	1,600	8,900	10,500	<0.80	<0.80	<0.20	<0.80	<0.80	<0.80	<0.80	<0.80	<0.40	<2.0	<1.6	<0.80	5.2	100	1.1	39	<0.50	230	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-31-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	<5.0	140	<1.0	7.4	na	10	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-32-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	<5.0	160	<1.0	8.1	na	10	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-33-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	<5.0	130	<1.0	6.4	na	17	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-34-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	7.8	190	<1.0	6.9	na	9.5	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-35-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	<5.0	120	<1.0	5.3	na	56	<5.0	<5.0	0.21	na	na	ND	na	na	na
AD-36-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.022	<0.040	<0.040	<0.040	<0.040	<0.040	0.030	<0.10	<0.080	0.051	7.0	200	<1.0	6.5	na	60	<5.0	<5.0	0.086	na	na	ND	na	na	na
AD-37-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	0.056	0.067	0.058	0.059	<0.040	0.048	<0.040	0.063	<0.10	<0.080	0.073	<5.0	170	<1.0	7.1	na	59	<5.0	<5.0	0.11	na	na	ND	na	na	na
AD-38-S	4/10/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.50	<0.40	<0.20	<5.0	160	<1.0	7.5	na	65	<5.0	<5.0	0.13	na	na	ND	na	na	na
AD-39-S	4/10/08	S	na	<20	<30	<100	<130	<0.20	<0.20	0.080	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.50	<0.40	<0.20	5.1	220	<1.0	7.6	na	49	<5.0	<5.0	<0.083	na	na	ND	na	na	na

TABLE 1. SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL RESULTS

SAMPLE ID	SAMPLE DATE	SAMPLE DEPTH	HC (418.1)	HYDROCARBONS (8015AZ)				PAH (8310)												METALS (6010B/7471A)									TCLP		VOCs (8260)	VOCs (8240)	SVOCs (8270)	PCBs (8082)
				C_6-C_{10} GRO	C_{10}-C_{22} DRO	C_{22}-C_{32} ORO	C_{10}-C_{32} SRL	Anthr	B[a]a	B[a]p	B[b]f	B[g,h,i]p	B[k]f	Chry	Flt	I[1,2,3-cd]p	N	Ph	Py	As	Ba	Cd	Cr^1	Cr^2	Pb	Se	Ag	Hg	As	Pb				
AD-40-S	7/7/08	S	na	<20	<30	<100	<130	<0.80	<0.80	0.58	<0.80	<0.80	<0.80	<1.2	1.6	0.66	<2.0	<8.0	<2.0	21	140	3.9	24	na	210	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-41-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	84	1.1	16	na	150	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-42-S	7/7/08	S	na	<20	37	500	537	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	0.029	<0.10	<0.40	<0.10	5.3	120	<1.0	8.8	na	250	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-43-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.23	<0.40	<0.40	<0.40	<0.60	<0.40	0.21	<1.0	<4.0	<1.0	<5.0	50	<1.0	7.5	na	47	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-44-S	7/7/08	S	na	<20	<30	140	140	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	150	1.3	16	na	260	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-45-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.19	<0.40	<0.40	<0.40	<0.60	<0.40	0.24	<1.0	<4.0	<1.0	<5.0	1,300	1.9	16	na	160	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-46-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.27	<0.40	<0.40	<0.40	<0.60	0.58	0.34	<1.0	<4.0	<1.0	6.0	210	1.8	26	na	330	<5.0	<5.0	0.12	na	na	na	na	na	na
AD-47-S	7/7/08	S	na	<20	<30	150	150	<0.40	<0.40	0.21	<0..40	0.44	<0.40	<0.60	<0.40	0.45	<1.0	<4.0	<1.0	5.7	150	1.5	11	na	150	<5.0	<5.0	0.16	na	na	na	na	na	na
AD-48-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	<0.10	<0.40	0.49	<0.40	<0.60	<0.40	0.32	<1.0	<4.0	<1.0	8.3	140	2.5	140	<0.50	300	6.0	<5.0	0.12	na	na	ND	na	na	na
AD-49-S	7/7/08	S	na	<20	<30	<100	<130	<0.080	<0.080	0.022	<0.080	<0.080	<0.080	<0.12	<0.080	<0.040	<0.20	<0.80	<0.20	7.8	86	<1.0	22	na	28	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-50-S	7/7/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.045	0.040	0.046	<0.040	<0.060	0.064	0.045	<0.10	<0.40	<0.10	<5.0	120	<1.0	6.5	na	23	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-51-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.17	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	170	<1.0	7.7	na	81	<5.0	<5.0	0.10	na	na	na	na	na	na
AD-52-S	7/7/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	98	120	2.3	32	<0.50	310	<5.0	<5.0	0.11	na	na	ND	na	na	na
AD-52A-S	9/23/08	S	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	<1.0	<1.0	na	na	na	na
AD-53-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	5.1	110	<1.0	6.2	na	10	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-54-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	86	<1.0	6.5	na	33	<5.0	<5.0	<0.083	na	na	na	na	ND	na
AD-55-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.024	<0.040	<0.040	<0.040	<0.060	<0.040	0.027	<0.10	<0.40	<0.10	<5.0	60	<1.0	<5.0	na	44	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-56-S	8/14/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	110	<1.0	9.9	na	110	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-57-S	8/14/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	5.0	140	<1.0	9.0	na	58	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-58-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	130	<1.0	8.3	na	<5.0	<5.0	<5.0	<0.083	na	na	na	na	ND	na
AD-59-S	8/14/08	S	na	<20	<30	140	140	<0.040	<0.040	0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	140	<1.0	7.7	na	38	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-60-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	120	<1.0	6.2	na	55	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-61-S	8/14/08	S	na	<20	<30	<100	<130	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	130	<1.0	12	na	120	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-62-S	8/14/08	S	na	<20	<30	<100	<130	<0.20	<0.20	0.19	0.22	<0.20	<0.20	<0.30	0.43	0.15	<0.50	<2.0	<0.50	<5.0	120	<1.0	7.3	na	130	<5.0	<5.0	0.19	na	na	na	na	na	na
AD-63-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	5.5	130	<1.0	7.1	na	15	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-64-S	8/14/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.19	<0.40	<0.40	<0.40	<0.60	<0.40	0.20	<1.0	<4.0	<1.0	6.0	160	<1.0	35	<0.50	150	<5.0	<5.0	0.18	na	na	na	na	na	na
AD-65-S	8/14/08	S	na	<20	<30	<100	<130	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	6.6	130	<1.0	17	na	58	<5.0	<5.0	<0.083	na	na	na	na	ND	na
AD-66-S	8/14/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.11	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	34	140	<1.0	47	<0.50	160	<5.0	<5.0	0.42	na	na	na	na	na	na
AD-67-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	150	<1.0	6.1	na	8.5	<5.0	<5.0	<0.083	na	na	na	na	ND	na
AD-68-S	8/14/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	5.8	140	<1.0	10	na	40	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-69-S	8/14/08	S	na	<20	100	1,000	1,100	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	96	<1.0	14	na	89	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-70-S	8/14/08	S	na	<200	1,400	26,000	27,400	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	5.2	150	<1.0	6.5	na	58	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-71-S	8/14/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	5.9	110	<1.0	11	na	48	<5.0	<5.0	<0.083	na	na	na	na	ND	na
AD-72-S	8/14/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.18	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	7.8	210	<1.0	7.4	na	130	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-73-S**	8/14/08	S	na	<20	85	620	705	<0.080	<0.080	<0.020	<0.080	<0.080	<0.080	<0.12	<0.080	0.046	<0.20	<0.80	<0.20	<5.0	160	<1.0	33	<0.50	63	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-74-S	8/14/08	S	na	<20	<30	130	<130	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	0.25	<1.0	<4.0	<1.0	9.8	120	7.0	47	<0.50	77	<5.0	<5.0	0.10	na	na	na	na	ND	na
AD-75-S	9/23/08	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	92	<1.0	6.6	na	71	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-76-S	9/23/08	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	5.8	110	<1.0	6.5	na	30	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-77-S	9/23/08	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	110	<1.0	5.9	na	25	<5.0	<5.0	0.56	na	na	ND	na	ND	na
AD-78-S	9/23/08	S	na	na	na	na	na	<0.040	<0.040	0.029	<0.040	0.047	<0.040	<0.060	<0.040	0.050	<0.10	<0.40	<0.10	<5.0	130	1.5	6.5	na	42	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-79-S	9/23/08	S	na	na	na	na	na	<0.20	0.24	0.22	<0.20	<0.20	<0.20	<0.30	0.23	0.18	<0.50	<2.0	<0.50	<5.0	190	1.5	23	na	170	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-80-S	9/23/08	S	na	na	na	na	na	<0.040	<0.040	0.020	<0.040	<0.040	<0.040	<0.060	0.062	0.031	<0.10	<0.40	<0.10	<5.0	110	<1.0	5.3	na	14	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-81-S	9/23/08	S	na	na	na	na	na	<0.20	<0.20	0.090	<0.20	<0.20	<0.20	<0.30	<0.20	0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-82-S	9/23/08	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-83-S	9/23/08	S	na	na	na	na	na	<0.040	<0.040	0.011	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	91	<1.0	6.6	na	51	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-84-S	9/23/08	S	na	na	na	na	na	<0.040	0.078	0.087	0.091	0.085	0.050	0.074	0.12	0.11	<0.10	<0.40	0.18	<5.0	120	<1.0	7.7	na	28	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-85-S	9/23/08	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	11	170	1.0	13	na	66	<5.0	<5.0	0.092	na	na	na	na	na	na
AD-86-S	9/23/08	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	22	200	1.3	21	na	290	<5.0	<5.0	0.24	na	na	na	na	na	na
AD-87-S	9/23/08	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	110	<1.0	9.4	na	85	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-88-S	9/23/08	S	na	na	na	na	na	<0.40	<0.40	0.38	<0.40	0.44	<0.40	<0.60	0.45	0.55	<1.0	<4.0	<1.0	<5.0	110	<1.0	7.6	na	50	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-89-S	9/24/08	S	na	na	na	na	na	<0.20	<0.20	0.070	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	86	<1.0	7.6	na	46	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-90-S	9/24/08	S	na	na	na	na	na	<0.040	<0.040	0.033	<0.040	<0.040	<0.040	<0.060	0.044	0.038	<0.10	<0.40	<0.10	<5.0	170	<1.0	6.4	na	24	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-91-S	9/24/08	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	50	<1.0	5.9	na	12	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-92-S	9/24/08	S	na	na	na	na	na	<0.80	2.0	2.4	2.0	2.1	1.3	2.6	4.6	2.7	<2.0	<8.0	6.5	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-93-S	9/24/08	S	na	na	na	na	na	<0.40	<0.40	0.37	<0.40	<0.40	<0.40	<0.60	<0.40	0.38	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-94-S	9/24/08	S	na	na	na	na	na	<0.20	<0.20	0.10	<0.20	<0.20	<0.20	<0.30	<0.20	0.13	<0.50	<2.0	<0.50	<5.0	130	<1.0	7.1	na	120	<5.0	<5.0	0.12	na	na	na	na	na	na
AD-95-S	9/24/08	S	na	na	na	na	na	<0.040	<0.040	0.034	<0.040	<0.040	<0.040	<0.060	0.051	0.044	<0.10	<0.40	<0.10	<5.0	180	<1.0	7.5	na	38	<5.0	<5.0	0.17	na	na	na	na	na	na
AD-96-S	9/24/08	S	na	na	na	na	na	<0.040	<0.040	0.030	<0.040	<0.040	<0.040	<0.060	<0.040	0.040	<0.10	<0.40	<0.10	<5.0	170	<1.0	7.8	na	59	<5.0	<5.0	1.6	na	na	ND	na	ND	na
AD-97-S	9/24/08	S	na	na	na	na	na	<0.20	<0.20	0.10	<0.20	<0.20	<0.20	<0.30	<0.20	0.12	<0.50	<2.0	<0.50	5.1	210	<1.0	6.0	na	17	<5.0	<5.0	0.087	na	na	ND	na	ND	na
AD-98-1++	9/24/08	1 ft	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	150	<1.0	17	na	53	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-98-1.5++	9/24/08	1.5 ft	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	0.022	<0.10	<0.40	<0.10	5.9	150	1.5	15	na	56	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-99-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	68	<1.0	5.4	na	43	<5.0	<5.0	<0.083	na	na	na	na	na	na

TABLE 1. SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL RESULTS

SAMPLE ID	SAMPLE DATE	SAMPLE DEPTH	HC (418.1)	HYDROCARBONS (8015AZ)				PAH (8310)												METALS (6010B/7471A)									TCLP		VOCs (8260)	VOCs (8240)	SVOCs (8270)	PCBs (8082)
				C_6-C_{10} GRO	C_{10}-C_{22} DRO	C_{22}-C_{32} ORO	C_{10}-C_{32} SRL	Anthr	B[a]a	B[a]p	B[b]f	B[g,h,i]p	B[k]f	Chry	Flt	I[1,2,3-cd]p	N	Ph	Py	As	Ba	Cd	Cr^1	Cr^2	Pb	Se	Ag	Hg	As	Pb				
AD-100-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-101-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-102-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-103-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-104-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-105-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	**110**	<1.0	**5.8**	na	**16**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-106-S	4/3/09	S	na	na	na	na	na	<0.80	<0.80	<0.20	<0.80	<0.80	<0.80	<1.2	<0.80	<0.40	<2.0	<8.0	<2.0	<5.0	**110**	<1.0	**12**	na	**72**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-107-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	**20**	**140**	<1.0	**22**	na	**180**	<5.0	<5.0	**0.14**	na	na	na	na	na	na
AD-108-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	**28**	**53**	<1.0	**13**	na	**100**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-109-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	**130**	<1.0	**6.2**	na	**28**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-110-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	**88**	<1.0	**5.0**	na	**17**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-111-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	**120**	<1.0	**5.1**	na	**37**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-112-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	**5.1**	**110**	<1.0	**9.7**	na	**22**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-113-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	**0.014**	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-114-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	**0.12**	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-115-S	4/3/09	S	na	na	na	na	na	**0.42**	**1.9**	**2.0**	**0.95**	**1.9**	**0.76**	**1.5**	**3.7**	**1.6**	<1.0	<4.0	**3.9**	**14**	**250**	**7.4**	**25**	na	**400**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-116-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-117-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	**110**	<1.0	**8.4**	na	**57**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-118-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	**0.080**	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-119-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-120-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	**120**	<1.0	**6.0**	na	**29**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-121-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-122-S	4/3/09	S	na	na	na	na	na	**1.0**	**9.6**	**10**	**4.9**	**8.5**	**3.9**	**8.4**	**20**	**7.8**	<2.0	**19**	**18**	<5.0	**76**	<1.0	**8.5**	na	**66**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-123-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-124-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	**6.5**	**170**	<1.0	**5.2**	na	**9.1**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-125-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	**0.21**	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	**5.5**	**180**	<1.0	**25**	na	**160**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-126-S	4/3/09	S	na	na	na	na	na	<0.80	**0.88**	**1.0**	<0.80	<0.80	<0.80	**1.2**	**2.8**	**0.90**	<2.0	<8.0	**2.5**	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-127-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	**0.16**	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-128-S	4/3/09	S	na	na	na	na	na	<0.80	<0.80	**0.32**	<0.80	<0.80	<0.80	<1.2	<0.80	<0.40	<2.0	<8.0	<2.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-129-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	**0.085**	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-130-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	**160**	<1.0	**6.0**	na	**50**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-131-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-132-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	**0.15**	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-133-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	**0.075**	<0.20	<0.20	<0.20	<0.30	**0.22**	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-134-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	**0.060**	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
B7-10	8/19/08	10 ft	na	<20	<30	<130	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	**40**	<1.0	<5.0	na	<5.0	<5.0	<5.0	**0.13**	na	na	ND	na	+++	na
B9-5	8/19/08	5 ft	na	<20	<30	<130	<130	<0.040	<0.040	**0.014**	<0.040	<0.040	<0.040	<0.060	<0.040	**0.023**	<0.10	<0.40	<0.10	<5.0	**150**	<1.0	**6.2**	na	**13**	<5.0	<5.0	**0.16**	na	na	ND	na	+++	na
B9-10	8/19/08	10 ft	na	<200	<300	**1,100**	<1,300	<1.6	<1.6	**0.80**	<1.6	**7.0**	<1.6	<2.4	<1.6	**3.8**	<4.0	<16	<4.0	**10**	**340**	**1.1**	**15**	na	**280**	<5.0	<5.0	**17**	na	na	ND	na	ND	na
RSRL (10^{-6} Risk)			none	none	none	none	none	none	**0.69**	**0.069**	**0.69**	none	**6.9**	**68**	none	**0.69**	none	none	none	**10**	none	none	none	**30**	none	none	none	none						
RSRL (10^{-5} Risk)			none	none	none	none	none	none	**6.9**	**0.69**	**6.9**	none	**69**	**680**	none	**6.9**	none	none	none	**10**	none	none	none	none	none	none	none	none						
RSRL (Non-carcinogen)			none	none	none	none	none	**22,000**	none	none	none	none	none	none	**2,300**	none	**56**	none	**2,300**	**10**	**15,000**	**39**	none	none	**400**	**390**	**390**	**23**						
NRSRL			none	none	none	none	none	**240,000**	**21**	**2.1**	**21**	none	**210**	**2,000**	**22,000**	**21**	**190**	none	**29,000**	**10**	**170,000**	**510**	none	**65**	**800**	**5,100**	**5,100**	**310**						
Minimum GPL			none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	**290**	**12,000**	**29.0**	**590**	none	**290**	**290**	none	**12**						
Alternative GPL			none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	**73**	none	none	none	none	**4,540**	none	none	**TBD**						
EPA TCLP Threshold Level																													**5.0**	**5.0**				

Notes:

Only compounds with detected concentrations are shown
All sample results are in mg/kg, except TCLP samples, which are in mg/L
na = Not analyzed
ND = Not Detected
GPL = Arizona Groundwater Protection Level (1996)
RSRL = Arizona Residential Soil Remediation Level
NRSRL = Arizona Non-Residential Soil Remediation Level
EPA TCLP = Environmental Protection Agency Toxicity Characteristic Leaching Procedure
none = There is no Arizona SRL for this compound
HC = Hydrocarbon
C_{10}-C_{22} DRO = Diesel fuel petroleum hydrocarbons
C_{22}-C_{32} DRO = Oil petroleum hydrocarbons
C_{10}-C_{32} SRL = Former Arizona Soil Remediation Level for petroleum hydrocarbons

PAH = Polynuclear Aromatic Hydrocarbons
Anthr = Anthracene
B[a]a = Benz[a]anthracene
B[a]p = Benzo[a]pyrene
B[b]f = Benzo[b]fluoranthene
B[g,h,i]p = Benzo[g,h,i]perylene
B[k]f = Benzo[k]fluoranthene
Chry = Chrysene
Fl t= Fluoranthene
I[1,2,3-cd]p = Indeno[1,2,3-cd]pyrene
N = Naphthalene
Ph = Phenanthrene
Py = Pyrene

As = Arsenic
Ba = Barium
Cd = Cadmium
Cr^1 = Total Chromium
Cr^2 = Chromium VI
Pb = Lead
Hg = Mercury
VOCs = Volatile organic compounds (8260)
SVOCs = Semi-volatile organic compounds (8270)
PCBs = Polychlorinated biphenyls

TBD = To Be Determined

Highlighted sample results exceed the RSRL or NRSRL
Highlighted samples that are non-detect indicate that the laboratory reporting limit exceeded the SRL
* Because the laboratory exceeded the hold time for VOCs, these samples were re-collected on 11/20/07 and 11/29/07 for this analysis
\+ Sample collected from just below visibly impacted soil
** Sample collected from soil in the bottom of the concrete trench for former steel rolling equipment
++ Samples collected from drywell in base of concrete trench for former steel rolling equipment; depths are from base of trench

+++ **Other Sample Results:**
(none exceed SRLs or GPLs)
AS1-0.5: Acetone = 0.140 mg/kg
AS3-0.5: Acetone = 0.190 mg/kg
4-Methyl-2-pentanone = 0.140 mg/kg
Toluene = 0.011 mg/kg
m- & p-Xylenes = 0.011 mg/kg
AS4-0.5: Acetone = 0.120 mg/kg
Toluene = 0.010 mg/kg
AS9-0.5: Acetone = 0.075 mg/kg
B7-10: Phenol = 6.4 mg/kg
B9-5: Phenol = 6.4 mg/kg

APPENDICES

APPENDIX A

SAMPLING AND ANALYSIS PLAN

SCS ENGINEERS

Sampling and Analysis Plan (SAP)

Old Fort Lowell Restoration Project
5460 East Fort Lowell Road
Tucson, Arizona

Presented to:

City of Tucson

Environmental Services
PO Box 27210
Tucson, AZ 85726-7210
(520) 791-3175

Presented by:

SCS ENGINEERS
2410 West Ruthrauff Road, Suite 110
Tucson, Arizona 85705
(520) 696-1617

October 14, 2011
File No. 10.204058.26

Offices Nationwide
www.scsengineers.com

APPROVAL PAGE

Approved by: _____ _____
City of Tucson Project Manager: Lynne Birkinbine **Date**

Approved by: _____ 10/14/2011
SCS Project Manager: Patricia M. Hartshorne, RG **Date**

Approved by: _____ 10/14/2011
SCS QA Manager: David F. Laney, CHMM **Date**

Approved by: _____ _____
Diane Strassmaier, Project Officer, USEPA Region IX **Date**

Approved by: _____ _____
Gail Morison, QA Manager, USEPA Region IX **Date**

Approved by: _____ _____
Danielle Taber, Project Manager, ADEQ VRP **Date**

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DISTRIBUTION LIST

Lynne Birkinbine, Environmental Manager
City of Tucson Environmental Services
PO Box 27210
Tucson, Arizona 85726-7210

Patricia M. Hartshorne, RG, Project Manager
SCS Engineers
2410 West Ruthrauff Road, Suite 110
Tucson, Arizona 85705

Bradley F. Johnston, RG, Project Director
SCS Engineers
4222 East Thomas Road, Suite 310
Phoenix, Arizona 85018

Diane Strassmaier, USEPA Project Officer
Brownfields and Site Assessment Section
US EPA Region 9
75 Hawthorne Street
San Francisco, California 94105

Gail Morison, USEPA QA Manager
Quality Assurance Office
US EPA Region 9
75 Hawthorne Street
San Francisco, California 94105

Danielle Taber, Project Manager
Voluntary Remediation Program
Arizona Department of Environmental Quality
1110 West Washington Street
Phoenix, Arizona 85007

ACRONYMS AND ABBREVIATIONS

AAC	Arizona Administrative Code
ABCA	Analysis for Brownfields Cleanup Alternatives
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
APN	Assessor's Parcel Number
ARAR	Applicable or relevant and appropriate requirement
AST	Aboveground storage tank
bgs	below ground surface
C	Centigrade
CHMM	Certified Hazardous Materials Manager
COT	City of Tucson
DEUR	Declaration of Environmental Use Restriction
DQI	Data quality indicator
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
EB	Equipment blank
ESA	Environmental site assessment
FSP	Field sampling plan
GPS	Global positioning system
GPL	Groundwater Protection Level
HASP	Health and safety plan
HPLC	High Performance Liquid Chromatography
IDW	Investigation-derived waste
LCS	Laboratory control sample
LIMS	Laboratory Information Management System
LQCS	Laboratory Quality Control Sample
MQO	Measurement quality objective
MS/MSD	Matrix spike and matrix spike duplicate
mg/L	Milligrams per liter
NA	Not applicable
NCP	National Contingency Plan
NRSRL	Arizona Non-Residential Soil Remediation Level
OERR	Office of Emergency and Remedial Response
PAH	Polynuclear aromatic hydrocarbon
ppm	parts per million
PPE	Personal protective equipment
QA	Quality assurance
QA/QC	Quality assurance/quality control
QAPP	Quality assurance project plan
QC	Quality control
RCRA	Resource Conservation and Recovery Act
RG	Registered Geologist
RL	Reporting Limit
RPD	Relative percent difference

RSRL	Arizona Residential Soil Remediation Level
SAP	Sampling and analysis plan (an integrated FSP and QAPP)
SCS	SCS Engineers
SHPO	Arizona State Historic Preservation Office
SOP	Standard operating procedures
TB	Trip blank
TBD	To be determined
TCLP	Toxicity Characteristic Leaching Procedure
USEPA	U.S. Environmental Protection Agency
UST	Underground storage tank
VOA	Volatile organic analysis
VOC	Volatile organic compound
VRP	Arizona Voluntary Remediation Program

1.0 INTRODUCTION

SCS Engineers (SCS) was retained by the City of Tucson (COT) to perform remediation of soil contamination for the Old Fort Lowell Restoration Project, located at 5460 East Fort Lowell Road, Tucson, Arizona. The property consists of approximately 5.2 acres of land located at the southwest corner of East Fort Lowell Road and North Craycroft Road.

The purpose of this project is the removal of soil containing polynuclear aromatic hydrocarbons, (PAHs), arsenic, lead, and mercury above the applicable target Arizona residential soil remediation levels (RSRLs) or groundwater protection levels (GPLs). Verification sampling will be used to verify that the horizontal and vertical extent of contamination has been remediated to below the target concentrations.

This Sampling and Analysis Plan (SAP) was prepared in accordance with the Environmental Protection Agency (EPA) document *Sampling and Analysis Plan Guidance and Template, Version 3, Brownfields Projects, R9QA/006,* draft dated September 2009. The SAP combines the basic elements of a Quality Assurance Project Plan (QAPP) and a Field Sampling Plan (FSP).

The project work will be performed using funding from a Brownfields Cleanup Grant provided by the EPA, Region IX. The project will be performed under the Arizona Department of Environmental Quality (ADEQ) Voluntary Remediation Program (VRP). In addition, due to the prehistoric and historic features present on the site and the historic listing on the National Register, the Arizona State Historic Preservation Office (SHPO) will approve planned site activities and the archaeological monitoring plan.

1.1 SITE NAME OR SAMPLING AREA

The site is referred to as the Old Fort Lowell Restoration Project property (site). It is also referred to as the Adkins property.

1.2 SITE OR SAMPLING AREA LOCATION

The site is located at 5460 East Fort Lowell Road, Tucson, Arizona. The Pima County Assessor's Parcel Numbers (APNs) for the five parcels that make up the site are 110-09-032A, 110-09-032B, 110-09-0330, 110-09-0340, and 110-09-0350. The site is located within the northeast quarter of Section 35, Township 13 South, Range 14 East of the Gila and Salt River Base Line and Meridian, Tucson, Pima County, Arizona. A site location map is included as Figure 1 in Attachment 1.

1.3 RESPONSIBLE AGENCY

The sampling activities described herein will be performed and managed by SCS. SCS is an environmental engineering firm that currently maintains more than 50 offices nationwide, with more than 600 employees. SCS has been providing environmental services throughout Arizona since the late 1970s. The firm opened the regional Phoenix office in 1987 and a permanently

staffed Tucson office in 1996. SCS personnel performing fieldwork and quality assurance are based in SCS's Tucson and Phoenix offices.

1.4 PROJECT ORGANIZATION

Project organization will be as detailed in the table below.

Key Project Personnel Contact Information and Responsibilities

Title	Name	Phone Number Email Address	Responsibility
EPA Project Manager	Diane Strassmaier	415-972-3247 Strassmaier.Diane@epamail.epa.gov	EPA project management
EPA Quality Assurance Officer (QAO)	Gail Morison	415-972-3807 Morison.Gail@epamail.epa.gov	EPA quality assurance review
ADEQ VRP Project Manager	Danielle Taber	602-771-4414 Taber.Danielle@azdeq.gov	ADEQ VRP project management
City of Tucson Project Manager	Lynne Birkinbine	520-791-5414 Lynne.Birkinbine@tucsonaz.gov	COT project management
SCS Engineers Project Manager	Patricia Hartshorne, RG	520-696-1617 phartshorne@scsengineers.com	Project management, field work, health and safety
SCS Engineers Quality Assurance Manager	David F. Laney, CHMM	602-840-2596 dlaney@scsengineers.com	QA of project tasks
SCS Engineers Project Director	Bradley F. Johnston, RG	602-840-2596 bjohnston@scsengineers.com	Technical and administrative support
TestAmerica Laboratory Quality Assurance Manager	Mary Tyer	602-437-3340 Mary.Tyer@testamericainc.com	Laboratory quality assurance
Desert Archaeology Project Director	Homer Thiel	520-881-2244 homer@desert.com	Director of archaeological activities
Desert Archaeology Project Manager	Trish Castalia	520-881-2244 trish@desert.com	Manager of archaeological activities
Innovative Excavating Project Manager	Dan Arnit	520-881-8648 urro@cox.net	Excavation of soil, equipment operator

2.0 BACKGROUND

2.1 SITE OR SAMPLING AREA DESCRIPTION

The site is unoccupied and contains two former residential structures, adobe ruins, three dry groundwater wells, and a water tower. The site is secured with fencing, lighting, and a caretaker that lives across the street from the site. Former structures and features on the site that were demolished in September 2010 included a work shop, windmill frame, concrete water tank, stormwater drainage feature, and concrete pads. Much of the site contains native vegetation, with

some landscaping around the site structures. The topography on the site slopes gently toward the north and northwest, with a change in elevation of approximately 8 feet from the southeast corner to the north boundary of the site. Site features present in 2008 are shown on Figure 2 in Attachment 1. The area planned for remediation is between approximately 0.3 to 1.2 acres in size; the potential minimum and maximum excavation areas planned for remediation are shown on Figure 3 in Attachment 1.

The site is bounded on the east by Craycroft Road and on the north by Fort Lowell Road. Properties that adjoin the site to the west and north include residences. Adjoining the site to the south include residences, a stormwater detention basin, San Francisco Boulevard, and a church. The stormwater basin is associated with the west adjoining neighborhood. Across Fort Lowell Road from the site to the east is Fort Lowell Park.

2.2 OPERATIONAL HISTORY

The site is located within a prehistoric Hohokam period site known as the Hardy Site. Various features, such as pit structures, cemetery-offertory area, a work area, etc., have been documented during investigations of nearby properties. Dating of the archaeological features indicated that the prehistoric occupation occurred between 650-750 AD and 1000-1300 AD, and probably in the intervening years. Numerous potsherds and stone flakes have been observed on the ground surface and in adobe bricks making up building walls at the site (Thiel 2009, Thiel et al 2008).

Beginning in 1873, the site was part of a United States Army supply base called Fort Lowell. The portion of Fort Lowell that was located on the site included Cottonwood Lane, the parade grounds, a guardhouse, bake house, adjutant's office, and three officers' quarters and associated kitchens and privies. The US Army closed the base in 1891.

Following its closure, the site portion of the former fort was used primarily for residential purposes. A tuberculosis sanatorium/rest home operated in the former fort officers' quarters on the site beginning sometime after 1908 to at least 1950. Two additional adobe houses were built on the site in 1927 and about 1935. The Adkins family operated a trucking and steel manufacturing business on the site from 1934 to 2006. The company initially manufactured steel buildings and tanks; the focus was on steel tanks from the 1950s to 2006.

Observations of the site while it was occupied by Adkins Steel indicated that there were significant amounts of debris, equipment, and material stockpiles stored on the site, including vehicles, vehicle parts, appliances, metal tanks, miscellaneous steel, scrap metal, buckets, containers, and other materials. A diesel fuel aboveground storage tank (AST), a 3,000-gallon gasoline underground storage tank (UST), a 450-gallon diesel fuel UST, numerous 55-gallon drums, and other containers were located on the site. Soil staining, metal debris, and granular materials that were likely associated with metal grinding, sanding, and cutting activities were observed in many locations, particularly in the vicinity of the shop building, 55-gallon drum storage areas, adjacent to the concrete pad and work areas, beneath the AST, and at other locations. The septic tank in the southeast portion of the site was reportedly placed in the former location of a "cesspool" observed during a 1990 site visit. At that time, the cesspool consisted of an approximately 10-foot diameter by 4-foot deep hole containing oily liquids, and was adjoined by stained soil and used oil filters. Currently there is no surface evidence of this former cesspool.

Pima County acquired a large portion of the former fort in 1957, establishing the Fort Lowell Historical and Recreation Area. On April 10, 1978, the Fort Lowell Multiple Resource Area was listed on the National Register. In 2006, the COT acquired the site through a complex land exchange and sale with a private developer as part of the Old Fort Lowell Restoration Project. The purchase was made by the COT because of the presence of significant historic and prehistoric features located on the site. The site will ultimately be added to Fort Lowell Park.

2.3 PREVIOUS INVESTIGATIONS/REGULATORY INVOLVEMENT

SCS performed previous assessments on this property for the COT. Based on results of Phase I Environmental Site Assessments (ESAs; SCS 1991, 2008), SCS recommended investigation of the nature and extent of potential impacts to surface soils at the site in areas of stained soil; areas where vehicle batteries, drums, ASTs, or other containers of petroleum hydrocarbons or hazardous materials were stored; and other areas of potential impacts observed at the site, including locations that exceeded the Arizona RSRLs for arsenic, lead and PAHs. It was also recommended that the nature and extent of potential impacts to subsurface soils should be investigated at the septic systems, including the former cesspool, and the stormwater drainage feature in the concrete-lined trench; the two unregistered inactive water wells should be registered with ADWR and all three inactive wells abandoned following ADWR guidelines; and the septic tank systems should be removed or properly abandoned.

Two soil borings were drilled adjacent to the gasoline UST west of the shop building in 1990; no evidence of impacts to soil from petroleum hydrocarbons was observed in the cuttings from the two borings and no petroleum hydrocarbons were detected in the two soil samples collected from each boring (SCS 1991).The two USTs on the site were removed and closure investigations were performed in 2007 (SCS 2007). Based on visual observations, soil sample laboratory results, and historical information, there did not appear to have been a release from either of the two UST systems. ADEQ closed out this UST case file in August 2007.

Twelve soil samples were collected in 1990 by SCS during a limited soil sampling investigation in areas of staining and at other locations, including a diesel fuel AST, battery and drum storage areas, black granular material area, and the cesspool. All the samples were from a maximum depth of 0.5 feet bgs, except for one sample collected from below the bottom of the cesspool at 7 feet below ground surface (SCS 1991). Phase II ESAs performed from 2007 through 2009 included several phases of soil sampling as part of site characterization activities to identify impacts to soil above RSRLs and NRSRLs and the extent of identified impacts (SCS 2009).

A total of 21 surface sample locations contained constituents that exceeded the 10^{-5} risk level RSRLs, non-carcinogen RSRLs, NRSRLs, or minimum GPLs, including the PAHs benz[a]anthracene, benzo[a]pyrene, and indeno[1,2,3-cd]pyrene and the metals arsenic and lead. The only constituent that exceeded the minimum GPLs for these samples was lead. Two samples collected north of the shop building from a depth of approximately 0.5 foot bgs contained constituents that exceeded the RSRLs or minimum GPLs, including benzo[a]pyrene and lead. One sample from the push-probe borings at the former cesspool location contained benzo[a]pyrene above the 10^{-5} risk level RSRL and mercury at a concentration that exceeded the minimum GPL. None of the constituents detected in the two samples from the stormwater

drainage feature exceed the RSRLs, NRSRLs, or minimum GPLs; the steel cylinder for this feature was removed during demolition activities along with the concrete trench for the steel sheet roller.

Two locations that had the highest detected concentrations of arsenic (98 mg/kg) and lead (870 mg/kg) were selected to be sampled and analyzed using the toxicity characteristic leaching procedure (TCLP). Neither of these samples contained detectable concentrations of arsenic or lead using the TCLP, and therefore did not exceed the EPA toxicity characteristic levels.

The areas of highest contamination (above NRSRLs or minimum GPLs) were concentrated around the former shop building and in former work and storage areas through the central portion of the site. Areas of lower concentrations (above RSRLs) extend through the central portion of the site from north to south. The areas of surface soil containing PAHs, arsenic, and/or lead concentrations that exceed the applicable RSRLs at the site encompass between approximately 0.3 to 1.2 acres to a depth of less than 1 foot, and probably less than 0.5 foot in most areas.

A summary of the soil sample laboratory analytical results is included in Table 1 in Attachment 2. Additional discussion of the findings of these investigations is included in Section 4.0 of the Analysis for Brownfields Cleanup Alternatives (ABCA) and Remediation Work Plan (Work Plan) and surface soil sample locations are shown on Figure 7, subsurface soil sample locations are shown on Figure 8, and soil boring locations and samples are shown on Figure 9 of the Work Plan. The EPA, ADEQ VRP, and SHPO will be reviewing the Work Plan and reports for this project.

2.4 SCOPING MEETING

Numerous meetings regarding planned site activities have been performed since 2007. Regular monthly planning meetings are held by the COT and Pima County to discuss planned site activities and any issues that require resolution. Quarterly Advisory Committee meetings are held to provide input from the advisory committee and interested general public, and emails are sent to key representatives to keep them informed on upcoming activities. Site meetings are held as needed to discuss upcoming activities.

2.5 GEOLOGICAL/METEOROLOGICAL INFORMATION

The site is within the Basin and Range Physiographic Province, which is characterized by broad alluvial-filled basins bounded by steep, fault-block mountains. The Tucson Basin is a structural depression within the Basin and Range Physiographic Province. The Tucson Basin fill deposits are characterized by three stratigraphic units (from top to bottom): the Fort Lowell Formation, the Tinaja beds, and the Pantano Formation. The Fort Lowell Formation is generally 300 to 400 feet thick, and consists of unconsolidated to moderately consolidated sediments grading from silty gravel at the basin margins to a sandy silt and clayey silt in the center of the basin. Overlying the Fort Lowell Formation are younger, well-preserved surficial alluvium terrace deposits. The surficial alluvium terrace sediments are generally thin (averaging 30 to 70 feet in thickness) and silty, and become younger and lower in relief closer to the Santa Cruz River. (Anderson 1987; McKittrick 1988; Murphy & Hedley 1984)

Information obtained from the Arizona Department of Water Resources (ADWR) website indicated that groundwater levels in the site area ranged from approximately 122 to 248 feet below ground surface (bgs) based on measurements performed in wells from 2000 through 2011. At the time of the registration of the northeast site well in 1982, the depth to water was reported as 120 feet bgs. Prior to sale of the site to the COT in 2006, owner Mr. Harry Adkins stated that the three wells on the site had been dry for many years. According to Tucson Water, the site was connected to the municipal water service in 1975. Videos of the three wells were attempted in 2007; however, due to the presence of well equipment in the casing of the northeast well and lumber blocking the casings of the two other wells, the camera was not able to be placed down the well casings. Because groundwater is not expected to have been impacted by activities on the site and because access to the interior of the well casings is blocked, no groundwater or soil samples will be collected from the wells.

2.6 IMPACT ON HUMAN HEALTH AND/OR THE ENVIRONMENT

Based on soil sampling performed on the site during Phase II ESA site characterization investigations, the PAHs benz[a]anthracene, benzo[a]pyrene, and indeno[1,2,3-cd]pyrene exceeded the 10^{-5} risk level RSRLs for carcinogens, the metals arsenic and lead exceeded the non-carcinogen RSRLs, and lead exceeded the minimum GPLs. Therefore, benz[a]anthracene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, arsenic, and lead are identified as the contaminants of concern at the site. In addition, mercury exceeded the minimum GPL at one subsurface location at the cesspool; mercury is therefore considered a contaminant of concern at the cesspool location.

Human impacts could potentially consist of human exposure to these contaminants in soil on the site during excavation. Pathways could include inhalation and dermal exposure to impacted soil.

3.0 PROJECT AND DATA QUALITY OBJECTIVES

3.1 PROJECT TASK AND PROBLEM DEFINITION

The objective of this project will be to remediate the horizontal and vertical extent of areas where contaminants of concern exceed applicable RSRLs and GPLs in soil. The goal is to collect data meeting the data quality indicators and other requirements of the SAP.

The remediation areas will be excavated and verification samples collected to determine if the extent of contamination has been remediated in accordance with the action levels shown in the table in Section 3.2.4. Verification samples from surface soil remediation areas will be analyzed to determine if PAHs, arsenic, and lead exceed the applicable RSRLs. Verification samples from the residential septic system areas will be analyzed to determine if PAHs, arsenic, lead, and mercury exceed the applicable RSRLs and GPLs. Verification samples from the non-residential septic system areas (work shop and cesspool locations) will be analyzed to determine if PAHs, arsenic, lead, mercury, and volatile organic compounds (VOCs) exceed the applicable RSRLs and GPLs. Areas where contaminants of concern exceed the cleanup levels will be further remediated.

The site is within the Fort Lowell Multiple Resource Area, which was placed on the National Register of Historic Places in 1978. The proposed plan for the site is to incorporate the area into the COT's larger Fort Lowell Historic Park, which is a large regional recreational center featuring swimming pools, ballfields, tennis and racquetball courts, picnic areas, a pecan orchard, a wetland, riparian areas, a fitness trail, and the Fort Lowell Museum. The remaining former features of the historic Fort Lowell located on the site will be rehabilitated, protected, or preserved; various former buildings will be represented by interpretive ghosting to show former outlines and/or floor plans; and the former Cottonwood Lane will be reestablished on the site and cottonwood trees replanted. The Adkins residence in the northeast corner of the site will be stabilized pending future decisions on its use or disposition. A new structure containing self-guided exhibits, restrooms, office, and storage will be constructed and a parking area will be added to the west portion of the site. The former parade grounds at the site will be used informally, and may be planted with turf or native drought tolerant grasses. A copy of the Final Concept Plan for the Fort Lowell Park Master Plan, which includes the site area, is included as Figure 10 in the Work Plan (Poster Frost 2009a, 2009b).

3.2 DATA QUALITY OBJECTIVES (DQOS)

Data quality objectives (DQOs) are quantitative and qualitative criteria developed using systematic planning to clarify the objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. The DQO decision making process is described in EPA's *Guidance for the Data Quality Objectives Process* (EPA QA/G-4, Final, February 2006).

3.2.1 Identify the Decision

The following questions and decision statements are posed by this remediation project:

1. **Following excavation and removal of contaminated soil in each surface soil area, has the vertical and lateral extent of contaminants of concern (PAHs, arsenic, and lead) been remediated?**

   The Decision Statement for this task is: Determine if the vertical and lateral extent of the contaminants of concern (PAHs, arsenic, and lead) has been remediated in surface soil areas by collecting and analyzing verification samples from the floor and perimeter of each excavation.

2. **Following excavation and removal of residential septic tank systems, are contaminants of concern (PAHs, arsenic, lead, and mercury) present in soil below the septic tanks, perforated piping, or leach fields?**

   The Decision Statement for this task is: Determine if the contaminants of concern (PAHs, arsenic, lead, and mercury) are present in soil below the residential septic tanks, perforated piping, or leach fields.

3. **Following excavation and removal of non-residential septic tank systems, are contaminants of concern (PAHs, arsenic, lead, and mercury, as well as VOCs) present in soil below the septic tanks, perforated piping, or leach fields?**

   The Decision Statement for this task is: Determine if the contaminants of concern (PAHs, arsenic, lead, and mercury, as well as VOCs) are present in soil below the non-residential septic tanks, perforated piping, or leach fields.

4. **If soil has been impacted by the contaminants of concern listed under numbers 1, 2, and 3 above, do concentrations exceed regulatory thresholds or levels that could pose a threat to human health or the environment?**

   The Decision Statement for this task is: Determine if applicable contaminants of concern (PAHs, arsenic, lead, and mercury, as well as VOCs) are present in soil at concentrations exceeding the applicable RSRLs or GPLs.

3.2.2 Identify the Inputs to the Decision

The following tasks and information are needed to resolve the decision statements listed in Section 3.2.1 (information sources, basis for Action Level, sampling/analysis method).

1. Excavate surface soil areas where contaminants of concern (PAHs, arsenic, and lead) have been identified as exceeding the applicable RSRLs.

2. Collect verification soil samples from the floor and perimeter of each excavation.

3. Collect verification soil samples from the area between the minimum and potential maximum excavation areas to confirm that these areas meet cleanup goals.

4. Excavate septic systems and collect soil samples from below the septic tanks, perforated piping, and leach fields.

5. Following receipt of laboratory analytical results:

   a. Surface soil samples – Compare detected contaminants of concern (PAHs, arsenic, and lead) with applicable RSRLs.

   b. Residential septic system area samples – Compare detected contaminants of concern (PAHs, arsenic, lead, and mercury) with applicable RSRLs and GPLs. If only minimum GPLs are exceeded for mercury, analyze these samples using the TCLP to determine if an alternative GPL is feasible for mercury.

   c. Non-residential septic system area samples – Compare detected contaminants of concern (PAHs, arsenic, lead, and mercury) and VOCs with applicable RSRLs and GPLs. If only minimum GPLs are exceeded for mercury, analyze these samples using the TCLP to determine if an alternative GPL is feasible for mercury.

6. If there are verification soil samples that exceed the applicable RSRLs or GPLs for the contaminants of concern, perform additional excavation and subsequent soil sampling until all areas have been fully remediated.

7. If locations in the surface soil remediation areas are found that exceed applicable RSRLs at 5 feet below ground surface, or in the case of the septic tanks, if locations are found that exceed applicable RSRLs or GPLs at 12 feet below ground surface, excavation will be halted and the results for that location evaluated to determine if excavation should continue, if other methods of investigation should be used, or if a Declaration of Environmental Use Restriction (DEUR) would be a feasible alternative.

3.2.3 Define the Boundaries of the Study

The area subject to soil remediation activities on the site is shown on Figure 3 in Attachment 1. Initially, soil will be excavated to a depth of 6 inches in the surface soil remediation areas. As excavation of each area is completed, verification samples will be collected from the floor and the ground surface around the perimeter of the excavation. If verification samples from the excavation exceed one or more of the applicable RSRLs, additional soil representing the failing sample will be excavated. Additional verification samples will be collected from the newly excavated portions of the excavation, and the above procedures will be repeated until RSRLs have been met. If locations in the remediation area are found that exceed RSRLs at 5 feet below ground surface, excavation will be halted and the results for that location evaluated to determine if excavation should continue, if other methods of investigation should be used, or if a DEUR would be a feasible alternative. The final depths and boundaries of the excavations will be determined based on site conditions and archaeological constraints.

Septic systems will be excavated and the septic tanks removed for disposal. Piping will be followed and excavated. Septic tank excavations will be observed for field evidence of contamination and soil samples will be collected beneath the septic tanks, piping, and leach fields. If samples only exceed the minimum GPL for mercury, they will be analyzed using the TCLP to determine if an alternative GPL is feasible. If soil samples from these locations exceed one or more of the applicable RSRLs or GPLs, additional soil representing the failing sample will be excavated. Additional verification samples will be collected from the newly excavated areas and the above procedures will be repeated until the applicable RSRLs or GPLs are met. If septic tank locations are found that exceed applicable RSRLs or GPLs at 12 feet below ground surface, excavation will be halted and the results for that location evaluated to determine if excavation should continue, if other methods of investigation should be used, or if a DEUR would be a feasible alternative. The final depths and boundaries of the excavations will be determined based on site conditions and archaeological constraints.

3.2.4 Develop a Decision Rule

Action Levels and decision rules that will be used to choose among alternative actions with regard to the results of sampling activities are discussed as follows. Verification soil samples for the surface soil areas will be analyzed for the following contaminants of concern:

- Polynuclear aromatic hydrocarbons (PAHs; EPA Method 8310)
- Arsenic and Lead (EPA Method SW6010B)

Soil samples collected at the residential septic system areas will be analyzed for the following:

- Polynuclear aromatic hydrocarbons (PAHs; EPA Method 8310)
- Arsenic and Lead (EPA Method SW6010B)
- Mercury (EPA Method SW7471A)

Soil samples collected at the non-residential septic system areas (work shop and cesspool locations) will be analyzed for the following:

- Polynuclear aromatic hydrocarbons (PAHs; EPA Method 8310)
- Arsenic and Lead (EPA Method SW6010B)
- Mercury (EPA Method SW7471A)
- Volatile Organic Compounds (VOCs; EPA Method 8260)

The Arizona RSRLs (Arizona Administrative Code [AAC] Title 18, Chapter 7, Article 2) used as the Action Levels for the soil samples will be the 10^{-5} risk level RSRLs for PAHs and the non-carcinogen RSRLs for lead and mercury. Arsenic has the same limit for the carcinogenic and non-carcinogenic RSRLs, as well as for the NRSRL. In addition, the analytical results will be compared to the GPLs. The following remediation action levels have been selected for use at the site as discussed in more detail in Section 6.1 of the Work Plan. The RSRLs for other PAHs are shown in Table 2 in Attachment 2; there are no GPLs for PAHs. VOCs have not been identified at the site above applicable RSRLs or GPLs; if detected in the non-residential septic tank samples, they will be compared to the concentrations listed in Table 4 in Attachment 2.

ACTION LEVELS		
Contaminant	**Remediation Level (mg/kg)**	**RSRL or GPL**
Benz[a]anthracene	6.9	10^{-5} Risk Level RSRL (Carcinogens)
Benzo[a]pyrene	0.69	
Indeno[1,2,3-cd]pyrene	6.9	
Arsenic	10	10^{-5} Risk Level RSRL (Carcinogens) and RSRL (non-carcinogenic)
Lead	400	RSRL (Non-Carcinogens)
Mercury	To be determined – If sample results exceed the Minimum GPL, an Alternative GPL will be calculated using TCLP results. If the Alternative GPL is greater than the Minimum GPL, the Action Level will be the lower of the RSRL or the Alternative GPL.	Alternative GPL
	12	Minimum GPL
	23	RSRL (Non-Carcinogens)

The decision rules for soil sampling are summarized below:

1. If contaminants of concern are not detected above laboratory reporting limits in the soil samples, then no further action is required.

2. If one or more contaminants of concern are detected in one or more soil samples, then the total concentration of each chemical in each sample will be compared with the applicable RSRLs (surface soil remediation areas) or RSRLs and GPLs (septic system areas). If the laboratory results do not equal or exceed the applicable RSRLs or GPLs, then no further action is required.

3. If one or more contaminants of concern are detected in a soil sample in concentrations that equal or exceed the applicable RSRLs or GPLs, then additional remediation (excavation) and verification soil sampling will be performed until the cleanup levels are achieved.

4. If locations are found that exceed applicable RSRLs at 5 feet bgs in the surface soil remediation areas, or in the case of the septic tanks, if locations are found that exceed applicable RSRLs or GPLs at 12 feet bgs, excavation will be halted and the results for that location evaluated to determine if excavation should continue, if other methods of investigation should be used, or if a DEUR would be a feasible alternative. The final depths of the excavations will be determined based on site conditions and archaeological constraints.

3.2.5 Specify Tolerable Limits on Decision Errors

A decision error occurs when random and/or systematic errors in the sample data set cause the wrong decision to be made, which in turn causes the wrong response action to be taken. There are typically two components contributing to decision errors, as discussed below.

- **Sampling Design Error:** Occurs when the data selection design does not capture the complete variability within the decision unit to the extent appropriate for the decision of interest. This is influenced by the inherent variability of the population over space and time, the sample collection design, and the number of samples.

- **Measurement Error:** Random and systematic measurement errors are introduced into the measurement process during physical sample collection, sample handling, sample preparation, sample analysis, data reduction, transmission, and storage.

These errors can result in false positive or false negative decisions. The consequences of making either type of decision error are discussed below.

- **A false positive decision error** would occur if the sample results indicated that the concentration of a contaminant of concern exceeded the respective Action Level, when the actual concentrations did not exceed the Action Level. The consequence of this type of error would result in additional unnecessary expense for subsequent additional investigations, sample analyses, and remedial or corrective actions. False positive decision errors will be minimized by adherence to the proper sampling methodology, use of laboratory control samples, and analysis of blanks.

- **A false negative decision error** would occur if the sample results indicated that the concentration of a contaminant of concern did not exceed the respective Action Level, when the actual concentrations did exceed the Action Level. The consequences

of this type of error are possible threats to human health and the environment. False negative decision errors will be minimized by adherence to the proper sampling methodology, use of laboratory control samples, and analysis of blanks.

3.3 MEASUREMENT QUALITY OBJECTIVES (MQOS)

Measurement Quality Objectives (MQOs) are criteria established to assess the viability and usability of field and laboratory data. Data quality indicators (DQI; precision, accuracy, representativeness, completeness, comparability, and sensitivity) refer to quality control (QC) criteria established for various aspects of data gathering, sampling, or analysis activity. In defining DQIs specifically for the project, the level of uncertainty associated with each measurement is defined.

3.3.1 Precision

Precision is the degree of mutual agreement between or among independent measurements of a similar property. Precision is usually reported, depending on the end use of the data, either as relative percent difference (RPD) or standard deviation. The equation for RPD is provided below.

$$\text{RPD} = \left(\frac{|\text{Sample} - \text{Sample Duplicate}|}{0.5 * (\text{Sample} + \text{Sample Duplicate})} \right) * 100$$

The field and laboratory precision objectives are identified as follows:

- Field duplicates will be collected at a frequency of one duplicate per 10 samples per sample matrix. Water matrix samples can be readily duplicated due to their homogeneous nature; however, the duplication of solid (e.g., soil, fill, sediment) samples is much more difficult due to their non-homogeneous nature. Consequently, target water and soil (or other solids) RPDs will be within 35% of the original result. Duplicate recoveries beyond these ranges may require further qualification of associated data, but data will not be rejected unless determined unusable by data validation.

- Laboratory precision will be based upon laboratory Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses. Tables 2, 3, and 4 included in Attachment 2 include specific control limits provided by TestAmerica that are proposed for this project. The laboratory will perform MS/MSD analyses at a rate of one for every 20 investigative samples. RPD values lower than the limits provided in the tables will be considered precise without further discussion. If one or more sample results fall outside the acceptance criteria, they will be flagged. Samples will not be re-extracted and analyzed.

3.3.2 Accuracy

Accuracy is the degree of agreement of a measurement with an accepted or true value. To determine accuracy expressed in terms of recovery, a laboratory value is compared to a known or true concentration. To determine accuracy expressed in terms of contamination, laboratory and field blanks are analyzed to assess the affect of any potential sample collection or laboratory preparation/analysis contaminant sources on the associated sample data. The field and laboratory accuracy objectives are identified as follows.

- Field accuracy is assessed by evaluating the results of field equipment and trip blank samples using the same procedures as laboratory samples. Trip blanks will only be required when VOCs will be analyzed. Equipment blanks will be performed for each type of area of contamination that is investigated (e.g., surface soil areas for PAHs, arsenic, and lead; residential septic system areas for PAHs, arsenic, lead, and mercury; and non-residential septic system areas for PAHs, arsenic, lead, mercury, and VOCs).

- Laboratory accuracy is determined by such QC indicators as matrix spikes, surrogate spikes, laboratory control samples (blank spikes), and performance samples. Laboratory acceptance criteria for accuracy are shown on Tables 2, 3, and 4 provided by TestAmerica in Attachment 2. If one or more sample results fall outside the acceptance criteria, they will be flagged.

3.3.3 Representativeness

Representativeness is the expression of the degree to which data accurately and precisely represent a characteristic of an environmental condition or a population. The field and laboratory representativeness objectives are identified as follows.

- Field representativeness will be accomplished by adhering to the sampling and analytical procedures and methods used to avoid false positives and false negatives and evaluation of QC samples for other DQIs. If any deviations occur, they are to be noted in the field record and an assessment is to be made regarding any impact to data representativeness. Soil samples will be homogenized to help ensure that representative soil samples are collected, except for VOC samples, which will be collected without mixing.

- Laboratory representativeness cannot be quantified, but will be achieved through adherence to prescribed analytical methods and procedures to produce laboratory data representative of site conditions and usable for determinations regarding subject properties. Use of laboratory-specific standard operating procedures (SOPs) and sub-sampling routines set forth in the laboratory Quality Assurance (QA) Manual provided in Attachment 3 will produce uniform data that represent on-site conditions sufficient to the project decision.

3.3.4 Comparability

Comparability expresses the degree of confidence with which one data set can be compared to another. Comparability also refers to the reporting of data in comparable units so direct comparisons are simplified. For example, this avoids comparison of milligrams per liter (mg/L) for nitrate reported as nitrogen to mg/L of nitrate reported as nitrate, or parts per million (ppm) vs. mg/L discussions.

- Field comparability will be achieved by conducting field work consistently per this SAP and relevant standard operating procedures. This approach will ensure that samples are properly collected, handled, and analyzed for comparable evaluation. On-site sample locations will be documented using global positioning system (GPS) technology, surveying, and/or field measurements from on-site reference points to assist in comparing data sets collected at various investigative phases.

- Laboratory comparability will be achieved when the data are collected and preserved in the same manner followed by analysis with the same standard regulatory method and laboratory reporting limits. Laboratory data comparability will therefore be achieved through consistent application of standard EPA methods and associated QC protocols.

3.3.5 Completeness

Completeness is expressed as percent of valid usable data actually obtained compared to the amount that was expected. Sometimes, due to a variety of circumstances, either not all samples scheduled to be collected can be collected or else the data from samples cannot be used (for example, samples lost, bottles broken, instrument failures, laboratory mistakes, etc.). The field and laboratory completeness objectives are identified as follows.

- Field completeness will be 85% or better for non-critical samples and 90% or better for critical samples. Samples will be considered critical if they are subject to definitive analyses and compared to cleanup levels. Non-critical samples will involve field screening samples used to direct the exploration in the field.

- The laboratory completeness objective is for 95% of the field samples to be analyzed, with greater than 90% meeting QA/QC objectives.

3.3.6 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest, for example, what is the capability of measuring a constituent at low concentrations. The analytical methods selected for this project are sufficiently sensitive to identify concentrations that are below the appropriate RSRLs and GPLs to be used for this project. The field and laboratory objectives are identified as follows:

- Field soil samples will be collected at a sufficient volume to adequately perform the required analyses.

- Laboratory QC samples, such as laboratory control samples, laboratory fortified blanks, etc., will be performed to ensure accurate quantification of data at the quantification limit. Calibration verification will be performed to assess the ability to accurately quantify data at the low end of the calibration curve.

3.4 DATA REVIEW AND VALIDATION

Due to the limited scope and limited duration of this project, data validation is not proposed. Data verification will be performed by the SCS QA Manager (Mr. David F. Laney, CHMM), who will not otherwise be involved in the sampling activities. The data verification will consist of an Evaluation Tier 2 review of the laboratory reports to identify analytical issues or deficiencies that might affect data quality and the user decisions based on the data. The data verification will consist of the elements discussed below, and will be performed on 100 percent of the data.

TestAmerica will internally perform data review and reporting as specified in their Laboratory QA Manual (Attachment 3). The vast majority of QA tasks are required by and the results calculated automatically by the Laboratory Information Management System (LIMS), objectively and with no conflict of interest.

Other QA/QC assessments (such as review of raw laboratory data, surveillance, peer review, management systems review, readiness review, technical systems audit, performance evaluation, etc.) will not be performed for this project because sampling activities are of limited scope and duration.

3.4.1 Completeness Check

A completeness check will be performed on 100 percent of the laboratory analytical data and shall include a review of:

- Case narrative;
- Chain of custody documentation; and
- Sample condition upon receipt.

The completeness check shall ensure that:

- All compounds and environmental samples are present;
- QC is present for every environmental sample; and
- The most technically valid result is reported for each compound.

3.4.2 Data Verification Criteria

Data verification shall be performed on 100 percent of the data and will include, but is not limited to, reviewing the:

- Completeness, as defined above;
- Case narrative, including but not limited to, a description of non-conformances and corrective actions that were taken, plus anomalies, deficiencies, and QC problems that have been identified;
- Chain of custody documentation and original chain of custody forms with identification numbers and laboratory receipt signatures, dates, and times;
- Sample condition upon receipt, including cooler temperature and shipping documentation;
- Timeliness and a check for errors, including requested deliverables, preservation, and holding times;
- Sample analysis results, with quantitation limits and reporting limits checked against the contract required limits and verification of dry weights and dilutions;
- QC summary including, but not limited to, method blanks, continuing calibration blanks, and preparation blanks; surrogate percent recoveries, spike percent recoveries and relative percent differences; and laboratory QC check sample and laboratory control sample (LCS) recoveries;
- Field duplicates, if identified, for which reproducibility shall be evaluated;
- Reporting Limits (RLs); and
- Laboratory duplicates.

3.4.3 Data Qualifier Flags

The guidance used for data verification is taken from the EPA Contract Laboratory Program National Function Guidelines for Organic Data Review, as revised, and EPA Contract Laboratory Program National Function Guidelines for Inorganic Data Review, as revised. The data qualification scheme is the basis for determining whether sample results should be qualified, but the reviewer's judgment is also critical in determining whether data quality and usability have been systematically influenced and whether data points require qualification. The staff performing the assessment must understand the analytical procedures being reviewed and understand how the data will be used. If QC results are out of criteria, the data will be qualified using the standard Contract Laboratory Program data flags (i.e., B, J, UJ, NJ, and R).

Problems or questions about analytical data quality that may require corrective action will be brought to the attention of the laboratory in writing from SCS QA Manager. The request may be

initiated if QC results exceed method or project criteria, if reporting or flagging errors are identified, or to request information that has not been reported. The laboratory's response shall include a written explanation of the problem, a plan and a schedule for corrective action, and/or a re-issuance of laboratory reports or electronic data files. If significant data quality problems have occurred and the data are critical to decision making, samples may be required to be reanalyzed, or recollected and reanalyzed at the discretion of SCS.

The ADHS has published standardized data qualifier flags that will be used by the laboratory in qualifying analytical results. Any data that is associated with a QC exceedance will be designated by the laboratory using the Arizona Data Qualifier flags to flag the sample results associated with the exceedance.

3.4.4 Data Verification Reports

The reviewer will prepare a data review report for each sample delivery group, including:

- A case narrative including, but not limited to, a list of recommended flags; a listing of the items reviewed and the criteria used to evaluate them; a discussion of any problems or QC exceedances associated with the actual analysis that might impact the sample integrity or data quality; and a summary of all laboratory contacts in which all communications with the laboratory, if any, would be identified; and

- The marking of recommended qualifier flags on the laboratory reports and/or in electronic data deliverables. Flags that are marked on hard copy shall be marked directly on copies of the laboratory reports in a contrasting color.

3.5 DATA MANAGEMENT

SCS field personnel will maintain a project field notebook and field logs to document field activities. Documentation will contain the project name and number, date, and identification of personnel completing the document (printed name, signature, and initials). Information will be entered in the notebook and logs at the time the information is generated.

While being used in the field, the field notebook and logs will remain with the SCS field personnel at all times. At the end of each field day, the notes and logs will be reviewed and information compared to ensure that the information is accurate and complete. Upon completion of all field activities, the field notebook will be filed and secured in the project office. Photocopies of the original field notebook will be used as working documents.

Chain of custody forms will be checked against the sample labels and field notes prior to shipping or delivering the samples to the laboratory. Laboratory analytical reports will be reviewed to ensure that the sample information is accurate. The analytical results will be compiled in one or more tables for the project report, and the completed data tables will be double-checked against the laboratory analytical report.

3.6 ASSESSMENT OVERSIGHT

Prior to the beginning of fieldwork, the SCS Field Staff/Project Manager will review the project SAP and health and safety plan (HASP) and will assemble the necessary field gear, including the field notebook and logs, copies of the project SAP and HASP, sampling and decontamination equipment, sample containers and labels, chain of custody forms and seals, sample shipping coolers and materials, and any other equipment and materials necessary for the fieldwork. The SCS Field Staff/Project Manager will contact the analytical laboratory in advance to schedule sample analyses and will arrange for transportation of samples to the laboratory.

The SCS Field Staff/Project Manager will generally be working alone in the field with other consultants and subcontractors, and thus will be responsible for performing fieldwork in accordance with the SAP, including sampling activities; documentation accuracy, completeness, and consistency; and packaging and transportation of samples to the laboratory.

The SCS Field Staff/Project Manager will communicate daily to the SCS Project Director and/or SCS QA Manager regarding field activities and any changes or corrections will be implemented. During and following the fieldwork, the SCS Field Staff/Project Manager will review field documentation and laboratory data for accuracy and completeness and will provide the information to the SCS QA Manager for additional review.

The analytical laboratory report will be reviewed by the SCS Field Staff/Project Manager and QA Manager to ensure that the sample information is correct and complete. The SCS QA Manager is granted the corporate and project-specific authority to ensure corrective actions, if necessary, are implemented.

4.0 SAMPLING DESIGN AND RATIONALE

4.1 SOIL SAMPLING

SCS prepared a map of surface soil conditions that shows the initial areas that will be excavated. The map was prepared using data from previous site characterization work. It is included as Figure 3 in Attachment 1. Contaminated soil will be excavated to an initial depth of approximately 6 inches using an excavator. Verification soil samples will be collected from completed excavation areas. Grab soil samples will be collected from the floor and ground surface around the perimeter of each excavation. Surface samples will also be collected within the area of potential maximum excavation to ensure that the area between the limits of the minimum and maximum areas of excavation meet cleanup goals. The samples will be analyzed for contaminants of concern (PAHs, arsenic, and lead) and the results will be compared to the applicable RSRLs.

Approximately six septic systems and related features (tanks, piping, leach fields, etc.) will be excavated and removed from the site. These include residential septic systems for the two residences in the northern portion of the site, a former trailer location, and a wastewater drainage feature apparently connected to the kitchen of the northeast residence. Non-residential septic tank systems include one associated with the shop restroom and the septic system in the

southeast portion of the site associated with a residence and the former cesspool. During excavation the septic systems will be observed for evidence of contamination, such as staining or odors, and will be investigated by the collection and analysis of soil samples.

Soil samples will be collected from below the septic tank, any perforated piping, and the leach field. If samples are collected in excavations that are more than 4 feet deep, the backhoe bucket will be used to collect the soil for the sample. Soil samples from the residential septic system areas will be analyzed for PAHs, arsenic, lead, and mercury; soil samples from the non-residential septic system areas will also be analyzed for VOCs. The results will be compared to applicable RSRLs and GPLs. If verification samples at the septic tanks contain mercury above the minimum GPL, TCLP analysis will be performed to determine whether an alternative GPL can be applied.

If a soil sample collected from the excavations exceeds the applicable RSRLs or GPLs, additional soil will be excavated horizontally and/or vertically, as necessary. After the additional excavation is complete, verification samples will be collected once more as described above. This process will continue until the full extent of contamination has been removed and verified.

If surface soil locations are found to exceed applicable RSRLs at 5 feet bgs, or in the case of the septic tanks, if locations are found that exceed applicable RSRLs or GPLs at 12 feet bgs, excavation will be halted and the results for that location evaluated to determine if excavation should continue, if other methods of investigation should be used, or if a DEUR would be a feasible alternative.

The estimated locations of the initial samples are shown on Figure 3 in Attachment 1. The locations of any additional verification samples will be determined based on the results of the initial samples and subsequent additional excavation locations. A summary of the verification samples and QC samples to be collected during remediation are shown in the table below.

Location	Depth (BGS)	Chemical Groups	Laboratory Method	Rationale
Floor of Excavation (Initial)	0.5 feet	PAHs Arsenic Lead	8310 6010B 6010B	Sampling of floor of excavations to provide adequate coverage (estimated at an average of one sample per approximately 30 x 30 foot area).
Ground Surface Around Excavations (Initial)	Surface	PAHs Arsenic Lead	8310 6010B 6010B	Sampling of perimeter of excavations to provide adequate coverage (estimated at an average of one sample per approximately 30 linear feet).
Floor of Excavation (Additional)	TBD	PAHs Arsenic Lead	8310 6010B 6010B	Sampling of floor of excavations to provide adequate coverage (estimated at an average of one sample per approximately 30 x 30 foot area).
Ground Surface Around Excavations (Additional)	TBD	PAHs Arsenic Lead	8310 6010B 6010B	Sampling of perimeter of excavations to provide adequate coverage (estimated at an average of one sample per approximately 30 linear feet).
All Septic Systems	TBD	PAHs Arsenic Lead Mercury	8310 6010B 6010B 7471	Sample from below septic tank, any perforating piping, and leach field
All Septic Systems	TBD	Mercury	TCLP 7471	TBD – Samples exceeding the minimum GPL for mercury

Location	Depth (BGS)	Chemical Groups	Laboratory Method	Rationale
Non-Residential Septic Systems	TBD	VOCs	8260	Sample from below septic tank, any perforating piping, and leach field
Field Duplicates	TBD	PAHs Arsenic Lead Mercury VOCs	8310 6010B 6010B 7471 8260	Collect at a rate of 10 percent of primary samples
EB-1	NA	PAHs Arsenic Lead	8310 6010B 6010B	Equipment rinse blank (surface soil areas).
EB-2	NA	PAHs Arsenic Lead Mercury	8310 6010B 6010B 7471	Equipment rinse blank (residential septic system areas).
EB-3	NA	PAHs Arsenic Lead Mercury VOCs	8310 6010B 6010B 7471 8260	Equipment rinse blank (non-residential septic system areas).
LQCS (MS/MSD)	Same as selected soil sample	PAHs Arsenic Lead Mercury VOCs	8310 6010B 6010B 7471 8260	Designate and label as laboratory QC sample. Collect in additional sample container(s) and select the same analyses as the primary sample.
Temperature Blank	NA	Temperature	NA	Temperature blank, one per cooler.

4.2 SEDIMENT SAMPLING

Not applicable

4.3 WATER SAMPLING

Not applicable

4.4 OTHER SAMPLING

Not applicable

5.0 REQUEST FOR ANALYSES

5.1 ANALYSES NARRATIVE

As shown in Table 5 in Attachment 2, an estimated 73 initial soil samples will be collected from the floor and from the ground surface around the perimeters of the surface soil excavation areas and will be analyzed for PAHs, arsenic, and lead. An estimated 16 samples will be collected at the four residential septic system areas and will be analyzed for PAHs, arsenic, lead, and mercury. An estimated eight samples will be collected at the two non-residential septic system areas and will be analyzed for PAHs, arsenic, lead, mercury, and VOCs. Soil samples selected for QC analyses will be collected in double volumes (triple for VOC analyses). Duplicate samples will be collected at a rate of 10 percent of the primary samples, for an estimated 10

duplicate samples. The locations for duplicate and QC samples will be determined based on field conditions (e.g., select samples with suspected higher levels of contaminants, if possible).

Based on the results from the initial soil samples, if concentrations of contaminants of concern exceed the applicable RSRLs or GPLs, additional excavation will be performed and additional soil samples, duplicates, and QC samples will be collected. The number of additional samples, duplicates, and QC samples cannot be determined at this time; however, if it is assumed that 10 percent of the samples exceed the applicable RSRL or GPL for one of the contaminants of concern, an additional 10 primary samples and one duplicate sample is estimated to be necessary to confirm that the full extent of contamination has been removed and verified.

5.2 ANALYTICAL LABORATORY

Samples collected during this project will be analyzed by an ADHS-certified laboratory, TestAmerica, Arizona Environmental Laboratory License number AZ0728 (fixed-base laboratory). The Laboratory QA Manual for TestAmerica is included in Attachment 3. Tables provided by the laboratory that show the analytical laboratory reporting limits and data acceptance criteria are included in Attachment 2. The laboratory stated that the data acceptance criteria are periodically revised; SCS will obtain any revised versions prior to the start of fieldwork.

6.0 FIELD METHODS AND PROCEDURES

6.1 FIELD EQUIPMENT

6.1.1 List of Equipment Needed

Soil samples will be collected using the following equipment:

- 4-ounce glass sample jars
- Lock and load type subsamplers
- Zip-lock plastic bags
- Sample and cooler custody seals
- Sample labels
- Nitrile or latex or vinyl gloves
- Permanent markers
- Sample coolers and ice
- Nails and whiskers (marking locations)
- Liquinox or Alconox detergent
- Excavator
- Sample bottles for blanks
- Methanol kits
- Sample logs
- Chain of custody forms
- Digital camera
- Stainless steel hand trowels
- Tape measure
- GPS receiver
- Field notebook
- Plastic bristle brush
- Buckets and sprayer

6.1.2 Calibration of Field Equipment

No field monitoring equipment will be used for this project.

6.2 FIELD SCREENING

Visual screening of soil will be performed during excavation activities. Soil exhibiting unusual discoloration, staining, or odors will be excavated and/or sampled.

6.3 SOIL SAMPLING

6.3.1 Surface Soil Sampling

Verification soil samples will be collected from completed excavation areas in the approximate locations shown on Figure 3 in Attachment 1. The locations of any additional soil samples will be determined based on locations of additional excavations. Soil sample locations will be identified with nail and whisker markers and recorded in the field notebook as sampling is completed. A sketch of the sample location will be entered into the notebook and any physical reference points will be labeled. The sample locations and excavation boundaries will be surveyed using a differentially-corrected GPS.

Grab soil samples (independent, discrete samples) will be collected from the initial excavation bases from a depth of 6 to 12 inches bgs and from the ground surface around the perimeter of the excavations (depth of 0 to 6 inches bgs). If additional excavation is required, the depth of sampling will be determined based on field conditions and archaeological constraints, as discussed in Section 3.2.3. A decontaminated stainless steel hand trowel will be used to excavate a small area of soil to the required depth at the sampling location. The excavated soil, which will be analyzed for PAHs, arsenic, and lead, will be mixed in place using a clean-gloved hand.

The grab soil sample will be collected from the homogenized excavated soil directly into a 4-ounce glass sample jar (provided by the laboratory). The jar will be filled to the top, taking care to prevent soil from remaining in the lid threads prior to being closed to prevent potential contaminant migration to or from the sample. The sample jars will be sealed with a Teflon-lined plastic cap as soon as they are filled, sealed into a plastic ziplock type bag, and immediately placed into a sample cooler and chilled to 4°C pending delivery to the analytical laboratory.

6.3.2 Subsurface Soil Sampling

A backhoe will be used to excavate the septic system locations, including tanks, pipes, and leach fields, depending on actual field conditions. The excavations will be evaluated for buried features (tanks and piping), visible staining, odors, and other indications of potential contamination. If visibly contaminated soils are encountered, they will be segregated from clean soil and temporarily stockpiled on plastic sheeting.

Soil samples will be collected from below the septic tanks, piping, and leach fields of the septic systems. The exact location of each soil sample will be determined in the field based on actual field conditions (locations of septic tank systems, actual boundaries of the excavations, locations of additional excavation, and other such factors).

Once the excavation has been inspected and the specific sample location selected, grab samples will be collected from the floor and/or sidewalls of the excavation, as appropriate. Samples will

be collected using a decontaminated stainless steel hand trowel to excavate a small area of soil to the required depth at the desired sampling location. If the excavation exceeds 4 feet in depth, the samples will be collected from the backhoe bucket. Samples to be analyzed for VOCs will be collected first, as independent, discrete samples. Soil samples will be collected directly from the desired location or backhoe bucket into a laboratory-provided lock and load type subsampling device (such as Terra Core®). A stainless steel hand trowel will be used to loosen and/or contain soil for sampling as necessary. Immediately following collection, the subsample will be placed into a VOA vial prepared by the laboratory with methanol for field preservation. Sample containers will be closed as soon as they are filled, sealed into a plastic ziplock-type bag, and immediately placed into a sample cooler and chilled to 4°C pending delivery to the analytical laboratory.

Soil samples collected for PAHs and metals analyses will be mixed in place using a clean-gloved hand, or if collected from the backhoe bucket, the excavated soil will be placed into a plastic ziplock type bag to be homogenized. The grab soil sample will be collected from the homogenized excavated soil directly into 4-ounce glass sample jars (provided by the laboratory). The jar will be filled to the top, taking care to prevent soil from remaining in the lid threads prior to being closed to prevent potential contaminant migration to or from the sample. The sample jars will be sealed with a Teflon-lined plastic cap as soon as they are filled, sealed into a plastic ziplock type bag, and immediately placed into a sample cooler and chilled to 4°C pending delivery to the analytical laboratory.

Soil sample locations will be identified with nail and whisker markers where possible and recorded in the field notebook as sampling is completed. A sketch of the sample location will be entered into the notebook and any physical reference points will be labeled. The sample locations and excavation boundaries will be surveyed using a differentially-corrected GPS.

6.4 SEDIMENT SAMPLING

Not applicable.

6.5 WATER SAMPLING

Not applicable.

6.5.1 Surface Water Sampling

Not applicable.

6.5.2 Groundwater Sampling

Not applicable.

6.6 OTHER SAMPLING

Not applicable.

6.7 DECONTAMINATION PROCEDURES

The decontamination procedures that will be followed are in accordance with approved procedures. Decontamination of sampling equipment will be conducted consistently to assure the quality of samples collected. All equipment that comes into contact with potentially contaminated soil or water will be decontaminated. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal. Decontamination will occur prior to and after each use of a piece of equipment.

The following will be performed in sequence for the decontamination of sampling equipment (hand trowels):

- Pre-rinse and scrub equipment if there is an excessive amount of soil attached
- Wash using tap water, Liquinox soap, and a scrub brush in a plastic container
- Rinse with distilled/deionized water in a plastic container
- Final rinse with distilled/deionized water using a water sprayer

Equipment will be decontaminated in a predesignated area on plastic sheeting, and clean bulky equipment will be stored on plastic sheeting in uncontaminated areas. These designated areas will change as the excavation progresses to be near the work areas. Cleaned small equipment will be stored in plastic bags. Materials to be stored more than a few hours will also be covered.

Used decontamination water will be collected into a storage container for storage pending waste characterization. Depending on the results of waste characterization sampling, the water will be disposed by spreading onto the ground surface or will be transported and disposed appropriately.

If necessary based on field observations, the excavator and backhoe buckets will be decontaminated between excavations and before leaving the site using non phosphate detergent and tap water wash, or a steam cleaner. It is not anticipated that the decontamination water from this procedure will need to be containerized.

7.0 SAMPLE CONTAINERS, PRESERVATION, PACKAGING, AND SHIPPING

The number of sample containers, volumes, and materials are listed in Table 5 in Attachment 2. The sample containers will be provided by the laboratory and have been pre-cleaned and ready to use; these containers will not be rinsed or decontaminated prior to sample collection. Any sample containers that require preservatives will be prepared in advance by the analytical laboratory (TestAmerica) prior to providing the containers to SCS.

7.1 SOIL SAMPLES

Soil samples to be analyzed for PAHs and metals will be homogenized and collected directly into 4-ounce glass jars using a hand trowel. One sample jar will be filled for each sample location. An additional jar will be filled for sample locations selected to be used as the MS/MSD. Samples to be analyzed using the TCLP will be collected into an 8-ounce glass jar. Sample

containers will be sealed into a ziplock type plastic bag and placed into a thermally insulated cooler with ice and chilled to 4° C immediately upon collection.

Soil samples to be analyzed for VOCs will not be homogenized and will be collected directly into a subsampling device. The soil in the subsampler will immediately be transferred to a methanol-preserved VOA vial. The preserved samples will be sealed into a ziplock type plastic bag and immediately placed into a thermally insulated cooler with ice and chilled to 4°C.

7.2 SEDIMENT SAMPLES

Not applicable.

7.3 WATER SAMPLES

Not applicable.

7.4 OTHER SAMPLES

Not applicable.

7.5 PACKAGING AND SHIPPING

All sample containers will be placed in a rigid shipping container (thermally insulated cooler) for transportation to the laboratory. Preservation of samples will be performed as described in Section 10.1. Samples will be hand delivered to the local office of TestAmerica by SCS under chain of custody procedures. The Tucson office of TestAmerica will ship the samples overnight to their Phoenix laboratory using appropriate packaging procedures.

8.0 DISPOSAL OF RESIDUAL MATERIALS

In the process of collecting environmental samples at the site, the SCS sampling team will generate a minimal amount of potentially contaminated investigation-derived wastes (IDW). These may include the following:

- Used personal protective equipment (PPE)
- Decontamination fluids

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

- Used PPE and disposable equipment will be double bagged and placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a

municipal landfill. Any PPE and disposable equipment that is to be disposed of which can still be reused will be rendered inoperable before disposal in the refuse dumpster.

- Decontamination fluids will consist of tap water wash and rinse, distilled water rinse, residual contaminants, and water containing non-phosphate detergent. The decontamination fluids will be collected into a storage container for storage pending waste characterization. One sample will be collected from the collected fluids and analyzed for PAHs (EPA Method 8310); arsenic and lead (EPA Method 6010B); mercury (EPA Method 7471); and VOCs (EPA Method 8260); however, if any of these compounds were not detected in the soil samples on the site, those compounds will not be analyzed in the decontamination fluids. Depending on the results of waste characterization sampling, the water will be disposed by spreading onto the ground surface or will be transported and disposed appropriately.

Excavated soil will be transported to the COT's Los Reales Landfill for disposal. Soil has already been characterized as non-hazardous based on previous soil sample results and TCLP samples and accepted for disposal at the landfill. The COT will provide trucks and operators to transport the soil to the landfill. Each truckload of soil will be weighed at the landfill and recorded.

9.0 SAMPLE DOCUMENTATION

9.1 FIELD NOTES

9.1.1 Field Notebooks and Logs

SCS field personnel will maintain a project field notebook and field logs to document where, when, how, and from whom any vital project information was obtained using factual, objective language. Notebook pages will be consecutively numbered. Notebook entries will be complete and accurate enough to permit reconstruction of field activities. All notebook entries will be legible, written in black ink, and signed by the individual making the entries. Errors will not be erased or crossed out, but corrected by putting a line through the erroneous information and by entering, initialing, and dating the correct information. Blank spaces will have an obliterating line drawn through to prevent addition of information. At a minimum, the following information will be recorded on the sample log, field notebook, chain of custody forms, etc.:

- Site or sampling area sketch showing sample location
- Sampler's name(s)
- Date and time of sample collection
- Type of sample (soil, sediment, or water, composite or grab)
- Type of sampling equipment used
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.)
- General sample descriptions
- Sample preservation
- Shipping arrangements (include shipping numbers as appropriate)

- Name(s) of recipient laboratory(ies)

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

- Team members and their responsibilities
- Time of arrival/entry on site and time of site departure
- Other personnel on site
- Summary of any meetings or discussions with any visitors to the project
- Deviations from work plans, sampling plans, and site safety plans
- Changes in personnel and responsibilities with reasons for the changes
- Levels of safety protection
- Calibration readings for any equipment used and equipment model and serial number

9.1.2 Photographs

Photographs will be taken at sampling locations and at other areas of interest on the site or sampling areas. They will serve to verify information entered in the field notebook. For each photograph taken, the following information will be written in the notebook or recorded in a separate field photography log:

- Time, date, location, and weather conditions
- Description of the subject photographed and the general direction faced
- Digital photograph number or film roll and photograph numbers
- Name of person taking the photograph

9.2 SAMPLE LABELING

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The sample labels will contain the following information: company name, project identification, initials of sampler, date and time of collection, analytical parameter(s), and method of preservation (if any). Every sample will be assigned a unique sample identification number.

9.3 SAMPLE CHAIN OF CUSTODY FORMS AND CUSTODY SEALS

All samples shipped or delivered to the analytical laboratory will be accompanied by a chain of custody record. Copies of the chain of custody forms are included in Attachment 3. Forms will be completed and sent with the samples for each laboratory and each shipment. If multiple coolers or other containers are sent or delivered to a single laboratory on a single day, forms will be completed and sent with the samples for each cooler.

The chain of custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, locked up, or kept in a secured area

that is restricted to authorized personnel. Until the samples are transferred to the laboratory, the custody of the samples will be the responsibility of SCS. The sampler will sign the chain of custody form in the "relinquished by" box and note date, time, and any shipping company names or shipping numbers in the appropriate locations. The sample numbers for all duplicate samples and blanks will be documented on this form. A copy of the completed chain of custody form will be retained by SCS for the project file.

10.0 QUALITY CONTROL

10.1 FIELD QUALITY CONTROL SAMPLES

10.1.1 Assessment of Field Contamination (Blanks)

10.1.1.1 Equipment Blanks

Equipment rinsate blanks will be collected for this project from rinsate from decontamination of sampling trowels or other field sampling equipment. One blank sample will be collected on the first full day of sampling in the area of PAH, lead, and arsenic contamination. A second equipment blank will be collected during excavation and sampling of suspect septic system areas. If there are changes in site conditions or in decontamination procedures, additional equipment blanks may be collected.

Equipment blanks will be collected to evaluate field sampling and decontamination procedures by pouring distilled or deionized water over the sampling equipment after decontamination has been performed. All surfaces of sampling equipment that come in contact with the sample will be rinsed. One equipment blank (EB-1) will be analyzed for PAHs, arsenic, and lead. One equipment blank representing sampling equipment used in the residential septic system areas (EB-2) will be analyzed for PAHs, arsenic, lead, and mercury. One equipment blank representing sampling equipment used in the non-residential septic system areas (EB-3) will be analyzed for PAHs, arsenic, lead, mercury, and VOCs.

The sample containers used to collect the equipment blanks will be obtained from the laboratory, preserved as appropriate to the analysis, prior to the sampling event. The equipment blanks will be preserved, packaged, and sealed in the manner described for the environmental samples. A separate sample number will be assigned to each sample and it will be submitted blind to the laboratory.

10.1.1.2 Field Blanks

No field blanks will be collected.

10.1.1.3 Trip Blanks

Trip blanks will be prepared to evaluate if the shipping and handling procedures are introducing contaminants into the samples, and if cross contamination in the form of VOC migration has occurred between the collected samples. A minimum of one trip blank will be submitted to the laboratory for analysis with every shipment of samples for VOC analysis. Therefore, they are

only applicable when collecting samples from the non-residential septic system excavations. Trip blanks are 40-mL vials that have been filled with High Performance Liquid Chromatography (HPLC)-grade water that has been purged so it is VOC free and shipped with the empty sampling containers to the site or sampling area prior to sampling. The sealed trip blanks are not opened in the field and are shipped to the laboratory in the same cooler with the samples collected for volatile analyses. The trip blanks will be preserved, packaged, and sealed in the manner described for the environmental samples. A separate sample number and station number will be assigned to each trip sample and it will be submitted blind to the laboratory.

10.1.1.4 Temperature Blanks

For each cooler that is transported to the laboratory, a sealed container or vial will be included that is marked "temperature blank." This blank will be used by the sample custodian to check the temperature of samples upon receipt.

10.1.2 Assessment of Field Variability (Field Duplicate or Co-located Samples)

Field duplicates will be collected at a frequency of one duplicate per 10 samples per sample matrix. The results for the field duplicate analyses will be compared to the results for the primary sample.

10.2 BACKGROUND SAMPLES

Background samples will not be collected.

10.3 FIELD SCREENING, INCLUDING CONFIRMATION SAMPLES, AND SPLIT SAMPLES

10.3.1 Field Screening Samples

Not applicable.

10.3.2 Confirmation Samples (Field Screening)

Not applicable.

10.3.3 Split Samples

Not applicable.

10.4 LABORATORY QUALITY CONTROL SAMPLES

Soil samples for laboratory QC purposes (MS/MSD) will be obtained by collecting double the number of equivalent sample containers in the same way as described for the primary soil sample. Soil samples for VOC analyses for laboratory QC purposes will be obtained by collecting triple the number of equivalent subsamples from a colocated location and placed into

VOA vials in the same way as the original samples, assigned unique sample numbers, and sent blind to the laboratory.

The selected QA/QC samples will be samples expected to contain moderate levels of contamination, if present. The MS/MSD samples will be labeled the same identification number as the primary sample and will also be identified as the MS/MSD sample. QC sample descriptions and names are shown on Table 5 in Attachment 2.

At a minimum, one laboratory QC sample is required per 14 days or one per 20 samples (including blanks and duplicates), whichever is greater. If the sample event lasts longer than 14 days or involves collection of more than 20 samples per matrix, additional QC samples will be designated.

11.0 FIELD VARIANCES

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

12.0 FIELD HEALTH AND SAFETY PROCEDURES

Health and safety procedures are described in the Site-Specific Health and Safety Plan provided in Appendix B of the Work Plan.

13.0 REFERENCES

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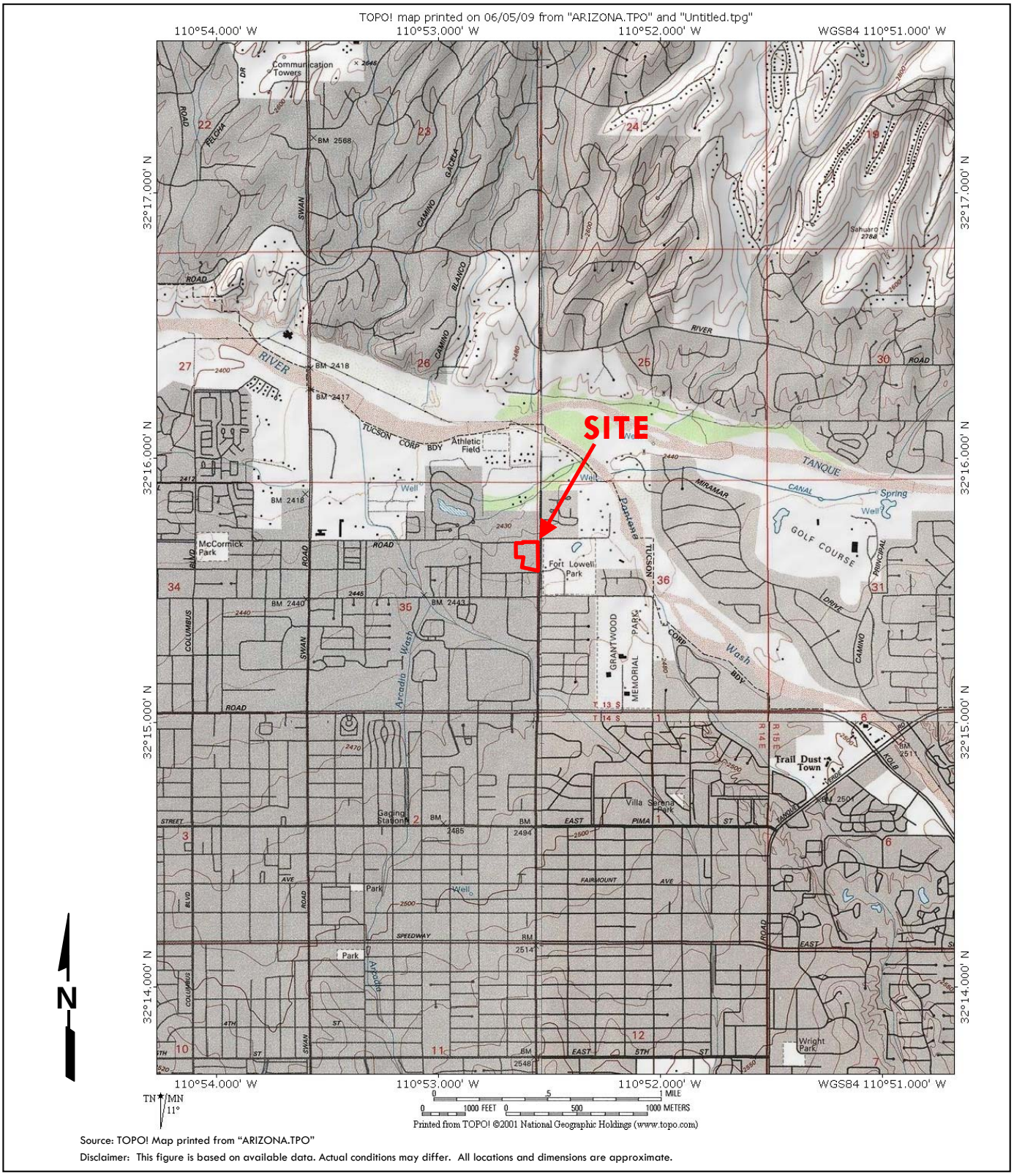
Thiel, J. Homer, M. L. Brack, and Tyler S. Theriot. 2008. *Cultural Resources Assessment for the Fort Lowell-Adkins Steel Property within Historic Fort Lowell, Tucson, Pima County, Arizona.* Technical Report No. 2008-08, Desert Archaeology, Inc.

ATTACHMENTS

ATTACHMENT 1

FIGURES



Source: TOPO! Map printed from "ARIZONA.TPO"

Disclaimer: This figure is based on available data. Actual conditions may differ. All locations and dimensions are approximate.

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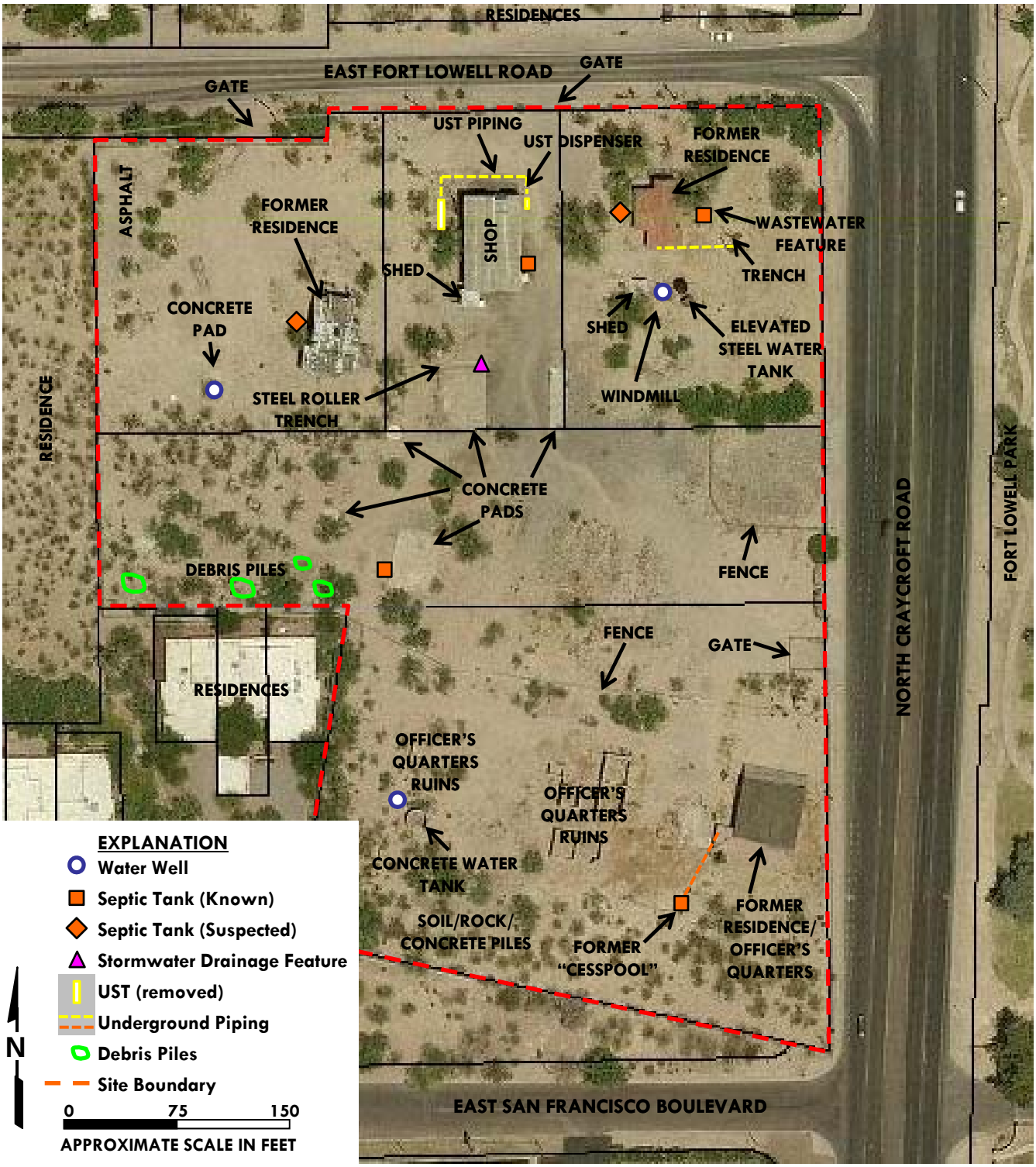
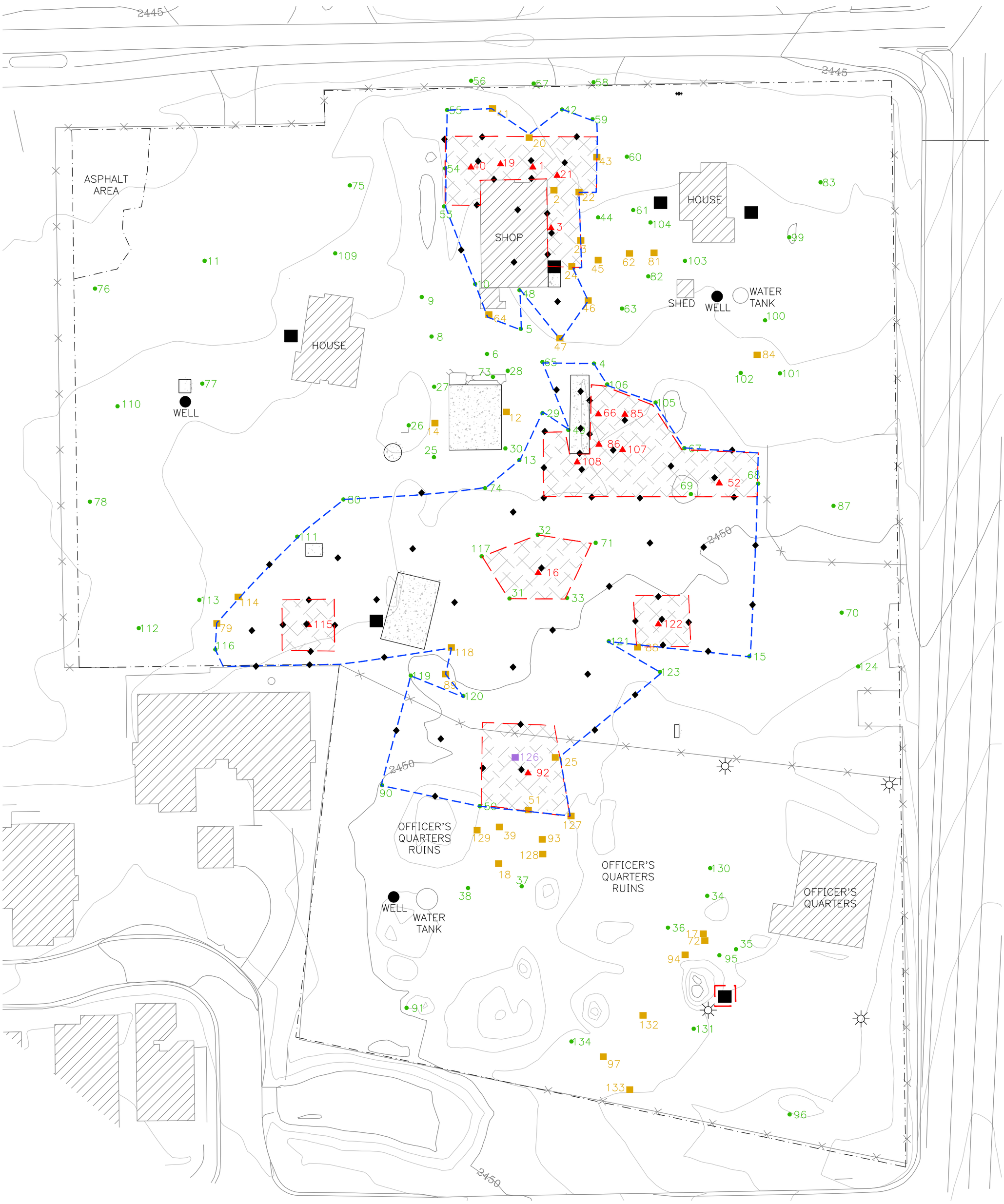
Sampling and Analysis Plan
Old Fort Lowell Restoration Project
5460 East Fort Lowell Road
Tucson, Arizona

Figure 1
Site Location Map



Source: PCDOT MapGuide Website, 2008 Aerial
Disclaimer: This figure is based on available data. Actual conditions may differ. All locations and dimensions are approximate.



EXPLANATION

- Estimated Minimum Area of Excavation
- Estimated Maximum Area of Excavation
- ▲ 86 Exceeds Non–Residential Soil Remediation Level (NRSRL)
- ■ 126 Exceeds Residential Soil Remediation Level (RSRL;10^{-5} Risk)
- ■ 41 Exceeds RSRL (10^{-6} Risk)
- • 13 Less Than RSRLs and NRSRLs
- ◆ Estimated Verification Sample Location
- ■ Estimated Septic Tank Location

BASE MAP PROVIDED BY POSTER FROST ASSOCIATES, INC.

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Sampling and Analysis Plan
Old Fort Lowell Restoration Project
5460 East Fort Lowell Road
Tucson, Arizona

Figure 3
Planned Excavation Areas and Sample Locations

ATTACHMENT 2

TABLES

TABLE 1. SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL RESULTS

SAMPLE ID	SAMPLE DATE	SAMPLE DEPTH	HC (418.1)	HYDROCARBONS (8015AZ)				PAH (8310)												METALS (6010B/7471A)									TCLP		VOCs (8260)	VOCs (8240)	SVOCs (8270)	PCBs (8082)
				C_6-C_{10} GRO	C_{10}-C_{22} DRO	C_{22}-C_{32} ORO	C_{10}-C_{32} SRL	Anthr	B[a]a	B[a]p	B[b]f	B[g,h,i]p	B[k]f	Chry	Flt	I[1,2,3-cd]p	N	Ph	Py	As	Ba	Cd	Cr[1]	Cr[2]	Pb	Se	Ag	Hg	As	Pb				
AS1-0.5	12/6/90	0.5	1,600	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	+++	na	na
AS2-0.5	12/6/90	0.5	2,460	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AS3-0.5	12/6/90	0.5	29,600	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	+++	na	na
AS4-0.5	12/6/90	0.5	2,630	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	+++	na	na
AS5-0.5	12/6/90	0.5	6,630	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AS6-0.5	12/6/90	0.5	13,000	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AS7-0.5	12/6/90	0.5	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	150	na	na	na	na	na	na	na	na	na
AS8-0.5	12/6/90	0.5	38,500	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AS9-0.5	12/6/90	0.5	168	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	+++	na	na
AS10-0.5	12/6/90	0.5	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	155	131	7	69	na	610	1.0	<1	0.410	na	na	na	na	na	na
AS11-7	12/6/90	7	78,900	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AS12-0.5	12/6/90	0.5	42,200	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-1-S*	11/13/07	S	na	<20	48	300	348	<0.80	1.5	1.4	1.4	1.0	<0.80	1.6	3.1	1.2	<1.0	<1.6	3.1	25	140	8.8	160	<0.50	870	<5.0	<5.0	0.11	na	na	ND	na	na	na
AD-1A-S	9/23/08	S	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	<1.0	<1.0	na	na	na	na
AD-1B-S+	9/23/08	~0.5 ft	na	na	na	na	na	<0.40	<0.40	0.95	0.45	2.0	<0.40	<0.60	1.6	1.5	<1.0	<4.0	2.0	8.4	120	3.3	18	na	530	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-1-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	150	<1.0	8.8	na	<5.0	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-2-S*	11/13/07	S	na	20	67	280	347	<0.40	<0.40	0.23	<0.40	<0.40	<0.40	<0.40	<0.40	0.38	<2.0	<0.80	<0.40	6.3	160	3.1	22	na	180	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-3-S*	11/13/07	S	na	<20	<30	<100	<130	<0.80	<0.80	0.64	<0.80	<0.80	<0.80	<0.80	1.3	0.84	<1.0	<1.6	<0.80	34	320	11	170	<0.50	470	<5.0	<5.0	0.75	na	na	ND	na	na	na
AD-3-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	270	<1.0	10	na	<5.0	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-4-S*	11/13/07	S	na	<20	33	<100	<130	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.40	<0.40	<0.20	<1.0	<0.80	<0.40	7.2	180	1.1	22	na	300	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-5-S*	11/13/07	S	na	<20	<30	<100	<130	<0.80	<0.80	<0.20	<0.80	<0.80	<0.80	<0.80	<0.80	<0.40	<2.0	<1.6	<0.80	8.5	280	2.8	67	<0.50	380	<5.0	<5.0	0.30	na	na	ND	na	na	na
AD-6A-S	11/14/07	S	na	<20	93	380	473	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	0.025	<0.10	<0.080	<0.040	6.0	120	<1.0	23	na	140	<5.0	<5.0	0.65	na	na	na	na	na	na
AD-8-S*	11/13/07	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	0.022	<0.10	<0.080	<0.040	5.2	150	<1.0	8.0	na	63	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-9-S*	11/13/07	S	na	<1,000	1,800	17,000	18,800	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.50	<0.40	<0.20	<5.0	110	<1.0	5.9	na	12	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-10-S*	11/13/07	S	na	27	100	590	690	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.40	<0.40	0.22	<1.0	<0.80	<0.40	<5.0	120	15	28	na	230	<5.0	<5.0	0.21	na	na	ND	na	na	na
AD-11-S*	11/13/07	S	na	23	37	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	5.0	130	<1.0	6.6	na	10	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-12-S*	11/13/07	S	na	<20	630	7,200	8,300	<0.40	<0.40	0.12	<0.40	<0.40	<0.40	<0.40	<0.40	<0.20	<1.0	<0.80	<0.40	5.8	180	<1.0	56	<0.50	160	<5.0	<5.0	0.31	na	na	ND	na	na	na
AD-12-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	180	<1.0	11	na	5.6	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-13-S	11/14/07	S	na	<1,000	7,400	41,000	48,400	<0.080	<0.080	<0.020	<0.080	<0.080	<0.080	<0.080	<0.080	<0.040	<0.20	<0.16	<0.080	<5.0	31	1.5	<5.0	na	20	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-13A-S	9/23/08	S	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	ND
AD-14-S	11/14/07	S	na	<20	39	300	339	<0.040	0.085	0.12	0.11	0.12	0.056	0.096	0.086	0.14	<0.10	0.11	0.10	<5.0	110	1.2	14	na	160	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-14-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	150	<1.0	9.6	na	<5.0	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-15-S	11/14/07	S	na	<400	1,100	19,000	20,100	<0.80	<0.80	<0.20	<0.80	<0.80	<0.80	<0.80	<0.80	0.54	<2.0	<1.6	<0.80	<5.0	110	<1.0	5.7	na	37	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-16-S	11/14/07	S	na	<20	30	140	170	<0.040	<0.040	0.037	<0.040	<0.040	<0.040	<0.040	<0.040	0.050	<0.10	<0.080	0.049	40	91	3.1	17	na	310	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-16-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	250	<1.0	8.6	na	<5.0	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-17-S*	11/14/07	S	na	<1,000	2,700	28,000	30,700	<0.80	<0.80	0.28	0.86	<0.80	<0.80	<0.80	<0.80	<0.40	<2.0	<1.6	<0.80	<5.0	140	<1.0	6.9	na	170	<5.0	<5.0	0.084	na	na	ND	na	na	na
AD-17-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	190	<1.0	7.3	na	6.1	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-18-S*	11/14/07	S	na	<100	<150	<500	<650	<0.40	<0.40	0.32	<0.40	<0.40	<0.40	<0.40	0.56	0.37	<1.0	<0.80	0.57	<5.0	190	1.6	9.6	na	130	<5.0	<5.0	0.092	na	na	ND	na	na	na
AD-18-1	7/7/08	1 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	5.7	330	<1.0	8.3	na	6.5	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-19-S	4/10/08	S	na	20	250	3,000	3,250	<0.80	1.6	4.8	3.4	6.8	1.2	2.2	12	6.1	2.3	7.6	12	15	410	6.2	35	<0.50	410	<5.0	<5.0	0.20	na	na	ND	na	na	na
AD-19A-S+	9/23/08	~0.5 ft	na	na	na	na	na	<0.040	<0.040	0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	7.7	160	3.0	11	na	340	<5.0	32	0.19	na	na	na	na	na	na
AD-19-1.5	7/7/08	1.5 ft	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	170	<1.0	7.7	na	5.8	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-20-S	4/10/08	S	na	<20	<30	<130	<130	<0.20	<0.20	0.17	<0.20	<0.20	<0.20	<0.20	0.39	0.18	<.050	<0.40	0.34	6.8	120	<1.0	13	na	100	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-21-S	4/10/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.14	<0.40	<0.40	<0.40	<0.40	<0.40	<0.20	<1.0	<0.80	<0.40	5.2	280	1.3	25	na	860	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-22-S	4/10/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.19	<0.40	<0.40	<0.40	<04.0	<0.40	<0.20	<1.0	<0.80	<0.40	9.5	140	2.6	43	<0.50	320	<5.0	<5.0	0.59	na	na	ND	na	na	na
AD-23-S	4/10/08	S	na	<20	<30	<100	<130	<0.40	0.44	0.40	<0.40	0.40	<0.40	<0.40	1.1	0.36	<1.0	<0.80	0.87	<5.0	130	1.6	13	na	70	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-24-S	4/10/08	S	na	<20	<30	<100	<130	<0.40	0.54	0.56	0.52	0.54	<0.40	0.42	1.3	0.56	<1.0	<0.80	0.97	7.0	170	1.9	22	na	190	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-25-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.041	0.040	0.053	<0.040	<0.060	0.070	0.050	<0.10	<0.40	<0.10	<5.0	110	<1.0	8.3	na	47	<5.0	<5.0	0.085	na	na	ND	na	na	na
AD-26-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	<5.0	120	<1.0	6.4	na	56	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-27-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	140	<1.0	7.1	na	26	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-28-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.011	<0.040	<0.040	<0.040	<0.060	<0.040	0.021	<0.10	<0.40	<0.10	<5.0	160	<1.0	10	na	42	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-29-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.012	<0.040	<0.040	<0.040	<0.060	<0.040	0.030	<0.10	<0.10	<0.10	5.3	200	<1.0	12	na	95	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-30-S	4/10/08	S	na	21	1,600	8,900	10,500	<0.80	<0.80	<0.20	<0.80	<0.80	<0.80	<0.80	<0.80	<0.40	<2.0	<1.6	<0.80	5.2	100	1.1	39	<0.50	230	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-31-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.01	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	<5.0	140	<1.0	7.4	na	10	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-32-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	<5.0	160	<1.0	8.1	na	10	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-33-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	<5.0	130	<1.0	6.4	na	17	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-34-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	7.8	190	<1.0	6.9	na	9.5	<5.0	<5.0	<0.083	na	na	ND	na	na	na
AD-35-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.10	<0.080	<0.040	<5.0	120	<1.0	5.3	na	56	<5.0	<5.0	0.21	na	na	ND	na	na	na
AD-36-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.022	<0.040	<0.040	<0.040	<0.040	<0.040	0.030	<0.10	<0.080	0.051	7.0	200	<1.0	6.5	na	60	<5.0	<5.0	0.086	na	na	ND	na	na	na
AD-37-S	4/10/08	S	na	<20	<30	<100	<130	<0.040	0.056	0.067	0.058	0.059	<0.040	0.048	<0.040	0.063	<0.10	<0.080	0.073	<5.0	170	<1.0	7.1	na	59	<5.0	<5.0	0.11	na	na	ND	na	na	na
AD-38-S	4/10/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.50	<0.40	<0.20	<5.0	160	<1.0	7.5	na	65	<5.0	<5.0	0.13	na	na	ND	na	na	na
AD-39-S	4/10/08	S	na	<20	<30	<100	<130	<0.20	<0.20	0.080	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.50	<0.40	<0.20	5.1	220	<1.0	7.6	na	49	<5.0	<5.0	<0.083	na	na	ND	na	na	na

TABLE 1. SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL RESULTS

SAMPLE ID	SAMPLE DATE	SAMPLE DEPTH	HC (418.1)	HYDROCARBONS (8015AZ)				PAH (8310)												METALS (6010B/7471A)									TCLP		VOCs (8260)	VOCs (8240)	SVOCs (8270)	PCBs (8082)
				C_6-C_{10} GRO	C_{10}-C_{22} DRO	C_{22}-C_{32} ORO	C_{10}-C_{32} SRL	Anthr	B[a]a	B[a]p	B[b]f	B[g,h,i]p	B[k]f	Chry	Flt	I[1,2,3-cd]p	N	Ph	Py	As	Ba	Cd	Cr^1	Cr^2	Pb	Se	Ag	Hg	As	Pb				
AD-40-S	7/7/08	S	na	<20	<30	<100	<130	<0.80	<0.80	0.58	<0.80	<0.80	<0.80	<1.2	1.6	0.66	<2.0	<8.0	<2.0	21	140	3.9	24	na	210	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-41-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	84	1.1	16	na	150	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-42-S	7/7/08	S	na	<20	37	500	537	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	0.029	<0.10	<0.40	<0.10	5.3	120	<1.0	8.8	na	250	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-43-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.23	<0.40	<0.40	<0.40	<0.60	<0.40	0.21	<1.0	<4.0	<1.0	<5.0	50	<1.0	7.5	na	47	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-44-S	7/7/08	S	na	<20	<30	140	140	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	150	1.3	16	na	260	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-45-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.19	<0.40	<0.40	<0.40	<0.60	<0.40	0.24	<1.0	<4.0	<1.0	<5.0	1,300	1.9	16	na	160	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-46-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.27	<0.40	<0.40	<0.40	<0.60	0.58	0.34	<1.0	<4.0	<1.0	6.0	210	1.8	26	na	330	<5.0	<5.0	0.12	na	na	na	na	na	na
AD-47-S	7/7/08	S	na	<20	<30	150	150	<0.40	<0.40	0.21	<0..40	0.44	<0.40	<0.60	<0.40	0.45	<1.0	<4.0	<1.0	5.7	150	1.5	11	na	150	<5.0	<5.0	0.16	na	na	na	na	na	na
AD-48-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	<0.10	<0.40	0.49	<0.40	<0.60	<0.40	0.32	<1.0	<4.0	<1.0	8.3	140	2.5	140	<0.50	300	6.0	<5.0	0.12	na	na	ND	na	na	na
AD-49-S	7/7/08	S	na	<20	<30	<100	<130	<0.080	<0.080	0.022	<0.080	<0.080	<0.080	<0.12	<0.080	<0.040	<0.20	<0.80	<0.20	7.8	86	<1.0	22	na	28	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-50-S	7/7/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.045	0.040	0.046	<0.040	<0.060	0.064	0.045	<0.10	<0.40	<0.10	<5.0	120	<1.0	6.5	na	23	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-51-S	7/7/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.17	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	170	<1.0	7.7	na	81	<5.0	<5.0	0.10	na	na	na	na	na	na
AD-52-S	7/7/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	98	120	2.3	32	<0.50	310	<5.0	<5.0	0.11	na	na	ND	na	na	na
AD-52A-S	9/23/08	S	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	<1.0	<1.0	na	na	na	na
AD-53-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	5.1	110	<1.0	6.2	na	10	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-54-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	86	<1.0	6.5	na	33	<5.0	<5.0	<0.083	na	na	na	na	ND	na
AD-55-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	0.024	<0.040	<0.040	<0.040	<0.060	<0.040	0.027	<0.10	<0.40	<0.10	<5.0	60	<1.0	<5.0	na	44	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-56-S	8/14/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	110	<1.0	9.9	na	110	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-57-S	8/14/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	5.0	140	<1.0	9.0	na	58	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-58-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	130	<1.0	8.3	na	<5.0	<5.0	<5.0	<0.083	na	na	na	na	ND	na
AD-59-S	8/14/08	S	na	<20	<30	140	140	<0.040	<0.040	0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	140	<1.0	7.7	na	38	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-60-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	120	<1.0	6.2	na	55	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-61-S	8/14/08	S	na	<20	<30	<100	<130	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	130	<1.0	12	na	120	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-62-S	8/14/08	S	na	<20	<30	<100	<130	<0.20	<0.20	0.19	0.22	<0.20	<0.20	<0.30	0.43	0.15	<0.50	<2.0	<0.50	<5.0	120	<1.0	7.3	na	130	<5.0	<5.0	0.19	na	na	na	na	na	na
AD-63-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	5.5	130	<1.0	7.1	na	15	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-64-S	8/14/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.19	<0.40	<0.40	<0.40	<0.60	<0.40	0.20	<1.0	<4.0	<1.0	6.0	160	<1.0	35	<0.50	150	<5.0	<5.0	0.18	na	na	na	na	na	na
AD-65-S	8/14/08	S	na	<20	<30	<100	<130	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	6.6	130	<1.0	17	na	58	<5.0	<5.0	<0.083	na	na	na	na	ND	na
AD-66-S	8/14/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.11	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	34	140	<1.0	47	<0.50	160	<5.0	<5.0	0.42	na	na	na	na	na	na
AD-67-S	8/14/08	S	na	<20	<30	<100	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	150	<1.0	6.1	na	8.5	<5.0	<5.0	<0.083	na	na	na	na	ND	na
AD-68-S	8/14/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	5.8	140	<1.0	10	na	40	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-69-S	8/14/08	S	na	<20	100	1,000	1,100	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	96	<1.0	14	na	89	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-70-S	8/14/08	S	na	<200	1,400	26,000	27,400	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	5.2	150	<1.0	6.5	na	58	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-71-S	8/14/08	S	na	<20	<30	<100	<130	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	5.9	110	<1.0	11	na	48	<5.0	<5.0	<0.083	na	na	na	na	ND	na
AD-72-S	8/14/08	S	na	<20	<30	<100	<130	<0.40	<0.40	0.18	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	7.8	210	<1.0	7.4	na	130	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-73-S**	8/14/08	S	na	<20	85	620	705	<0.080	<0.080	<0.020	<0.080	<0.080	<0.080	<0.12	<0.080	0.046	<0.20	<0.80	<0.20	<5.0	160	<1.0	33	<0.50	63	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-74-S	8/14/08	S	na	<20	<30	130	<130	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	0.25	<1.0	<4.0	<1.0	9.8	120	7.0	47	<0.50	77	<5.0	<5.0	0.10	na	na	na	na	ND	na
AD-75-S	9/23/08	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	92	<1.0	6.6	na	71	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-76-S	9/23/08	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	5.8	110	<1.0	6.5	na	30	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-77-S	9/23/08	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	110	<1.0	5.9	na	25	<5.0	<5.0	0.56	na	na	ND	na	ND	na
AD-78-S	9/23/08	S	na	na	na	na	na	<0.040	<0.040	0.029	<0.040	0.047	<0.040	<0.060	<0.040	0.050	<0.10	<0.40	<0.10	<5.0	130	1.5	6.5	na	42	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-79-S	9/23/08	S	na	na	na	na	na	<0.20	0.24	0.22	<0.20	<0.20	<0.20	<0.30	0.23	0.18	<0.50	<2.0	<0.50	<5.0	190	1.5	23	na	170	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-80-S	9/23/08	S	na	na	na	na	na	<0.040	<0.040	0.020	<0.040	<0.040	<0.040	<0.060	0.062	0.031	<0.10	<0.40	<0.10	<5.0	110	<1.0	5.3	na	14	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-81-S	9/23/08	S	na	na	na	na	na	<0.20	<0.20	0.090	<0.20	<0.20	<0.20	<0.30	<0.20	0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-82-S	9/23/08	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-83-S	9/23/08	S	na	na	na	na	na	<0.040	<0.040	0.011	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	91	<1.0	6.6	na	51	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-84-S	9/23/08	S	na	na	na	na	na	<0.040	0.078	0.087	0.091	0.085	0.050	0.074	0.12	0.11	<0.10	<0.40	0.18	<5.0	120	<1.0	7.7	na	28	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-85-S	9/23/08	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	11	170	1.0	13	na	66	<5.0	<5.0	0.092	na	na	na	na	na	na
AD-86-S	9/23/08	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	22	200	1.3	21	na	290	<5.0	<5.0	0.24	na	na	na	na	na	na
AD-87-S	9/23/08	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	110	<1.0	9.4	na	85	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-88-S	9/23/08	S	na	na	na	na	na	<0.40	<0.40	0.38	<0.40	0.44	<0.40	<0.60	0.45	0.55	<1.0	<4.0	<1.0	<5.0	110	<1.0	7.6	na	50	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-89-S	9/24/08	S	na	na	na	na	na	<0.20	<0.20	0.070	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	86	<1.0	7.6	na	46	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-90-S	9/24/08	S	na	na	na	na	na	<0.040	<0.040	0.033	<0.040	<0.040	<0.040	<0.060	0.044	0.038	<0.10	<0.40	<0.10	<5.0	170	<1.0	6.4	na	24	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-91-S	9/24/08	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	50	<1.0	5.9	na	12	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-92-S	9/24/08	S	na	na	na	na	na	<0.80	2.0	2.4	2.0	2.1	1.3	2.6	4.6	2.7	<2.0	<8.0	6.5	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-93-S	9/24/08	S	na	na	na	na	na	<0.40	<0.40	0.37	<0.40	<0.40	<0.40	<0.60	<0.40	0.38	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-94-S	9/24/08	S	na	na	na	na	na	<0.20	<0.20	0.10	<0.20	<0.20	<0.20	<0.30	<0.20	0.13	<0.50	<2.0	<0.50	<5.0	130	<1.0	7.1	na	120	<5.0	<5.0	0.12	na	na	na	na	na	na
AD-95-S	9/24/08	S	na	na	na	na	na	<0.040	<0.040	0.034	<0.040	<0.040	<0.040	<0.060	0.051	0.044	<0.10	<0.40	<0.10	<5.0	180	<1.0	7.5	na	38	<5.0	<5.0	0.17	na	na	na	na	na	na
AD-96-S	9/24/08	S	na	na	na	na	na	<0.040	<0.040	0.030	<0.040	<0.040	<0.040	<0.060	<0.040	0.040	<0.10	<0.40	<0.10	<5.0	170	<1.0	7.8	na	59	<5.0	<5.0	1.6	na	na	ND	na	ND	na
AD-97-S	9/24/08	S	na	na	na	na	na	<0.20	<0.20	0.10	<0.20	<0.20	<0.20	<0.30	<0.20	0.12	<0.50	<2.0	<0.50	5.1	210	<1.0	6.0	na	17	<5.0	<5.0	0.087	na	na	ND	na	ND	na
AD-98-1++	9/24/08	1 ft	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	150	<1.0	17	na	53	<5.0	<5.0	<0.083	na	na	ND	na	ND	na
AD-98-1.5++	9/24/08	1.5 ft	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	0.022	<0.10	<0.40	<0.10	5.9	150	1.5	15	na	56	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-99-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	68	<1.0	5.4	na	43	<5.0	<5.0	<0.083	na	na	na	na	na	na

TABLE 1. SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL RESULTS

SAMPLE ID	SAMPLE DATE	SAMPLE DEPTH	HC (418.1)	HYDROCARBONS (8015AZ)				PAH (8310)												METALS (6010B/7471A)									TCLP		VOCs (8260)	VOCs (8240)	SVOCs (8270)	PCBs (8082)
				C_6-C_{10} GRO	C_{10}-C_{22} DRO	C_{22}-C_{32} ORO	C_{10}-C_{32} SRL	Anthr	B[a]a	B[a]p	B[b]f	B[g,h,i]p	B[k]f	Chry	Flt	I[1,2,3-cd]p	N	Ph	Py	As	Ba	Cd	Cr^1	Cr^2	Pb	Se	Ag	Hg	As	Pb				
AD-100-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-101-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-102-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-103-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-104-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-105-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	**110**	<1.0	**5.8**	na	**16**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-106-S	4/3/09	S	na	na	na	na	na	<0.80	<0.80	<0.20	<0.80	<0.80	<0.80	<1.2	<0.80	<0.40	<2.0	<8.0	<2.0	<5.0	**110**	<1.0	**12**	na	**72**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-107-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	**20**	**140**	<1.0	**22**	na	**180**	<5.0	<5.0	**0.14**	na	na	na	na	na	na
AD-108-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	**28**	**53**	<1.0	**13**	na	**100**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-109-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	**130**	<1.0	**6.2**	na	**28**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-110-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	**88**	<1.0	**5.0**	na	**17**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-111-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	**120**	<1.0	**5.1**	na	**37**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-112-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	**5.1**	**110**	<1.0	**9.7**	na	**22**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-113-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	**0.014**	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-114-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	**0.12**	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-115-S	4/3/09	S	na	na	na	na	na	**0.42**	**1.9**	**2.0**	**0.95**	**1.9**	**0.76**	**1.5**	**3.7**	**1.6**	<1.0	<4.0	**3.9**	**14**	**250**	**7.4**	**25**	na	**400**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-116-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-117-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	**110**	<1.0	**8.4**	na	**57**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-118-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	**0.080**	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-119-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-120-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	<5.0	**120**	<1.0	**6.0**	na	**29**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-121-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-122-S	4/3/09	S	na	na	na	na	na	**1.0**	**9.6**	**10**	**4.9**	**8.5**	**3.9**	**8.4**	**20**	**7.8**	<2.0	**19**	**18**	<5.0	**76**	<1.0	**8.5**	na	**66**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-123-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-124-S	4/3/09	S	na	na	na	na	na	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	**6.5**	**170**	<1.0	**5.2**	na	**9.1**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-125-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	**0.21**	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	**5.5**	**180**	<1.0	**25**	na	**160**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-126-S	4/3/09	S	na	na	na	na	na	<0.80	**0.88**	**1.0**	<0.80	<0.80	<0.80	**1.2**	**2.8**	**0.90**	<2.0	<8.0	**2.5**	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-127-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	**0.16**	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-128-S	4/3/09	S	na	na	na	na	na	<0.80	<0.80	**0.32**	<0.80	<0.80	<0.80	<1.2	<0.80	<0.40	<2.0	<8.0	<2.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-129-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	**0.085**	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-130-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	<0.10	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	<5.0	**160**	<1.0	**6.0**	na	**50**	<5.0	<5.0	<0.083	na	na	na	na	na	na
AD-131-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	<0.050	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-132-S	4/3/09	S	na	na	na	na	na	<0.40	<0.40	**0.15**	<0.40	<0.40	<0.40	<0.60	<0.40	<0.20	<1.0	<4.0	<1.0	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-133-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	**0.075**	<0.20	<0.20	<0.20	<0.30	**0.22**	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
AD-134-S	4/3/09	S	na	na	na	na	na	<0.20	<0.20	**0.060**	<0.20	<0.20	<0.20	<0.30	<0.20	<0.10	<0.50	<2.0	<0.50	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
B7-10	8/19/08	10 ft	na	<20	<30	<130	<130	<0.040	<0.040	<0.010	<0.040	<0.040	<0.040	<0.060	<0.040	<0.020	<0.10	<0.40	<0.10	<5.0	**40**	<1.0	<5.0	na	<5.0	<5.0	<5.0	**0.13**	na	na	ND	na	+++	na
B9-5	8/19/08	5 ft	na	<20	<30	<130	<130	<0.040	<0.040	**0.014**	<0.040	<0.040	<0.040	<0.060	<0.040	**0.023**	<0.10	<0.40	<0.10	<5.0	**150**	<1.0	**6.2**	na	**13**	<5.0	<5.0	**0.16**	na	na	ND	na	+++	na
B9-10	8/19/08	10 ft	na	<200	<300	**1,100**	<1,300	<1.6	<1.6	**0.80**	<1.6	**7.0**	<1.6	<2.4	<1.6	**3.8**	<4.0	<16	<4.0	**10**	**340**	**1.1**	**15**	na	**280**	<5.0	<5.0	**17**	na	na	ND	na	ND	na
RSRL (10^{-6} Risk)			none	none	none	none	none	none	**0.69**	**0.069**	**0.69**	none	**6.9**	**68**	none	**0.69**	none	none	none	**10**	none	none	none	**30**	none	none	none	none						
RSRL (10^{-5} Risk)			none	none	none	none	none	none	**6.9**	**0.69**	**6.9**	none	**69**	**680**	none	**6.9**	none	none	none	**10**	none	none	none	none	none	none	none	none						
RSRL (Non-carcinogen)			none	none	none	none	none	**22,000**	none	none	none	none	none	none	**2,300**	none	**56**	none	**2,300**	**10**	**15,000**	**39**	none	none	**400**	**390**	**390**	**23**						
NRSRL			none	none	none	none	none	**240,000**	**21**	**2.1**	**21**	none	**210**	**2,000**	**22,000**	**21**	**190**	none	**29,000**	**10**	**170,000**	**510**	none	**65**	**800**	**5,100**	**5,100**	**310**						
Minimum GPL			none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	**290**	**12,000**	**29.0**	**590**	none	**290**	**290**	none	**12**						
Alternative GPL			none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	**73**	none	none	none	none	**4,540**	none	none	**TBD**						
EPA TCLP Threshold Level																													**5.0**	**5.0**				

Notes:

Only compounds with detected concentrations are shown
All sample results are in mg/kg, except TCLP samples, which are in mg/L
na = Not analyzed
ND = Not Detected
GPL = Arizona Groundwater Protection Level (1996)
RSRL = Arizona Residential Soil Remediation Level
NRSRL = Arizona Non-Residential Soil Remediation Level
EPA TCLP = Environmental Protection Agency Toxicity Characteristic Leaching Procedure
none = There is no Arizona SRL for this compound
HC = Hydrocarbon
C_{10}-C_{22} DRO = Diesel fuel petroleum hydrocarbons
C_{22}-C_{32} DRO = Oil petroleum hydrocarbons
C_{10}-C_{32} SRL = Former Arizona Soil Remediation Level for petroleum hydrocarbons

PAH = Polynuclear Aromatic Hydrocarbons
Anthr = Anthracene
B[a]a = Benz[a]anthracene
B[a]p = Benzo[a]pyrene
B[b]f = Benzo[b]fluoranthene
B[g,h,i]p = Benzo[g,h,i]perylene
B[k]f = Benzo[k]fluoranthene
Chry = Chrysene
Fl t= Fluoranthene
I[1,2,3-cd]p = Indeno[1,2,3-cd]pyrene
N = Naphthalene
Ph = Phenanthrene
Py = Pyrene

As = Arsenic
Ba = Barium
Cd = Cadmium
Cr^1 = Total Chromium
Cr^2 = Chromium VI
Pb = Lead
Hg = Mercury
VOCs = Volatile organic compounds (8260)
SVOCs = Semi-volatile organic compounds (8270)
PCBs = Polychlorinated biphenyls

TBD = To Be Determined

Highlighted sample results exceed the RSRL or NRSRL
Highlighted samples that are non-detect indicate that the laboratory reporting limit exceeded the SRL
* Because the laboratory exceeded the hold time for VOCs, these samples were re-collected on 11/20/07 and 11/29/07 for this analysis
\+ Sample collected from just below visibly impacted soil
** Sample collected from soil in the bottom of the concrete trench for former steel rolling equipment
++ Samples collected from drywell in base of concrete trench for former steel rolling equipment; depths are from base of trench

+++ **Other Sample Results:**
(none exceed SRLs or GPLs)
AS1-0.5: Acetone = 0.140 mg/kg
AS3-0.5: Acetone = 0.190 mg/kg
4-Methyl-2-pentanone = 0.140 mg/kg
Toluene = 0.011 mg/kg
m- & p-Xylenes = 0.011 mg/kg
AS4-0.5: Acetone = 0.120 mg/kg
Toluene = 0.010 mg/kg
AS9-0.5: Acetone = 0.075 mg/kg
B7-10: Phenol = 6.4 mg/kg
B9-5: Phenol = 6.4 mg/kg

Table 2. PAHs - Arizona SRLs, GPLs, and Laboratory Reporting Limits

Analyte	Matrix	Arizona Soil Remediation Levels				Minimum	TestAmerica
		RSRL - 10^{-6}	RSRL - 10^{-5}	RSRL - NC	NRSRL	GPL	RL
Acenaphthene	Soil			3700	29000	none	0.20
Acenaphthylene	Soil					none	0.30
Anthracene	Soil			22000	240000	none	0.020
Benz[a]anthracene	Soil	0.69	6.9		21	none	0.010
Benzo[a]pyrene	Soil	0.069	0.69		2.1	none	0.010
Benzo[b]fluoranthene	Soil	0.69	6.9		21	none	0.020
Benzo[g,h,i]perylene	Soil					none	0.030
Benzo[k]fluoranthene	Soil	6.9	69		210	none	0.010
Chrysene	Soil	68	680		2000	none	0.020
Dibenz[a,h]anthracene	Soil	0.069	0.69		2.1	none	0.010
Fluoranthene	Soil			2300	22000	none	0.030
Fluorene	Soil			2700	26000	none	0.030
Indeno[1,2,3-cd]pyrene	Soil	0.69	6.9		21	none	0.010
Naphthalene	Soil			56	190	none	0.20
Phenanthrene	Soil					none	0.030
Pyrene	Soil			2300	29000	none	0.020

All concentrations are in mg/kg

RSRL: Residential Soil Remediation Level, at $1x10^{-6}$, $1x10^{-5}$, and non-cancerous (NC) risk levels

NRSRL: Non-Residential Soil Remediation Level

GPL: Minimum Groundwater Protection Limit (ADEQ 1996)

RL: TestAmerica laboratory Reporting Limit

TestAmerica Phoenix

11/8/2010

Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
N_8310 (PAHs) in Soil (SW8310)								
Prep Method: N_EPA 3545		**Preservation:** 4 C, Cool						
Container: 4 oz Jar		**Amount Required:**			**Hold Time:** 14 days			
Naphthalene	0.086	0.20 mg/kg		35	24 - 111	35	49 - 105	35
Acenaphthylene	0.094	0.30 mg/kg		35	18 - 140	35	45 - 111	35
Acenaphthene	0.056	0.20 mg/kg		35	24 - 121	35	42 - 118	35
Fluorene	0.0080	0.030 mg/kg		35	21 - 115	35	51 - 111	35
Phenanthrene	0.0050	0.030 mg/kg		35	36 - 154	35	49 - 116	35
Anthracene	0.0050	0.020 mg/kg		35	24 - 124	35	47 - 143	35
Fluoranthene	0.0080	0.030 mg/kg		35	18 - 149	35	54 - 121	35
Pyrene	0.0060	0.020 mg/kg		35	24 - 144	35	52 - 128	35
Benzo(a)anthracene	0.0080	0.010 mg/kg		35	12 - 150	35	57 - 124	35
Chrysene	0.0040	0.020 mg/kg		35	24 - 128	35	57 - 126	35
Benzo(b)fluoranthene	0.013	0.020 mg/kg		35	12 - 138	35	58 - 122	35
Benzo(k)fluoranthene	0.0050	0.010 mg/kg		35	20 - 131	35	52 - 131	35
Benzo(a)pyrene	0.0040	0.010 mg/kg		35	12 - 158	35	52 - 122	35
Dibenz(a,h)anthracene	0.0040	0.010 mg/kg		35	20 - 122	35	38 - 138	35
Benzo(g,h,i)perylene	0.0080	0.030 mg/kg		35	18 - 141	35	57 - 120	35
Indeno(1,2,3-cd)pyrene	0.0060	0.010 mg/kg		35	14 - 122	35	57 - 123	35
surr: 2-Chloroanthracene	0.0		23.5 - 125		23 - 125		61 - 121	

* = *Analyte not a part of normal reporting list. Special request only*

TestAmerica Phoenix

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Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
N_8310 (PAHs) in Water (SW8310)								
Prep Method: N_EPA 3520C		**Preservation:** 4 C, Cool						
Container: 1 L Amber		**Amount Required:**			**Hold Time:** 7 days			
Chrysene	0.013	0.10 ug/l			40 - 135	35	61 - 128	35
Acenaphthene	0.058	1.0 ug/l			44 - 116	35	52 - 122	35
Acenaphthylene	0.69	1.0 ug/l			52 - 113	35	55 - 122	35
Anthracene	0.041	0.050 ug/l			50 - 118	35	68 - 134	35
Benzanthracene	0.030	0.20 ug/l			41 - 129	35	56 - 103	35
Benzo(a)pyrene	0.012	0.050 ug/l			44 - 124	35	57 - 116	35
Benzo(b)fluoranthene	0.021	0.10 ug/l			39 - 135	35	62 - 119	35
Benzo(k)fluoranthene	0.011	0.050 ug/l			40 - 135	35	56 - 117	35
Pyrene	0.038	0.10 ug/l			43 - 129	35	67 - 125	35
Dibenz(a,h)anthracene	0.035	0.10 ug/l			38 - 143	35	44 - 125	35
Fluoranthene	0.031	0.10 ug/l			43 - 129	35	67 - 117	35
Fluorene	0.084	0.10 ug/l			49 - 115	35	56 - 132	35
Indeno(1,2,3-cd)pyrene	0.011	0.10 ug/l			38 - 133	35	52 - 125	35
Naphthalene	0.43	0.50 ug/l			46 - 109	35	41 - 116	35
Phenanthrene	0.036	0.10 ug/l			50 - 126	35	64 - 140	35
Benzo(g,h,i)perylene	0.019	0.10 ug/l			43 - 131	35	54 - 121	35
surr: 2-Chloroanthracene	0.0		48.2 - 124				62 - 126	

** = Analyte not a part of normal reporting list. Special request only*

Table 3. Metals - Arizona SRLs, GPLs, and Laboratory Reporting Limits

Analyte	Matrix	Arizona Soil Remediation Levels				Minimum GPL	Alternative GPL	TestAmerica RL
		RSRL - 10^{-6}	RSRL - 10^{-5}	RSRL - NC	NRSRL			
Arsenic	Soil	10	10	10	10	290	366	5.0
Barium	Soil			15000	170000	12000		5.0
Cadmium	Soil			39	510	29		0.50
Chromium	Soil					590		2.0
Chromium III*	Soil			120000	1000000			
Chromium IV*	Soil	30	NA		65			
Lead	Soil			400	800	290	4540	5.0
Mercury	Soil			23	310	12	TBD	0.10
Mercury (Methyl)*	Soil			6.1	62			
Selenium	Soil			390	5100	290		5.0
Silver	Soil			390	5100			2.5

All concentrations are in mg/kg
RSRL: Residential Soil Remediation Level, at $1x10^{-6}$, $1x10^{-5}$, and non-cancerous (NC) risk levels
NRSRL: Non-Residential Soil Remediation Level
GPL: Minimum Groundwater Protection Limit (ADEQ 1996)
Alternate GPL calculated using TCLP sample results
RL: TestAmerica laboratory Reporting Limit
* Only analyzed if specifically requested
TBD: To be determined

TestAmerica Phoenix

11/8/2010

Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
N_ICP Arsenic (6010B) in Soil (SW6010B)								
Prep Method: N_EPA 3050B ICP		**Preservation:**	4 C, Cool					
Container: 4 oz Jar		**Amount Required:**			**Hold Time:** 180 days			
Arsenic	0.72	5.0 mg/kg			75 - 125	20	80 - 120	20
N_ICP Barium (6010B) in Soil (SW6010B)								
Prep Method: N_EPA 3050B ICP		**Preservation:**	4 C, Cool					
Container: 4 oz Jar		**Amount Required:**			**Hold Time:** 180 days			
Barium	0.020	5.0 mg/kg			75 - 125	20	80 - 120	20
N_ICP Cadmium (6010B) in Soil (SW6010B)								
Prep Method: N_EPA 3050B ICP		**Preservation:**	4 C, Cool					
Container: 4 oz Jar		**Amount Required:**			**Hold Time:** 180 days			
Cadmium	0.040	0.50 mg/kg			75 - 125	20	80 - 120	20
N_ICP Chromium (6010B) in Soil (SW6010B)								
Prep Method: N_EPA 3050B ICP		**Preservation:**	4 C, Cool					
Container: 4 oz Jar		**Amount Required:**			**Hold Time:** 180 days			
Chromium	0.085	2.0 mg/kg			75 - 125	20	80 - 120	20
N_ICP Lead (6010B) in Soil (SW6010B)								
Prep Method: N_EPA 3050B ICP		**Preservation:**	4 C, Cool					
Container: 4 oz Jar		**Amount Required:**			**Hold Time:** 180 days			
Lead	0.30	5.0 mg/kg			75 - 125	20	80 - 120	20
N_ICP Selenium (6010B) in Soil (SW6010B)								
Prep Method: N_EPA 3050B ICP		**Preservation:**	4 C, Cool					
Container: 4 oz Jar		**Amount Required:**			**Hold Time:** 180 days			
Selenium	1.8	5.0 mg/kg			75 - 125	20	80 - 120	20
N_ICP Silver (6010B) in Soil (SW6010B)								
Prep Method: N_EPA 3050B ICP		**Preservation:**	4 C, Cool					
Container: 4 oz Jar		**Amount Required:**			**Hold Time:** 180 days			
Silver	0.19	2.5 mg/kg			75 - 125	20	80 - 120	20
N_Mercury (7471A) in Soil (SW7471A)								
Prep Method: N_EPA 7471A Hg		**Preservation:**	4 C, Cool					
Container: 4 oz Jar		**Amount Required:**			**Hold Time:** 28 days			
Mercury	0.0052	0.10 mg/kg		20	85 - 115	20	85 - 115	20
N_RCRA 8 Metals (6010) Soil in Soil (varies)								
Prep Method:		**Preservation:**	[Group Analysis]					
Container:		**Amount Required:**			**Hold Time:** 7 days			

* = *Analyte not a part of normal reporting list. Special request only*

TestAmerica Phoenix

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Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
N_ICP Arsenic (6010B) in Water (SW6010B)								
Prep Method: N_3005A_W		**Preservation:**	4 C, HNO3					
Container: 500 ml Poly		**Amount Required:**			**Hold Time:** 180 days			
Arsenic	0.014	0.10 mg/l			70 - 130	20	85 - 115	20
N_ICP Barium (6010B) in Water (SW6010B)								
Prep Method: N_3005A_W		**Preservation:**	4 C, HNO3					
Container: 500 ml Poly		**Amount Required:**			**Hold Time:** 180 days			
Barium	0.00040	0.10 mg/l			70 - 130	20	85 - 115	20
N_ICP Cadmium (6010B) in Water (SW6010B)								
Prep Method: N_3005A_W		**Preservation:**	4 C, HNO3					
Container: 500 ml Poly		**Amount Required:**			**Hold Time:** 180 days			
Cadmium	0.00080	0.0010 mg/l			70 - 130	20	85 - 115	20
N_ICP Chromium (6010B) in Water (SW6010B)								
Prep Method: N_3005A_W		**Preservation:**	4 C, HNO3					
Container: 500 ml Poly		**Amount Required:**			**Hold Time:** 180 days			
Chromium	0.0012	0.010 mg/l			70 - 130	20	85 - 115	20
N_ICP Lead (6010B) in Water (SW6010B)								
Prep Method: N_3005A_W		**Preservation:**	4 C, HNO3					
Container: 500 ml Poly		**Amount Required:**			**Hold Time:** 180 days			
Lead	0.0060	0.015 mg/l			70 - 130	20	85 - 115	20
N_ICP Selenium (6010B) in Water (SW6010B)								
Prep Method: N_3005A_W		**Preservation:**	4 C, HNO3					
Container: 500 ml Poly		**Amount Required:**			**Hold Time:** 180 days			
Selenium	0.037	0.10 mg/l			70 - 130	20	85 - 115	20
N_ICP Silver (6010B) in Water (SW6010B)								
Prep Method: N_3005A_W		**Preservation:**	4 C, HNO3					
Container: 500 ml Poly		**Amount Required:**			**Hold Time:** 180 days			
Silver	0.0038	0.010 mg/l			70 - 130	20	85 - 115	20
N_Mercury (7470) in Water (SW7470A)								
Prep Method: N_EPA 245.1/7470A Hg		**Preservation:**	4 C, HNO3					
Container: 500 ml Poly		**Amount Required:**			**Hold Time:** 28 days			
Mercury	0.000089	0.00050 mg/l		20	85 - 115	20	85 - 115	20

** = Analyte not a part of normal reporting list. Special request only*

Table 4. VOCs - Arizona Soil Remediation Levels

Analyte	Matrix	Arizona Soil Remediation Levels				Minimum GPL	Alternative GPL	TestAmerica RL
		RSRL - 10^{-6}	RSRL - 10^{-5}	RSRL - NC	NRSRL			
Acetone	Soil			14000	54000			1.000
Benzene	Soil	0.65	NA		1.4	0.71	1751000 (1)	0.050
Bromobenzene	Soil			28	92			0.250
Bromochloromethane	Soil							0.250
Bromodichloromethane	Soil	0.83	8.3		18			0.100
Bromoform	Soil	69	690		2200			0.250
Bromomethane	Soil			3.9	13			0.250
2-Butanone	Soil							1.000
n-Butylbenzene	Soil			240	240			0.250
sec-Butylbenzene	Soil			220	220			0.250
tert-Butylbenzene	Soil			390	390			0.250
Carbon disulfide	Soil			360	720			0.500
Carbon tetrachloride	Soil	0.25	2.5	2.2	5.5	1.6		0.250
Chlorobenzene	Soil			150	530	22		0.050
Chloroethane	Soil	3.0	30		65			0.250
Chloroform	Soil	0.94	9.4		20	6.8		0.100
Chloromethane	Soil			48	160			0.250
2-Chlorotoluene	Soil			160	510			0.250
4-Chlorotoluene	Soil							0.250
Dibromochloromethane	Soil	1.1	11		26			0.100
1,2-Dibromo-3-chloropropane	Soil	0.53	5.3	1.5	6.5			0.250
1,2-Dibromoethane (EDB)	Soil	0.029	0.29		0.63			0.025
Dibromomethane	Soil							0.100
1,2-Dichlorobenzene	Soil			600	600	72		0.100
1,3-Dichlorobenzene	Soil			530	600			0.100
1,4-Dichlorobenzene	Soil	3.5	35		79	9.3		0.100
Dichlorodifluoromethane	Soil			94	310			0.250
1,1-Dichloroethane	Soil			510	1700			0.100
1,2-Dichloroethane	Soil	0.28	2.8		6.0	0.21		0.050
1,1-Dichloroethene	Soil			120	410	0.81		0.250
cis-1,2-Dichloroethene	Soil			43	150	4.9		0.100
trans-1,2-Dichloroethene	Soil			69	230	8.4		0.100
1,2-Dichloropropane	Soil	0.34	3.4		7.4	0.28		0.100
1,3-Dichloropropane	Soil			100	360			0.100
2,2-Dichloropropane	Soil							0.100
1,1-Dichloropropene	Soil							0.100
cis-1,3-Dichloropropene	Soil							0.100
trans-1,3-Dichloropropene	Soil							0.100
Ethylbenzene	Soil			400	400	120	6183000 (3)	0.100
Hexachlorobutadiene	Soil	7.0	70	18	180			0.250
2-Hexanone	Soil							1.000
Iodomethane	Soil							0.250
Isopropylbenzene	Soil							0.100
4-Isopropyltoluene	Soil							0.100
Methylene chloride	Soil	9.3	93		210			0.500
4-Methyl-2-pentanone (MIBK)	Soil							1.000
Methyl tert-butyl ether (MTBE)	Soil	32	320		710			0.250
Naphthalene	Soil			56	190			0.250
n-Propylbenzene	Soil			240	240			0.100
Styrene	Soil			1500	1500	36		0.100
1,1,1,2-Tetrachloroethane	Soil	3.2	32		73			0.250

Table 4. VOCs - Arizona Soil Remediation Levels

Analyte	Matrix	Arizona Soil Remediation Levels				Minimum GPL	Alternative GPL	TestAmerica
		RSRL - 10^{-6}	RSRL - 10^{-5}	RSRL - NC	NRSRL			RL
1,1,2,2-Tetrachloroethane	Soil	0.42	4.2		9.3			0.100
Tetrachloroethene	Soil	0.51	5.1		13	1.3	93.4 (1)	0.100
Toluene	Soil			650	650	400	2534000 (2)	0.100
1,2,3-Trichlorobenzene	Soil							0.250
1,2,4-Trichlorobenzene	Soil			62	220			0.250
1,1,1-Trichloroethane	Soil			1200	1200	1.0	64.2 (1)	0.100
1,1,2-Trichloroethane	Soil	0.74	7.4		16			0.100
Trichloroethene	Soil	3.0	30	17	65	0.61	33 (1)	0.100
Trichlorofluoromethane	Soil			390	1300			0.250
1,2,3-Trichloropropane	Soil	**0.0050**	**0.050**		0.11			0.500
1,2,4-Trimethylbenzene	Soil			52	170			0.100
1,3,5-Trimethylbenzene	Soil			21	70			0.100
Vinyl acetate	Soil			430	1400			1.200
Vinyl chloride	Soil	**0.085**	NA		0.75			0.250
Xylenes, Total	Soil			420		2200	3642000 (4)	0.150

All concentrations are in mg/kg

RSRL: Residential Soil Remediation Level, at $1x10^{-6}$, $1x10^{-5}$, and non-cancerous (NC) risk levels

NRSRL: Non-Residential Soil Remediation Level

Values in red indicate that the laboratory RL is greater than one or more of the SRLs

GPL: Minimum Groundwater Protection Limit (ADEQ 1996)

Minimum GPL for chloroform is for Total Trihalomethanes based on Chloroform

Alternate GPL calculated using X meters as the greatest depth at which a soil concentration above the applicable Minimum GPL is detected and XX meters as the depth to groundwater, as listed below (ADEQ 1996):

(1) 5 meters and 40 meters
(2) 5 meters and 20 meters
(3) 5 meters and 30 meters
(4) 5 meters and 20 meters (o-Xylene)

RL: TestAmerica laboratory Reporting Limit

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Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
8260 (UST) in Soil (EPA 8260B)								
Prep Method: EPA 5035 GCMS		**Preservation:** 4 C, Cool						
Container: Encore		**Amount Required:** 100 grams			**Hold Time:** 2 days			
Acetone	320	1000 ug/kg			10 - 150	35	10 - 150	35
Benzene	5.2	50 ug/kg			55 - 120	25	75 - 120	15
Bromobenzene	14	250 ug/kg			60 - 125	25	80 - 120	20
Bromochloromethane	13	250 ug/kg			50 - 135	30	75 - 125	20
Bromodichloromethane	14	100 ug/kg			60 - 120	20	75 - 120	15
Bromoform	75	250 ug/kg			40 - 125	35	60 - 120	25
Bromomethane	12	250 ug/kg			10 - 140	35	20 - 140	35
2-Butanone (MEK)	99	1000 ug/kg			40 - 150	35	40 - 150	35
n-Butylbenzene	6.2	250 ug/kg			40 - 135	25	65 - 130	20
sec-Butylbenzene	4.6	250 ug/kg			50 - 130	20	75 - 125	15
tert-Butylbenzene	6.8	250 ug/kg			55 - 125	25	80 - 120	15
Carbon disulfide	7.2	500 ug/kg			20 - 130	35	40 - 135	25
Carbon tetrachloride	7.4	250 ug/kg			40 - 135	30	70 - 130	20
Chlorobenzene	4.2	50 ug/kg			65 - 120	20	80 - 120	15
Chloroethane	14	250 ug/kg			10 - 140	35	10 - 130	30
Chloroform	7.9	100 ug/kg			60 - 125	25	75 - 120	20
Chloromethane	12	250 ug/kg			10 - 140	35	25 - 140	35
2-Chlorotoluene	9.1	250 ug/kg			60 - 120	20	80 - 120	15
4-Chlorotoluene	6.1	250 ug/kg			55 - 130	20	80 - 120	15
Dibromochloromethane	11	100 ug/kg			55 - 125	30	75 - 120	20
1,2-Dibromo-3-chloropropane	44	250 ug/kg			35 - 150	35	50 - 150	35
1,2-Dibromoethane (EDB)	16	25 ug/kg			55 - 120	25	70 - 120	20
Dibromomethane	7.6	100 ug/kg			40 - 150	25	70 - 120	25
1,2-Dichlorobenzene	9.6	100 ug/kg			60 - 120	25	80 - 120	20
1,3-Dichlorobenzene	5.1	100 ug/kg			60 - 120	25	80 - 120	15
1,4-Dichlorobenzene	5.9	100 ug/kg			60 - 120	20	80 - 120	15
Dichlorodifluoromethane	6.9	250 ug/kg			10 - 150	35	10 - 150	35
1,1-Dichloroethane	7.5	100 ug/kg			55 - 125	25	70 - 125	20
1,2-Dichloroethane	13	50 ug/kg			55 - 130	25	70 - 130	20
1,1-Dichloroethene	11	250 ug/kg			25 - 140	35	50 - 135	20
cis-1,2-Dichloroethene	8.0	100 ug/kg			55 - 125	25	70 - 125	15
trans-1,2-Dichloroethene	9.1	100 ug/kg			50 - 130	25	70 - 130	20
1,2-Dichloropropane	11	100 ug/kg			60 - 120	25	80 - 120	20
1,3-Dichloropropane	12	100 ug/kg			60 - 120	25	70 - 120	20
2,2-Dichloropropane	7.8	100 ug/kg			45 - 130	25	65 - 130	20
1,1-Dichloropropene	8.3	100 ug/kg			55 - 125	25	75 - 120	15
cis-1,3-Dichloropropene	8.4	100 ug/kg			55 - 120	20	75 - 125	15
trans-1,3-Dichloropropene	16	100 ug/kg			55 - 125	25	65 - 130	20
Ethylbenzene	4.5	100 ug/kg			60 - 125	20	80 - 120	15
Hexachlorobutadiene	18	250 ug/kg			40 - 150	30	40 - 150	25
2-Hexanone	57	1000 ug/kg			20 - 150	35	20 - 150	35
Iodomethane	9.3	250 ug/kg			30 - 140	30	55 - 140	20
Isopropylbenzene	7.9	100 ug/kg			50 - 150	25	80 - 130	20
p-Isopropyltoluene	7.0	100 ug/kg			45 - 135	25	75 - 130	15
Methylene Chloride	19	500 ug/kg			50 - 120	30	65 - 125	20
4-Methyl-2-pentanone (MIBK)	43	1000 ug/kg			40 - 130	30	50 - 130	35

* = *Analyte not a part of normal reporting list. Special request only*

TestAmerica Phoenix

11/8/2010

Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Methyl-tert-butyl Ether (MTBE)	14	250 ug/kg			50 - 130	35	65 - 130	20
Naphthalene	14	250 ug/kg			35 - 150	35	40 - 150	30
n-Propylbenzene	5.4	100 ug/kg			55 - 130	20	75 - 130	15
Styrene	9.2	100 ug/kg			55 - 125	20	80 - 120	15
1,1,1,2-Tetrachloroethane	7.8	250 ug/kg			40 - 140	25	75 - 125	15
1,1,2,2-Tetrachloroethane	14	100 ug/kg			50 - 130	25	60 - 125	30
Tetrachloroethene	9.8	100 ug/kg			60 - 130	20	70 - 130	15
Toluene	14	100 ug/kg			55 - 125	35	75 - 120	15
1,2,3-Trichlorobenzene	14	250 ug/kg			35 - 140	30	55 - 140	25
1,2,4-Trichlorobenzene	10	250 ug/kg			45 - 150	25	50 - 150	25
1,1,1-Trichloroethane	9.6	100 ug/kg			50 - 125	15	75 - 120	15
1,1,2-Trichloroethane	13	100 ug/kg			55 - 120	25	65 - 125	30
Trichloroethene	7.6	100 ug/kg			40 - 145	35	80 - 120	15
Trichlorofluoromethane	64	250 ug/kg			20 - 150	35	50 - 150	25
1,2,3-Trichloropropane	13	500 ug/kg			35 - 140	35	60 - 130	30
1,2,4-Trimethylbenzene	15	100 ug/kg			50 - 130	20	75 - 120	15
1,3,5-Trimethylbenzene	8.5	100 ug/kg			45 - 135	20	80 - 130	15
Vinyl Acetate	14	1200 ug/kg			10 - 150	35	35 - 150	35
Vinyl chloride	4.7	250 ug/kg			10 - 150	35	10 - 150	35
Xylenes, Total	13	150 ug/kg			50 - 125	20	80 - 120	15
surr: Dibromofluoromethane			60 - 130					
surr: Toluene-d8			65 - 125					
surr: 4-Bromofluorobenzene			65 - 125					
*o-Xylene								
*m,p-Xylenes								

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TestAmerica Phoenix

10/11/2010

Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
8260 Ultra Low Long List in Water (EPA 8260B)								
Prep Method: EPA 5030 GCMS		**Preservation:** 4 C, HCL						
Container: 40 ml Voa Vial		**Amount Required:** 80 ml			**Hold Time:** 14 days			
Acetone	3.2	10 ug/l			10 - 150	35	10 - 150	35
Benzene	0.37	0.50 ug/l			70 - 125	25	80 - 120	15
Bromobenzene	0.28	0.50 ug/l			75 - 120	20	80 - 120	15
Bromochloromethane	0.18	0.50 ug/l			75 - 130	20	80 - 125	15
Bromodichloromethane	0.090	0.50 ug/l			75 - 125	20	80 - 120	15
Bromoform	0.44	1.0 ug/l			65 - 125	25	75 - 130	20
Bromomethane	0.19	1.0 ug/l			45 - 150	35	55 - 150	20
2-Butanone (MEK)	1.3	2.5 ug/l			15 - 150	30	40 - 150	35
n-Butylbenzene	0.29	0.50 ug/l			70 - 130	30	80 - 130	15
sec-Butylbenzene	0.24	0.50 ug/l			70 - 125	30	80 - 125	15
tert-Butylbenzene	0.30	0.50 ug/l			70 - 125	25	80 - 120	15
Carbon disulfide	0.16	0.50 ug/l			65 - 145	25	70 - 140	15
Carbon tetrachloride	0.080	0.50 ug/l			65 - 135	25	75 - 130	20
Chlorobenzene	0.12	0.50 ug/l			75 - 120	20	80 - 120	15
Chloroethane	0.10	1.0 ug/l			65 - 140	25	70 - 130	15
Chloroform	0.090	0.50 ug/l			70 - 130	20	75 - 120	15
Chloromethane	0.17	1.0 ug/l			55 - 145	35	60 - 140	20
2-Chlorotoluene	0.26	0.50 ug/l			70 - 125	25	80 - 120	15
4-Chlorotoluene	0.32	0.50 ug/l			70 - 125	25	80 - 120	15
Dibromochloromethane	0.090	0.50 ug/l			70 - 130	20	80 - 120	15
1,2-Dibromo-3-chloropropane	0.87	2.5 ug/l			50 - 150	30	50 - 150	35
1,2-Dibromoethane (EDB)	0.14	0.50 ug/l			70 - 125	20	80 - 120	15
Dibromomethane	0.33	0.50 ug/l			70 - 120	20	75 - 120	15
1,2-Dichlorobenzene	0.47	0.50 ug/l			75 - 120	20	80 - 120	15
1,3-Dichlorobenzene	0.33	0.50 ug/l			75 - 120	25	80 - 120	15
1,4-Dichlorobenzene	0.35	0.50 ug/l			70 - 125	20	80 - 120	15
Dichlorodifluoromethane	0.070	0.50 ug/l			60 - 150	30	60 - 150	30
1,1-Dichloroethane	0.060	0.50 ug/l			70 - 130	20	70 - 125	15
1,2-Dichloroethane	0.090	0.50 ug/l			65 - 140	20	75 - 130	15
1,1-Dichloroethene	0.21	0.50 ug/l			70 - 130	25	75 - 125	20
cis-1,2-Dichloroethene	0.11	0.50 ug/l			70 - 125	20	80 - 120	15
trans-1,2-Dichloroethene	0.090	0.50 ug/l			75 - 125	25	80 - 120	15
1,2-Dichloropropane	0.15	0.50 ug/l			75 - 125	20	80 - 120	15
1,3-Dichloropropane	0.11	0.50 ug/l			70 - 120	20	80 - 120	15
2,2-Dichloropropane	0.050	1.0 ug/l			65 - 140	25	75 - 130	15
1,1-Dichloropropene	0.29	0.50 ug/l			65 - 130	25	75 - 120	15
cis-1,3-Dichloropropene	0.10	0.50 ug/l			75 - 130	20	80 - 120	15
trans-1,3-Dichloropropene	0.19	0.50 ug/l			70 - 130	20	80 - 125	15
Ethylbenzene	0.10	0.50 ug/l			70 - 125	25	80 - 120	15
Hexachlorobutadiene	0.28	1.0 ug/l			40 - 150	30	40 - 150	35
2-Hexanone	0.93	2.5 ug/l			20 - 150	30	20 - 150	35
Iodomethane	0.10	2.5 ug/l			60 - 150	30	80 - 130	10
Isopropylbenzene	0.19	0.50 ug/l			75 - 130	25	80 - 130	15
p-Isopropyltoluene	0.27	0.50 ug/l			70 - 130	30	80 - 130	15
Methylene Chloride	0.11	1.0 ug/l			65 - 130	20	70 - 120	15
4-Methyl-2-pentanone (MIBK)	0.45	2.5 ug/l			55 - 135	25	60 - 135	25

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Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Methyl-tert-butyl Ether (MTBE)	0.12	0.50 ug/l			65 - 140	25	70 - 130	20
Naphthalene	0.45	2.5 ug/l			40 - 150	30	40 - 150	30
n-Propylbenzene	0.21	0.50 ug/l			70 - 130	30	75 - 130	15
Styrene	0.21	0.50 ug/l			55 - 135	35	80 - 120	15
1,1,1,2-Tetrachloroethane	0.29	0.50 ug/l			70 - 125	20	75 - 125	15
1,1,2,2-Tetrachloroethane	0.090	0.50 ug/l			70 - 125	25	80 - 120	20
Tetrachloroethene	0.19	0.50 ug/l			65 - 130	25	70 - 130	20
Toluene	0.080	0.50 ug/l			70 - 125	20	80 - 120	15
1,2,3-Trichlorobenzene	0.40	1.0 ug/l			50 - 150	35	55 - 150	35
1,2,4-Trichlorobenzene	0.43	1.0 ug/l			50 - 150	25	50 - 150	30
1,1,1-Trichloroethane	0.080	0.50 ug/l			70 - 130	25	75 - 125	15
1,1,2-Trichloroethane	0.15	0.50 ug/l			75 - 125	20	80 - 120	15
Trichloroethene	0.050	0.50 ug/l			70 - 125	25	80 - 120	15
Trichlorofluoromethane	0.090	0.50 ug/l			65 - 150	25	70 - 150	25
1,2,3-Trichloropropane	0.54	1.0 ug/l			70 - 130	25	70 - 130	20
1,2,4-Trimethylbenzene	0.26	0.50 ug/l			70 - 125	30	80 - 120	15
1,3,5-Trimethylbenzene	0.20	0.50 ug/l			75 - 130	25	80 - 130	15
Vinyl Acetate	0.18	1.0 ug/l			40 - 150	30	40 - 150	25
Vinyl chloride	0.11	0.50 ug/l			60 - 140	25	70 - 130	20
Xylenes, Total	0.42	1.0 ug/l			75 - 120	15	60 - 140	15
surr: Dibromofluoromethane			80 - 130					
surr: Toluene-d8			80 - 120					
surr: 4-Bromofluorobenzene			80 - 125					
*o-Xylene	0.15	0.50 ug/l						
*m,p-Xylenes	0.27	1.0 ug/l						
*Freon 113	0.10	2.0 ug/l			65 - 140	20	60 - 140	15
*n-Hexane	0.27	1.0 ug/l			70 - 130	20	70 - 130	20

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TABLE 5. SUMMARY OF SAMPLES, CONTAINERS, AND ANALYTICAL METHODS

ANALYSES REQUESTED					ORGANIC					INORGANIC			TOTAL NUMBER CONTAINERS							
SPECIFIC ANALYSES REQUESTED					Polynuclear Aromatic Hydrocarbons (PAHs): 8310		Volatile Organic Compounds (VOCs): 8260B			Total Arsenic, Lead, Mercury: 6010B/7471A or TCLP Mercury: 7471A/1311										
MATRIX					Soil	Aqueous	Soil		Aqueous	Soil		Aqueous								
PRESERVATIVES					Chill to 4°C	Chill to 4°C	Chill to 4°C; CH_3OH		Chill to 4°C; HCl to pH<2	Chill to 4°C		Chill to 4°C								
ANALYTICAL HOLDING TIME(S)					<14 days prior to extraction; 40 days after extraction	<7 days prior to extraction; 40 days after extraction	<14 days for preseved sample		<14 days for preserved sample	<180 days (<28 days for Mercury)		<180 days (<28 days for Mercury)								
					Number of Sample Containers per Sample															
Sample	Sample Number	Matrix	Sample Type	Depth (in feet)	4-oz Glass Jar	I-L Amber bottle	Lock and Load type sampler	40-ml VOA (CH_3OH)	40-ml VOA (HCl)	4-oz Glass Jar (Totals; same jar as PAHs)	8-oz Glass Jar (TCLP)	500-ml poly bottle	4-oz Glass Jar	8-oz Glass Jar	Lock and Load type sampler	40-ml VOA (CH_3OH)	I-L Amber bottle	40-ml VOA (HCl)	500-ml poly bottle	40-ml VOA (water)
SURFACE SOIL REMEDIATION AREAS																				
1	FR-1-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
2	FR-2-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
3	FR-3-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
4	FR-4-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
5	FR-5-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
6	FR-6-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
7	FR-7-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
8	FR-8-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
9	FR-9-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
10	FR-10-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
11	FR-11-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
12	FR-12-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
13	FR-13-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
14	FR-14-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
15	FR-15-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
16	FR-16-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
17	FR-17-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
18	FR-18-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
19	FR-19-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
20	FR-20-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
21	FR-21-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
22	FR-22-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
23	FR-23-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
24	FR-24-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
25	FR-25-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
26	FR-26-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
27	FR-27-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
28	FR-28-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
29	FR-29-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
30	FR-30-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
31	FR-31-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
32	FR-32-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
33	FR-33-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
34	FR-34-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
35	FR-35-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
36	FR-36-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
37	FR-37-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
38	FR-38-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							

TABLE 5. SUMMARY OF SAMPLES, CONTAINERS, AND ANALYTICAL METHODS

ANALYSES REQUESTED					ORGANIC					INORGANIC			TOTAL NUMBER CONTAINERS							
SPECIFIC ANALYSES REQUESTED					Polynuclear Aromatic Hydrocarbons (PAHs): 8310		Volatile Organic Compounds (VOCs): 8260B			Total Arsenic, Lead, Mercury: 6010B/7471A or TCLP Mercury: 7471A/1311										
MATRIX					Soil	Aqueous	Soil		Aqueous	Soil		Aqueous								
PRESERVATIVES					Chill to 4°C	Chill to 4°C	Chill to 4°C; CH_3OH		Chill to 4°C; HCl to pH<2	Chill to 4°C		Chill to 4°C								
ANALYTICAL HOLDING TIME(S)					<14 days prior to extraction; 40 days after extraction	<7 days prior to extraction; 40 days after extraction	<14 days for preseved sample		<14 days for preserved sample	<180 days (<28 days for Mercury)		<180 days (<28 days for Mercury)								
					Number of Sample Containers per Sample															
Sample	Sample Number	Matrix	Sample Type	Depth (in feet)	4-oz Glass Jar	I-L Amber bottle	Lock and Load type sampler	40-ml VOA (CH_3OH)	40-ml VOA (HCl)	4-oz Glass Jar (Totals; same jar as PAHs)	8-oz Glass Jar (TCLP)	500-ml poly bottle	4-oz Glass Jar	8-oz Glass Jar	Lock and Load type sampler	40-ml VOA (CH_3OH)	I-L Amber bottle	40-ml VOA (HCl)	500-ml poly bottle	40-ml VOA (water)
39	FR-39-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
40	FR-40-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
41	FR-41-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
42	FR-42-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
43	FR-43-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
44	FR-44-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
45	FR-45-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
46	FR-46-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
47	FR-47-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
48	FR-48-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
49	FR-49-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
50	FR-50-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
51	FR-51-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
52	FR-52-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
53	FR-53-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
54	FR-54-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
55	FR-55-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
56	FR-56-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
57	FR-57-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
58	FR-58-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
59	FR-59-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
60	FR-60-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
61	FR-61-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
62	FR-62-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
63	FR-63-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
64	FR-64-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
65	FR-65-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
66	FR-66-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
67	FR-67-0.5	Soil	Grab - exc base	0.5-1	1					1 (As, Pb)			1							
68	FR-68-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
69	FR-69-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
70	FR-70-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
71	FR-71-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
72	FR-72-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
73	FR-73-S	Soil	Grab - exc side	0-0.5	1					1 (As, Pb)			1							
Addnl	TBD	Soil	Grab - TBD	TBD	TBD					TBD			TBD							

TABLE 5. SUMMARY OF SAMPLES, CONTAINERS, AND ANALYTICAL METHODS

ANALYSES REQUESTED					ORGANIC					INORGANIC			TOTAL NUMBER CONTAINERS							
SPECIFIC ANALYSES REQUESTED					Polynuclear Aromatic Hydrocarbons (PAHs): 8310		Volatile Organic Compounds (VOCs): 8260B			Total Arsenic, Lead, Mercury: 6010B/7471A or TCLP Mercury: 7471A/1311										
MATRIX					Soil	Aqueous	Soil		Aqueous	Soil		Aqueous								
PRESERVATIVES					Chill to 4°C	Chill to 4°C	Chill to 4°C; CH_3OH		Chill to 4°C; HCl to pH<2	Chill to 4°C		Chill to 4°C								
ANALYTICAL HOLDING TIME(S)					<14 days prior to extraction; 40 days after extraction	<7 days prior to extraction; 40 days after extraction	<14 days for preseved sample		<14 days for preserved sample	<180 days (<28 days for Mercury)		<180 days (<28 days for Mercury)								
					Number of Sample Containers per Sample															
Sample	Sample Number	Matrix	Sample Type	Depth (in feet)	4-oz Glass Jar	I-L Amber bottle	Lock and Load type sampler	40-ml VOA (CH_3OH)	40-ml VOA (HCl)	4-oz Glass Jar (Totals; same jar as PAHs)	8-oz Glass Jar (TCLP)	500-ml poly bottle	4-oz Glass Jar	8-oz Glass Jar	Lock and Load type sampler	40-ml VOA (CH_3OH)	I-L Amber bottle	40-ml VOA (HCl)	500-ml poly bottle	40-ml VOA (water)
D1	D101	Soil	Duplicate	TBD	1					1 (As, Pb)			1							
D2	D102	Soil	Duplicate	TBD	1					1 (As, Pb)			1							
D3	D103	Soil	Duplicate	TBD	1					1 (As, Pb)			1							
D4	D104	Soil	Duplicate	TBD	1					1 (As, Pb)			1							
D5	D105	Soil	Duplicate	TBD	1					1 (As, Pb)			1							
D6	D106	Soil	Duplicate	TBD	1					1 (As, Pb)			1							
D7	D107	Soil	Duplicate	TBD	1					1 (As, Pb)			1							
D8	D108	Soil	Duplicate	TBD	1					1 (As, Pb)			1							
Addnl	TBD	Soil	Duplicate	TBD	TBD					TBD			TBD							
M1	MS/MSD	Soil	Lab QC	TBD	1					1 (As, Pb)			1							
M2	MS/MSD	Soil	Lab QC	TBD	1					1 (As, Pb)			1							
M3	MS/MSD	Soil	Lab QC	TBD	1					1 (As, Pb)			1							
M4	MS/MSD	Soil	Lab QC	TBD	1					1 (As, Pb)			1							
E1	EB-1	Water	Field QC	NA		2						1 (As, Pb)					2		1	
NA	Temp	Water	Temp	NA																TBD
SEPTIC SYSTEM AREAS																				
1	FS1-1	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
2	FS1-2	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
3	FS1-3	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
4	FS1-4	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
5	FS2-1	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
6	FS2-2	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
7	FS2-3	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
8	FS2-4	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
9	FS3-1	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
10	FS3-2	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
11	FS3-3	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
12	FS3-4	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
13	FS4-1	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
14	FS4-2	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
15	FS4-3	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
16	FS4-4	Soil	Grab - septic	TBD	1					1 (As, Pb, Hg)			1							
17	FS5-1	Soil	Grab - septic	TBD	1		1	1		1 (As, Pb, Hg)			1		1	1				
18	FS5-2	Soil	Grab - septic	TBD	1		1	1		1 (As, Pb, Hg)			1		1	1				
19	FS5-3	Soil	Grab - septic	TBD	1		1	1		1 (As, Pb, Hg)			1		1	1				
20	FS5-4	Soil	Grab - septic	TBD	1		1	1		1 (As, Pb, Hg)			1		1	1				
21	FS6-1	Soil	Grab - septic	TBD	1		1	1		1 (As, Pb, Hg)			1		1	1				
22	FS6-2	Soil	Grab - septic	TBD	1		1	1		1 (As, Pb, Hg)			1		1	1				
23	FS6-3	Soil	Grab - septic	TBD	1		1	1		1 (As, Pb, Hg)			1		1	1				

TABLE 5. SUMMARY OF SAMPLES, CONTAINERS, AND ANALYTICAL METHODS

ANALYSES REQUESTED					ORGANIC					INORGANIC			TOTAL NUMBER CONTAINERS							
SPECIFIC ANALYSES REQUESTED					Polynuclear Aromatic Hydrocarbons (PAHs): 8310		Volatile Organic Compounds (VOCs): 8260B			Total Arsenic, Lead, Mercury: 6010B/7471A or TCLP Mercury: 7471A/1311										
MATRIX					Soil	Aqueous	Soil		Aqueous	Soil		Aqueous								
PRESERVATIVES					Chill to 4°C	Chill to 4°C	Chill to 4°C; CH_3OH		Chill to 4°C; HCl to pH<2	Chill to 4°C		Chill to 4°C								
ANALYTICAL HOLDING TIME(S)					<14 days prior to extraction; 40 days after extraction	<7 days prior to extraction; 40 days after extraction	<14 days for preseved sample		<14 days for preserved sample	<180 days (<28 days for Mercury)		<180 days (<28 days for Mercury)								
					Number of Sample Containers per Sample															
Sample	Sample Number	Matrix	Sample Type	Depth (in feet)	4-oz Glass Jar	l-L Amber bottle	Lock and Load type sampler	40-ml VOA (CH_3OH)	40-ml VOA (HCl)	4-oz Glass Jar (Totals; same jar as PAHs)	8-oz Glass Jar (TCLP)	500-ml poly bottle	4-oz Glass Jar	8-oz Glass Jar	Lock and Load type sampler	40-ml VOA (CH_3OH)	l-L Amber bottle	40-ml VOA (HCl)	500-ml poly bottle	40-ml VOA (water)
24	FS6-4	Soil	Grab - septic	TBD	1		1	1		1 (As, Pb, Hg)			1		1	1				
Addnl	TBD	Soil	Grab - TBD	TBD	TBD		TBD	TBD		TBD			TBD		TBD	TBD				
TCLP	TBD	Soil	Grab - TBD	TBD							TBD			TBD						
D9	D109	Soil	Duplicate	TBD	1					1 (As, Pb, Hg)			1							
D10	D110	Soil	Duplicate	TBD	1					1 (As, Pb, Hg)			1							
D11	D111	Soil	Duplicate	TBD	1		1	1		1 (As, Pb, Hg)			1		1	1				
Addnl	TBD	Soil	Duplicate	TBD	TBD		TBD	TBD		TBD			TBD		TBD	TBD				
M5	MS/MSD	Soil	Lab QC	TBD	1					1 (As, Pb, Hg)			1							
M6	MS/MSD	Soil	Lab QC	TBD	1		2	2		1 (As, Pb, Hg)			1		2	2				
E2	EB-2	Water	Field QC	NA		2						1 (As, Pb, Hg)					2		1	
E3	EB-3	Water	Field QC	NA		2			3			1 (As, Pb, Hg)					2	3	1	
TB1	TB	Water	Field QC	NA					1									1		
NA	Temp	Water	Temp	NA																TBD
TOTAL # ENVIRONMENTAL SAMPLES*					97	0	8	8	0	97	TBD	0								
TOTAL # DUPLICATE SAMPLES*					11	0	1	1	0	11		0	**114**	**TBD**	**11**	**11**	**6**	**4**	**3**	**TBD**
TOTAL # QC SAMPLES*					6	3	1	1	2	6		3								

NOTES: * = Total number of sample locations, not including additional samples that will be determined based on sample results. The number of containers is shown in individual cells and is totaled on the

TBD = To be determined

NA = Not applicable

As = Arsenic, Pb = Lead, Hg = Mercury

MS/MSD = Matrix Spike/Matrix Spike Duplicate

EB = Equipment Blank

Temp = Temperature Blank, one per cooler

ATTACHMENT 3

LABORATORY QUALITY ASSURANCE MANUAL

Cover Page:

Quality Assurance Manual

TestAmerica Phoenix
4625 East Cotton Center Boulevard
Suite 189
Phoenix, Arizona 85040
Phone No. 602-437-3340
Fax No. 602-454-9303

www.testamericainc.com

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Title Page:

Quality Assurance Manual
Approval Signatures

Laboratory Director (Interim) – Bosco Ramirez	12/3/2010 Date
Quality Assurance Manager – Mary Tyer	12/3/2010 Date
Industrial Hygiene Program Manager – Stephanie Stimson	12/3/2010 Date
Volatiles Manager – Shawn Kusma	12/3/2010 Date
Semi-Volatiles/Extractions Manager – Jessica Reichers	12/3/2010 Date
Wet Chemistry Manager (Interim) – Amy Cerwinske	12/3/2010 Date
Metals Manager (Interim) – Bryan Roberts	12/3/2010 Date
Client Services Manager – Linda Eshelman	12/3/2010 Date
Elizabeth Baker – Business Development Manager	12/3/2010 Date

SECTION 2

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REFERENCED CORPORATE SOPs AND POLICIES

SOP / Policy Reference	Title
CA-Q-S-001	Solvent and Acid Lot Testing and Approval
CA-Q-S-002	Acceptable Manual Integration Practices
CA-Q-S-004	Method Compliance & Data Authenticity Audits
CA-Q-S-006	Detection Limits
CA-Q-S-008	Management Systems Review
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CA-L-S-001	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CA-L-S-002	Subcontracting Procedures
CA-L-P-001	Ethics Policy
CA-L-P-002	Contract Compliance Policy
CW-F-P-002	Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CA-C-S-001	Work Sharing Process
CA-T-P-001	Qualified Products List
CW-F-S-007	Controlled Purchases Policy
CW-F-S-018	Vendor Selection
CA-Q-M-002	Corporate Quality Management Plan
CW-E-M-001	Corporate Environmental Health & Safety Manual

REFERENCED LABORATORY SOPs

SOP Reference	Title
PE-ADM-001	Computer Security
PE-ADM-002	Back-up for Network Data Files
PE-PMD-001	Data Reporting, Validation and Distribution
PE-QAD-001	Control Charts and Statistical Process Control
PE-QAD-002	Pipette Calibration
PE-QAD-003	Sub-sampling
PE-QAD-004	Thermometer Calibration
PE-QAD-006	Logbook Documentation
PE-QAD-007	Corrective Actions
PE-QAD-008	Personnel Certification and Training
PE-QAD-009	Manual Integration / Data Integrity
PE-QAD-010	Document Control
PE-QAD-012	Receipt Process for General Supplies and Chemicals
PE-QAD-013	Reagent and Standard Preparation, Control and Documentation
PE-QAD-014	Creation and Maintenance of SOPs
PE-QAD-015	Initial Demonstration of Capability
PE-QAD-016	Balance Calibration and Documentation
PE-QAD-017	Record Archiving
PE-QAD-018	Use of Data Qualifiers
PE-QAD-019	Determination of Method Detection Limits
PE-QAD-024	General Data Review
PE-QAD-026	Internal Chain of Custody Procedures

SOP Reference	Title
PE-SMP-001	Sample Control
PE-PMD-002	Project Management Communication and Documentation
PE-SMP-004	Field Sampling
PE-SMP-005	Bottle Preparation
PE-SMP-006	Receiving and Waste Management of Foreign Soils
PE-SMP-007	Calibrating Sampling Pumps

SECTION 3

INTRODUCTION *(NELAC 5.1 - 5.3)*

3.1 INTRODUCTION AND COMPLIANCE REFERENCES

TestAmerica Phoenix's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with the 2003 National Environmental Laboratory Accreditation Conference (NELAC) standards, 2010 AIHA Policies and ISO/IEC Guide 17025 (2005). In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plan (CQMP) and the various accreditation and certification programs listed in Appendix 3. The CQMP provides a summary of TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all TestAmerica facilities shall conduct their operations. Please note that the 2003 NELAC standard is based on the 1999 version of 17025.

The QAM has been prepared to be consistent with the requirements of the following documents:

- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water,* EPA, Revised July 1991.
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water,* Supplement III, EPA, August 1995.
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* EPA, March 1979.
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- *Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*
- APHA, *Standard Methods for the Examination of Water and Wastewater,* 19th and 20th Editions.
- *U.S. Department of Energy* Order 414.1B, *Quality Assurance*, Approved April 29, 2004.
- Toxic Substances Control Act (TSCA).
- *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, EPA, Second Edition, 1999.
- *NIOSH Manual of Analytical Methods*, Fourth Edition, 1994.
- U.S. Department of Labor, Occupational Safety & Health Administration, *Index of Sampling & Analytical Methods*, Revision Date: 21 November 2001.
- AIHA Policies for Laboratory Quality Assurance Programs, 2010 Policy Modules, Effective April 1, 2010.

- *Arizona Administrative Code*, Department of Health Services, Title 9. Health Services, Chapter 14. Department of Health Services Laboratories, December 31, 2006.
- EPA 815-R-05-004, *Manual for the Certification of Laboratories Analyzing Drinking Water,* EPA, 5th Edition, January 2005.
- *New York State Regulations*, Title 10 – Department of Health, Chapter 11 – Administrative Rules and Regulations, Part 55 – Approval of Laboratories Performing Environmental Analysis, Revision Date: February 20, 2008.
- *Oregon Administrative Rules*, Chapter 333, Division 64, October 2000.
- *Nevada Administrative Code,* Chapter 445A Water Controls – Certification of Laboratories to Analyze Substances in Water; Chapter 445A – Certification of Laboratories to Analyze Drinking Water; November 2008.
- California Environmental Laboratory Improvement Act (Chapter 4 commencing with Section 100825, Part 1, Division 101, of the California Health And Safety Code). ELAP, January 1989.
- California Code of Regulations, Title 22. Social Security, Division 4. Environmental Health, Chapter 19. Certification of Environmental Laboratories; NELAP, January 2000.
- SKC EPA IP-6 Method Update: DETERMINATION OF FORMALDEHYDE AND OTHER ALDEHYDES IN INDOOR AIR; Publication 1661 Rev 1001.
- "Compendium of Methods for the Determination of Pollutants in Indoor Air, "U.S. EPA PB 90-200288, 1990
- American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103, 04.09, 1986.

3.2 TERMS AND DEFINITIONS

A Quality Assurance Program is a company-wide system designed to ensure that data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 2 for the Glossary/Acronyms.

3.3 SCOPE / FIELDS OF TESTING

The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among air, drinking water, effluent water, groundwater, hazardous waste, sludge, soils and air for industrial hygiene on varying types of media. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical and biological parameters. The Program also contains guidelines on maintaining documentation of analytical process, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all requests to provide analyses are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found in Appendix 4. The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director, Account Executive, Business Development Manager, Client Services Manager and/or the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and/or Industrial Hygiene Program Manager and the QA Manager must determine if it is in the lab's best interest to follow the less stringent requirements.

3.4 MANAGEMENT OF THE MANUAL

3.4.1 Review Process

This manual is reviewed annually by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be reviewed by the senior laboratory management staff. The laboratory updates and approves such changes according to our Document Control procedures (refer to SOP PE-QAD-010 Document Control).

SECTION 4

ORGANIZATION AND MANAGEMENT *(NELAC 5.4.1)*

4.1 OVERVIEW

TestAmerica Phoenix is a local operating unit of TestAmerica Laboratories, Inc. The organizational structure, responsibilities and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., President, Chief Operating Officer, Corporate Quality Assurance, etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate & TestAmerica Phoenix is presented in Figures 4-1.

4.2 ROLES AND RESPONSIBILITIES

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance Program.

4.2.1 Quality Assurance Program

The responsibility for quality lies with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for upholding the standards therein. Each person carries out his/her daily tasks in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for Corporate personnel are defined in the CQMP. This manual is specific to the operations of TestAmerica's Phoenix laboratory.

4.2.2 Laboratory Director

TestAmerica Phoenix's Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource and service performance of the whole laboratory and reports to their respective GM. The Laboratory Director provides the resources necessary to implement and maintain an effective and comprehensive Quality Assurance and Data Integrity Program. The Laboratory Director who is absent for a period of time exceeding 15 consecutive calendar days shall designate another full time staff member who meets the minimum qualifications of the Laboratory Manager to temporally perform the Laboratory Director function. Also, if this absence exceeds 65 consecutive calendar days, the primary NELAP accrediting authority must be notified in writing.

Specific responsibilities include, but are not limited to:

- Captains the management team, consisting of the QA Manager, the Industrial Hygiene Program Manager, the Business Development Manager, and the Department Manager(s) as direct reports.
- Ensures that all staff has the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented.

- Ensures that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work.
- Ensures TestAmerica's human resource policies are adhered to and maintained.
- Ensures that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory.
- Ensures that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director.
- Reviews and approves all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to.
- Pursues and maintains appropriate laboratory certification and contract approvals. Supports ISO 17025 requirements.
- Ensures client specific reporting and quality control requirements are met.
- Evaluates the level of internal/external non-conformances for all departments.
- Continuously evaluates production capacity and improves capacity utilization.
- Continuously evaluates turnaround time and addresses any problems that may hinder meeting the required and committed turnaround time from the various departments.
- Develops and improves the training of all analysts in cooperation with the Laboratory Director, the Department Manager(s) and QA Manager and in compliance with regulatory requirements.
- Works to ensure that scheduled instrument maintenance is completed.
- Is responsible for efficient utilization of supplies.
- Constantly monitors and modifies the processing of samples through the departments.
- Fully supports the quality system and, if called upon in the absence of the QA Manager, serves as his/her substitute in the interim.

4.2.3 Quality Assurance (QA) Manager

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system based on ISO 17025.

Qualifications: The Quality Manager of the laboratory shall possess a bachelor's degree in an applicable basic or applied science and have at least one year of nonacademic analytical or quality control experience appropriate to the types of analyses performed by the laboratory; or quality control experience appropriate to the types of analyses performed by the laboratory; or in lieu of a bachelor's degree, four years of nonacademic analytical or quality control experience. The Quality Manager shall have documented training in statistics or laboratory quality assurance/quality control. The Quality Manager may be a part-time employee or consultant.

NOTE: Appropriate documentation of training in statistics or laboratory quality assurance/quality control shall include at least one of the following: 1) College level course in statistics; 2) Continuing education in laboratory quality assurance/quality control (e.g., AIHA-LAP, LLC or equivalent course); or 3) Relevant

experience – documented examples of the level of quality assurance/quality control used in applicable work experience.

Any changes in laboratory ownership, location (except for mobile and field operations laboratories), management, quality control personnel, or any other change that significantly affects the laboratory's capability, scope of accreditation, or ability to meet the policy requirements, shall be reported in writing to AIHA-LAP, LLC within twenty (20) business days of the change. Any absence of personnel for a period in excess of twenty (20) consecutive working days, that impacts the laboratory's ability to perform its scope of testing, shall be reported to AIHA-LAP, LLC within twenty (20) business days. This notification requirement shall be in effect if the Technical Manager, the Quality Manager, or an analyst who is the only staff member that performs a given test, are absent for reasons of extended family leave, illness, temporary disability, etc.

The QA Manager reports directly to the Laboratory Director and has access to Corporate QA for advice and resources. This position is able to evaluate data objectively and perform assessments without outside (i.e., managerial) influence. Corporate QA may be used as a resource in dealing with regulatory requirements, certifications and other quality assurance related items. The QA Manager directs the activities of the QA officers to accomplish specific responsibilities, which include, but are not limited to:

- Ensuring Communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs are temporarily suspended following the procedures outlined in Section 12.
- Evaluation of the thoroughness and effectiveness of training
- Having functions independent from laboratory operations for which he/she has quality assurance oversight.
- Maintaining and updating the QAM.
- Monitoring and evaluating laboratory certifications; scheduling proficiency testing samples.
- Monitoring and communicating regulatory changes that may affect the laboratory to management.
- Training and advising the laboratory staff on quality assurance/quality control procedures that are pertinent to their daily activities.
- Having a general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed).
- Arranging for or conducting internal audits on quality systems and the technical operation.
- The laboratory QA Manager will maintain records of all ethics-related training, including the type and proof of attendance.
- Maintain, improve, and evaluate the corrective action database and the corrective and preventive action systems.
- Monitoring standards of performance in quality control and quality assurance.

- Coordinating of document control of SOPs, MDLs, control limits, and miscellaneous forms and information.
- Review a percentage of all final data reports for internal consistency. Review of Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness of any corrective action statements, calculations, format, holding time, sensibility and completeness of the project file contents.
- Review of external audit reports and data validation requests.
- Follow-up with audits to ensure client QAPP requirements are met.
- Establishment of reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.
- Development of suggestions and recommendations to improve quality systems.
- Research of current state and federal requirements and guidelines.
- Captains the QA team to enable communication and to distribute duties and responsibilities.

4.2.4 Industrial Hygiene Program/Technical Manager

The Industrial Hygiene Program/Technical Manager reports directly to the Laboratory Director and shall posses the qualifications and assume the responsibilities listed below in addition to the responsibilities listed under the department/program manager title.

Any changes in laboratory ownership, location (except for mobile and field operations laboratories), management, quality control personnel, or any other change that significantly affects the laboratory's capability, scope of accreditation, or ability to meet the policy requirements, shall be reported in writing to AIHA-LAP, LLC within twenty (20) business days of the change. Any absence of personnel for a period in excess of twenty (20) consecutive working days, that impacts the laboratory's ability to perform its scope of testing, shall be reported to AIHA-LAP, LLC within twenty (20) business days. This notification requirement shall be in effect if the Technical Manager, the Quality Manager, or an analyst who is the only staff member that performs a given test, are absent for reasons of extended family leave, illness, temporary disability, etc.

- The laboratory shall provide day to day supervision of its technical operations by designating at least one Technical Manager (TM) per program.
- Qualifications of the Industrial Hygiene Program/Technical Manager:
- Minimum of three (3) years relevant nonacademic analytical experience. A minimum of two (2) years experience shall be in industrial hygiene analyses within the scope of accreditation. The remaining one (1) year may be from other laboratory analytical procedures. Relevant academic experience may be substituted for the remaining one (1) year work experience. A relevant post-graduate degree (MS or Ph.D.) shall also be considered equivalent to one (1) year of work experience. Academic experience and post-graduate degrees may not be substituted for the two (2) years industrial hygiene experience. (Environmental, forensic, or similar microanalytical experience shall be reviewed to determine if the specific experience is a reasonable substitute.) The Industrial Hygiene

Program/Technical Manager shall possess a bachelor's degree in an applicable physical or biological science.

- The Industrial Hygiene Program/Technical Manager shall be an employee of the laboratory.
- The Industrial Hygiene Program/Technical Manager shall be present on site at least 20 hours per week or 50 percent of the laboratory operating hours (whichever is less) to address technical issues for laboratory staff and customers.
- The Industrial Hygiene Program/Technical Manager shall authorize and document that all analyses for which the laboratory is accredited are completed by personnel with appropriate education and/or technical background in the Industrial Hygiene department. The Laboratory Director shall have the responsibility to ensure that personnel in other departments, performing industrial hygiene analyses, have appropriate education and/or technical background.
- The Industrial Hygiene Program/Technical Manager shall ensure that adequate supervision is provided for all laboratory technical personnel.
- The Industrial Hygiene Program/Technical Manager or their designee shall function as the approved signatory. The IH Program/Technical Manager/Laboratory Director/Customer Service Manager shall designate those individuals that may function as approved signatories using the Demonstration of Capability form for IH, PX-QAD-005.
- The Industrial Hygiene Program/Technical Manager/Laboratory Director/Customer Service Manager shall designate those individuals that may direct projects from setup through data interpretation and reporting.
- The Industrial Hygiene Program/Technical Manager shall in conjunction with the QA Department Manager ensure on-going proficiency for analysts and technicians that perform analyses that fall under the Industrial Hygiene Program: Every six months a chemist/tech must demonstrate ongoing proficiency. This can be accomplished through the analysis of PAT samples, at least 2 pairs of LCS/LCSD during the six month period, or by repeating the IDC as described in this SOP studies (every six months).
- The Industrial Hygiene Program/Technical Manager shall in conjunction with the QA Department Manager ensure initial/annual reporting level verification spikes are completed as appropriate for each analyte by analysts and technicians that perform analyses that fall under the Industrial Hygiene Program.
- The Industrial Hygiene Program/Technical Manager shall ensure method validation/desorption efficiency studies are performed as appropriate by for analysts and technicians that perform analyses that fall under the Industrial Hygiene Program.
- The Industrial Hygiene Program/Technical Manager shall research and development of new analytical procedures and improvements to current procedures.
- The Industrial Hygiene Program/Technical Manager or their designee, during an absence, shall perform secondary review of all data produced for analyses that fall under the Industrial Hygiene Program.

- The Industrial Hygiene Program/Technical Manager shall posses the following authority:

  Stop work on analytical methods that fall under the Industrial Hygiene Program.

  Hold or stop issuance of reports that fall under the Industrial Hygiene Program.

4.2.5 Environmental Health and Safety Coordinator

The Environmental Health and Safety Coordinator reports directly to the Laboratory Director and has a dotted line reporting responsibility to the Corporate Environmental Health and Safety Officer. The Environmental Health and Safety Coordinator may also act as the Hazardous Waste Manager or delegate the duties to an authorized and properly trained employee.

- Ensuring compliance with air permits.
- Conduct ongoing, required safety training and conduct new employee safety orientation.
- Assist in developing and maintaining the Facility Addendum to the Corporate Employee Health and Safety Manual.
- The Environmental Health and Safety and Hazardous Waste Coordinators shall be tasked with reviewing and updating annually the Hazardous Waste Contingency Plan in the Facility Addendum to the Corporate Environmental Health & Safety Manual
- Administer dispersal of all Material Safety Data Sheet (MSDS) information.
- Perform regular chemical hygiene and housekeeping instruction.
- Give instruction on proper labeling and practice.
- Serve as chairman of the laboratory safety committee.
- Provide and train personnel on protective equipment.
- Oversee the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash stations, etc. and ensure prompt repairs as needed.
- Supervise and schedule fire drills and emergency evacuation drills.
- The Environmental Health and Safety and Hazardous Waste Coordinators shall be tasked to determine what initial and subsequent exposure monitoring, if necessary to determine potential employee exposure to chemicals used in the laboratory.
- When determined necessary, conduct exposure monitoring assessments.
- Determine when a complaint of possible over-exposure is “reasonable” and should be referred for medical consultation.
- Assist in the internal and external coordination of the medical consultation/monitoring program conducted by TestAmerica’s medical consultants.

4.2.6 Hazardous Waste Coordinator

The Hazardous Waste Coordinator reports directly to the Laboratory Director. The duties consist of:

- Staying current with the hazardous waste regulations.
- Continuing training on hazardous waste issues.

- The Hazardous Waste and Environmental Health and Safety Coordinators shall be tasked with reviewing and updating annually the Hazardous Waste Contingency Plan in the Facility Addendum to the Corporate Environmental Health & Safety Manual.
- Contacting the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste.
- The Hazardous Waste and Environmental Health and Safety Coordinators shall be tasked to determine what initial and subsequent exposure monitoring, if necessary to determine potential employee exposure to chemicals used in the laboratory.
- Ensure proper collection and disposal of all hazardous waste.

4.2.7 Department Program Managers

The Department/Program Managers report directly to the Laboratory Director. Each one is responsible to:

- Ensure that analysts in their department/program adhere to applicable SOPs and the QA Manual. They perform frequent SOP and QA Manual review to determine if analysts are in compliance and if new, modified, and optimized measures are feasible and should be added to these documents.
- With regard to analysts, participates in the selection, training (as documented in Section 17.3), development of performance objectives and standards of performance, appraisal (measurement of objectives), scheduling, counseling, discipline, and motivation of analysts and documents these activities in accordance with systems developed by the QA and Human Resources Departments. They evaluate staffing sufficiency and overtime needs. Training consists of familiarization with SOP, QC, Safety, and computer systems.
- Encourage the development of analysts to become cross-trained in various methods and/or operate multiple instruments efficiently while performing maintenance and documentation, self-supervise, and function as a department team.
- Provide guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the QA Manager. Each is responsible for 100% of the data review and documentation, non-conformance and CAR issues, the timely and accurate completion of performance evaluation samples and MDLs, for his/her department/program.
- Ensure all logbooks are maintained, current, and properly labeled or archived.
- Report all non-conformance conditions to the QA Manager and/or Laboratory Director.
- Ensure that preventive maintenance is performed on instrumentation as detailed in the QA Manual or SOPs. He/She is responsible for developing and implementing a system for preventive maintenance, troubleshooting, and repairing or arranging for repair of instruments.
- Maintain adequate and valid inventory of reagents, standards, spare parts, and other relevant resources required to perform daily analysis.
- Achieve optimum turnaround time on analyses and compliance with holding times.
- Conduct efficiency and cost control evaluations on an ongoing basis to determine optimization of labor, supplies, overtime, first-run yield, capacity (designed vs.

demonstrated), second- and third-generation production techniques/instruments, and long-term needs for budgetary planning.

- Provide written responses to external and internal audit issues.

4.2.8 Industrial Hygiene Laboratory Analysts/Technicians

The industrial hygiene program distinguishes two titles for those conducting analytical procedures within the laboratory. An analyst is one who has a bachelor's degree in chemistry or a related science. A technician is one who does not have a degree in chemistry or a related science.

Analysts and Technicians that perform analyses which fall under the Industrial Hygiene Program shall report directly to the Industrial Hygiene Program/Technical Manager information regarding any analysis that fall under the Industrial Hygiene Program. Analysts and technicians may in addition to the IH Program/Technical Manager report to the designated department manager regarding other non-industrial Hygiene analyses and personnel issues.

Analysts and Technicians that perform analyses which fall under the Industrial Hygiene Program shall posses the qualifications and assume the responsibilities listed below in addition to the responsibilities listed under the Laboratory Analyst title.

This position is responsible for a variety of routine analyses or preparation procedures to determine and evaluate chemical and physical properties. Responsible for interpretation, organization, coordination and completion of routine and/or complex assignments as well preparation of sampling equipment and materials.

Any changes in laboratory ownership, location (except for mobile and field operations laboratories), management, quality control personnel, or any other change that significantly affects the laboratory's capability, scope of accreditation, or ability to meet the policy requirements, shall be reported in writing to AIHA-LAP, LLC within twenty (20) business days of the change. Any absence of personnel for a period in excess of twenty (20) consecutive working days, that impacts the laboratory's ability to perform its scope of testing, shall be reported to AIHA-LAP, LLC within twenty (20) business days. This notification requirement shall be in effect if the Technical Manager, the Quality Manager, or an analyst who is the only staff member that performs a given test, are absent for reasons of extended family leave, illness, temporary disability, etc.

- Successful training (in-house courses are acceptable) in specific methodologies used in the laboratory shall be documented. In house training to be provided on sample preparation and instrument analysis prior to performing independent analysis of laboratory samples. All analysts and technicians shall have a minimum of twenty (20) business days of hands-on experience conducting analyses in an industrial hygiene laboratory before initiation of independent work on customer samples. The criteria and training requirements for laboratory personnel shall be clearly defined, documented and maintained on file in the Quality Assurance office.

- Training Program content, duration, qualifications of the trainer, and objective evidence that the analyst/technician has successfully analyzed unknown reference samples of the matrices/analytes of concern within specified criteria. The dates of authorization to perform

specific tasks shall be recorded on the DOC form, PX-QAD-005 and a copy be placed on file in the Quality Assurance office.

- Analysts and Technicians shall have demonstrated ability to produce reliable results through accurate analysis of certified reference materials (CRMs), proficiency testing samples, or in-house quality control samples. Their performance must be documented.

- Analysts and Technicians shall be responsible for complying with all quality assurance and quality control requirements pertaining to their technical functions.

- Analysts and Technicians shall be responsible to perform on-going proficiency for analyses that fall under the Industrial Hygiene Program: Every six months a chemist/tech must demonstrate ongoing proficiency. This can be accomplished through the analysis of PAT samples, at least 2 pairs of LCS/LCSD during the six month period, or by repeating the IDC as described in this SOP studies (every six months).

- Analysts and Technicians shall be responsible to ensure initial and/or annual reporting level verification spikes are completed as appropriate for each analyte for each method as appropriate, that fall under the Industrial Hygiene Program.

- Analysts and Technicians shall ensure method validation/desorption efficiency studies are performed as appropriate by for analysts and technicians that perform analyses that fall under the Industrial Hygiene Program.

- Analysts and Technicians may assist in research and development of new analytical procedures and improvements to current procedures.

- Analysts and Technicians shall perform preparation and analyses on a variety of samples according to the associated SOP.

- Analysts and Technicians shall train new analysts and technicians in proper use of equipment, maintenance, setup and procedures, as appropriate.

- Analysts and Technicians shall operate, maintain, and trouble shoot as applicable various analytical instrumentation including but not limited to GC-MS, GC, ICP, ICP-MS, cold vapor AA, IC, HPLC UV/VIS, etc.

- Analysts and Technicians shall be responsible to prepare data, perform routine calculations, prepare graphs, tables, and control charts, maintain appropriate organization and cleanliness in lab areas and keep inventory of supplies.

4.2.9 Laboratory Analysts

Laboratory analysts are responsible for conducting analysis and performing all tasks assigned to them by the group leader or Department Manager. The responsibilities of the analysts are listed below:

- Perform analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.

- Document standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on logbooks, benchsheets, lab notebooks and/or the Non-Conformance Database.
- Report all non-conformance situations, instrument problems, matrix problems and QC failures, which might affect the reliability of the data, to their Department or Program Manager as applicable, and/or the QA Manager or member of QA staff.
- Perform 100% review of the data generated prior to entering and submitting for secondary level review.
- Suggest method improvements to their Department/Program Manager, and the QA Manager. These improvements, if approved, will be incorporated. Ideas for the optimum performance of their assigned area, for example, through the proper cleaning and maintenance of the assigned instruments and equipment, are encouraged.
- Work cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

4.2.10 LIMS Specialist

The LIMS Specialist is the individual responsible for the operation, validation, and implementation of the laboratory information management system. LIMS consist of the computer and software used to identify, schedule, prioritize, perform calculations, generate reports, store results, and perform any other computerized function necessary to control the flow of samples through the laboratory. This person should have a bachelor's degree and/or appropriate laboratory and/or computer skills and education.

4.2.11 Client Services Manager (CSM)

The Client Services Manager reports to the Laboratory Director and serves as the interface between the laboratory's technical departments and the laboratory's clients. The staff consists of the Project Management team. With the overall goal of total client satisfaction, the functions of this position are outlined below:

- Technical training and growth of the Project Management team.
- Technical liaison for the Project Management team.
- Human resource management of the Project Management team.
- Responsible to ensure that clients receive the proper sampling supplies.
- Accountable for response to client inquiries concerning sample status.
- Responsible for assistance to clients regarding the resolution of problems concerning COC.
- Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory.
- Notifying the Department Managers of incoming projects and sample delivery schedules.
- Accountable to clients for communicating sample progress in status meetings with agreed-upon due dates.

- Responsible for discussing with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff.
- Responsible for staff familiarization with specific quotes, sample log-in review, and final report completeness.
- Monitor the status of all data package projects in-house to ensure timely and accurate delivery of reports.
- Inform clients of data package-related problems and resolve service issues.
- Coordinate requests for sample containers and other services (data packages).

4.2.12 Sample Receiving

In addition to the client services duties (4.2.1), the Client Services Manager oversees the Sample Receiving Department. He/She, or designee is responsible for ensuring the timely and correct shipment of sample containers, including proper preservatives and instructions, to clients. He/She maintains accurate records of sample container shipments. The responsibilities are outlined below:

- Direct the logging of incoming samples into the LIMS.
- Ensure the verification of data entry from login.
- Supervises the organized storage and appropriate climate control of samples.
- Supervises the disposal of samples in accordance with the Waste Disposal SOP, the corporate Environmental Health and Safety Manual, the Hazardous Waste Contingency Plan in the facility addendum to the corporate safety manual, and the U. S. Department of Agriculture requirements.

4.3 DEPUTIES

The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy	Comment
Laboratory Director	Business Development Manager	Operational Issues
Laboratory Director	Quality Assurance Manager	Quality Assurance Issues
QA Manager	Laboratory Director and / or QA Specialist	
Client Services Manager	Business Development Manager	
Sample Receiving Group Leader	Client Services Manager	
Industrial Hygiene Program/Technical Manager	Business Development Manager	

Key Personnel	Deputy	Comment
VOA Department Manager	VOAs Lead, SVOAs Manager and /or Laboratory Director	
SVOA/Extractions Department Manager	SVOAs Lead, VOAs Manager and / or Laboratory Director	
Inorganics Manager	Metals Lead, Inorganics Lead and / or Laboratory Director	
Environmental Health & Safety Coordinator	Hazardous Waste Coordinator/ or Laboratory Director	
Hazardous Waste Coordinator	Environmental Health & Safety Coordinator and / or Laboratory Director	

Figure 4-1

Corporate Organizational Chart

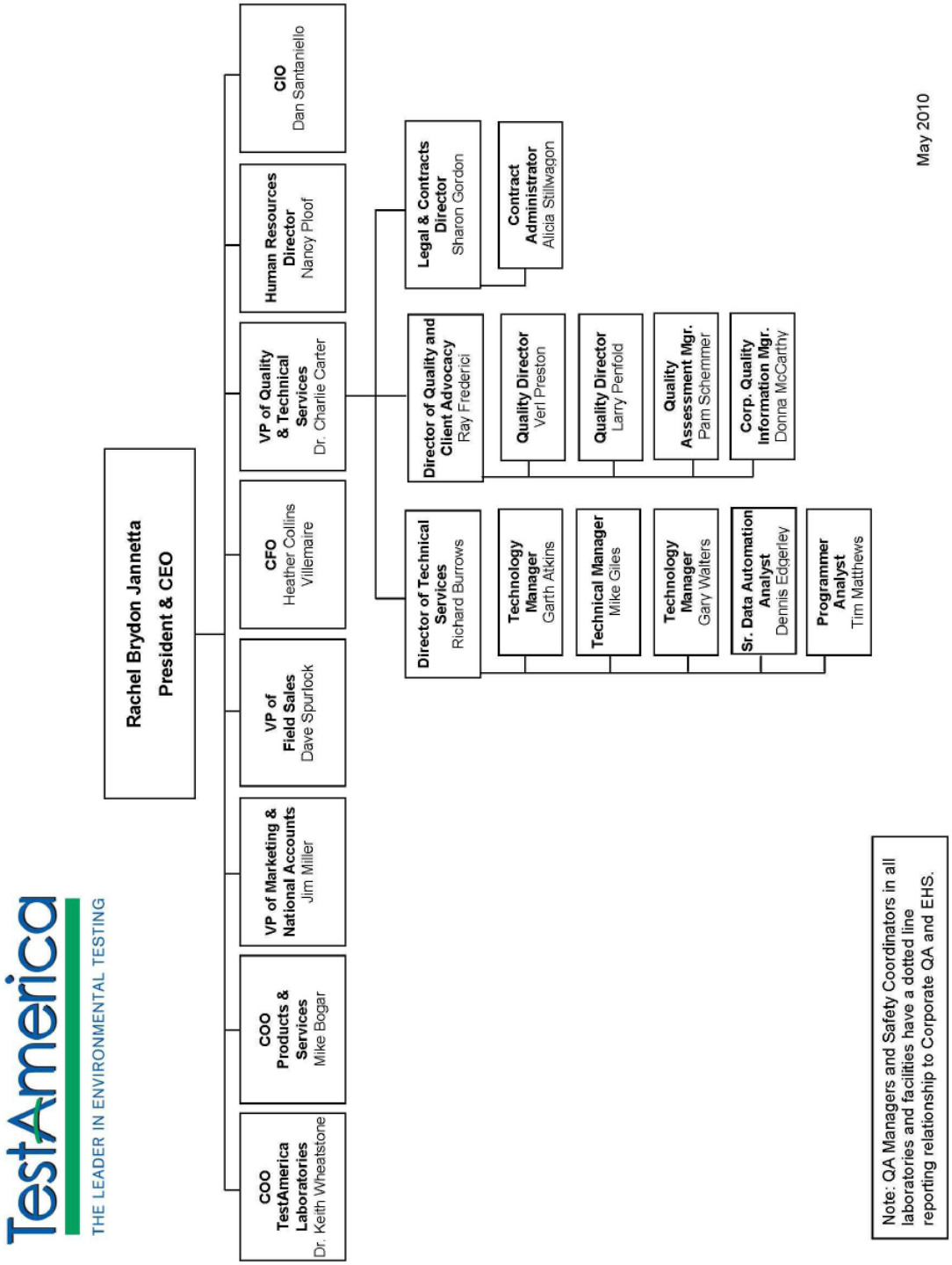
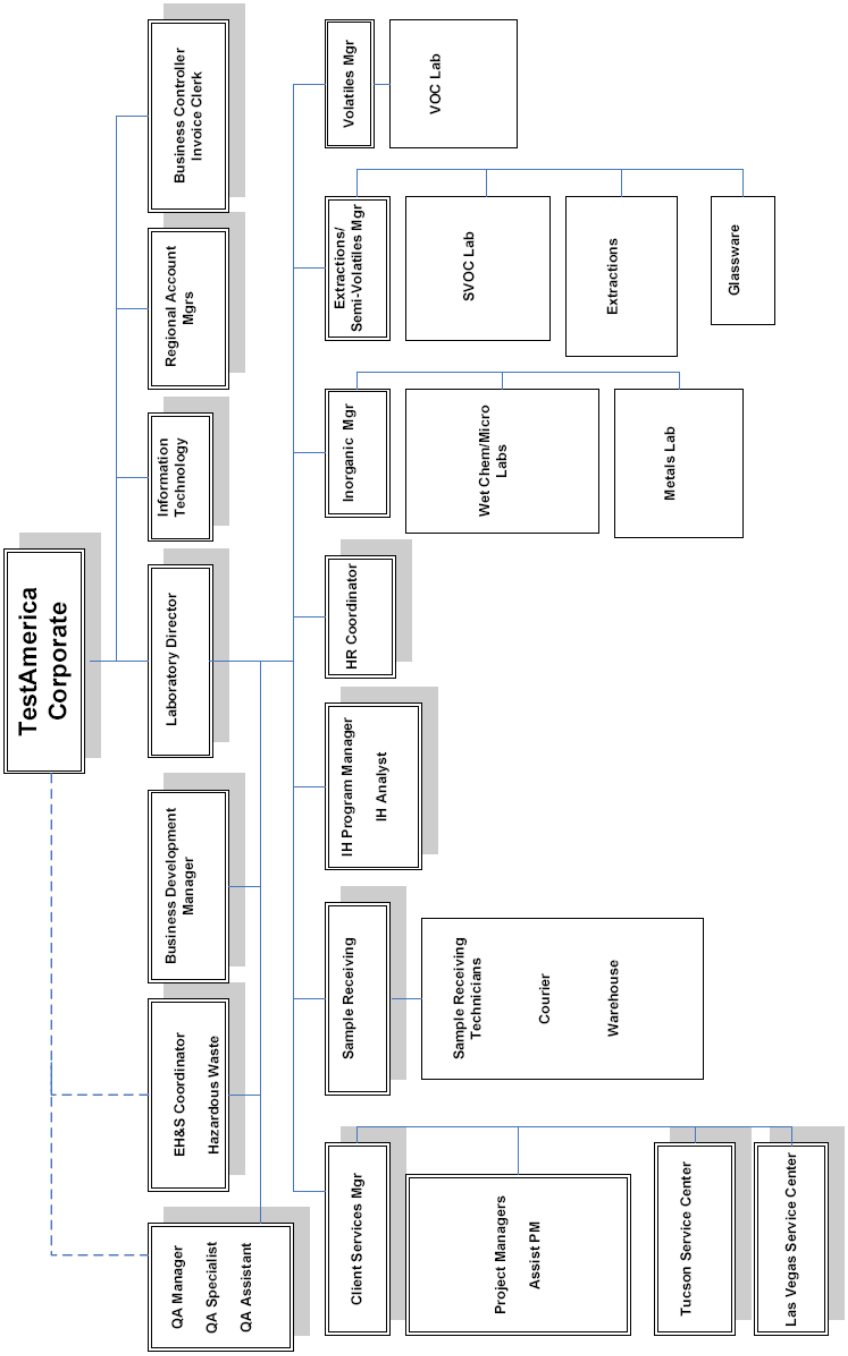


Figure 4-1

Laboratory Organizational Chart



A laboratory Organizational Chart with personnel listed is on file in QA Office

SECTION 5

QUALITY SYSTEM *(NELAC 5.4.2)*

5.1 QUALITY POLICY STATEMENT

It is TestAmerica's Policy to:

- Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.
- Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.
- Continually improve systems and provide support to quality improvement efforts in laboratory, administrative and managerial activities. TestAmerica recognizes that the implementation of a quality assurance program requires management's commitment and support as well as the involvement of the entire staff.
- Provide clients with the highest level of professionalism and the best service practices in the industry.
- It is TestAmerica Phoenix's Policy to comply with the ISO/IEC 17025:2005 International Standard for all NELAC and AIHA analyses, and to continually improve the effectiveness of the management system.

Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 ETHICS AND DATA INTEGRITY

TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of TestAmerica's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy CA-L-P-001) and Employee Ethics Statements.
- Ethics and Compliance Officers (ECOs).
- A Training Program.
- Self-governance through disciplinary action for violations.
- A Confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct (Corporate SOP CA-L-S-001).
- Procedures and guidance for recalling data if necessary (Corporate SOP CA-L-S-001).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15).
- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs).

- Present services in a confidential, honest and forthright manner.
- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 QUALITY SYSTEM DOCUMENTATION

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab specific quality assurance manual.
- Corporate SOPs and Policies – Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.
- Work Instructions – A subset of procedural steps, tasks or forms associated with an operation of a management system (e.g., checklists, preformatted bench sheets, forms).
- Laboratory SOPs – General and Technical.
- Corporate Quality Policy Memorandums.
- Laboratory QA/QC Policy Memorandums.

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Policy Memorandum
- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), memos, flow charts, etc.)

Note: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP

conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's (QAM) shall take precedence over the CQMP in those cases.

5.4 QA/QC OBJECTIVES FOR THE MEASUREMENT OF DATA

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control is generally understood to be limited to the analyses of samples and to be synonymous with the term *"analytical quality control"*. QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. Additionally, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS). For AIHA we add Bias and Measurement Uncertainty.

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference between separately procured, but otherwise identical samples or sample aliquots.

The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision and reporting limits with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability will be defined in a QAPP, project scope or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), interelement corrections (separation), use of matrix modifiers (separation), specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific wavelengths (identification), specific mass spectra (identification), specific electrodes (separation and identification), etc.

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Method Detection Limit) or quantified (Reporting Limit).

5.5 CRITERIA FOR QUALITY INDICATORS

The laboratory precision and accuracy acceptability limits for performed analyses can be found in Element. This summary includes an effective date, is updated each time new limits are generated and are managed by the laboratory's QA department. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from published methods (US EPA methods and other regulatory methods) when they are required. Where method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits are contained in SOP PE-QAD-001 Control Charts and Statistical Process Control and/or Section 24.

5.6 STATISTICAL QUALITY CONTROL

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs [such as Arizona Department of Health Services (ADHS)]. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The analysts are instructed to use the current limits in the laboratory (dated and approved by the Department Manager and QA Manager) and entered into the Laboratory Information Management System (LIMS). The Quality Assurance department maintains an archive of all limits used within the laboratory (see SOP PE-QAD-001). If a method defines the QC limits, the method limits are used.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the LIMS following the guidelines described in Section 24. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

Surrogate recoveries are determined for a specific time period as defined above. The resulting ranges are entered in LIMS.

Current QC limits are entered and maintained in the LIMS analyte database. As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.6.1 QC Charts

The QA Manager and Department Supervisor evaluate these to determine if adjustments need to be made or for corrective actions to methods. All findings are documented and kept on file.

5.7 QUALITY SYSTEM METRICS

In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

SECTION 6

DOCUMENT CONTROL *(NELAC 5.4.3)*

6.1 OVERVIEW

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled:

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Corporate Policies and Procedures distributed outside the intranet

Corporate Quality posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP CW-Q-S-001, Corporate Document Control and Archiving. The laboratory's internal document control procedure is defined in SOP PE-QAD-010 Document Control.

The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. Instrument manuals (hard or electronic copies) are also maintained by the laboratory.

The laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports (CAR). Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports.

6.2 DOCUMENT APPROVAL AND ISSUE

The pertinent elements of a document control system for each document include a unique document title and number, the number of pages of the item, the effective date, revision number and the laboratory's name. The QA personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department and other management personnel. In order to develop a new document, a Department Manager submits an electronic draft to the QA Department for suggestions and approval before use. Upon approval, QA personnel add the identifying version information to the document and retains the official document on the QA Server. The official document is provided to all applicable operational units (may include

electronic access). Controlled documents are identified as such and records of their distribution (where applicable) are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed at a minimum of every year for drinking water and AIHA methods, and every two years for all other methods and are revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 PROCEDURES FOR DOCUMENT CONTROL POLICY

For changes to the QA Manual, refer to SOP PE-QAD-010 Document Control. Previous revisions and back-up data are stored by the QA Department. Electronic copies are stored on the Public server in the QA folder (\\phx-fs-01\QAPublic) for the applicable revision, accessible to all Phoenix employees.

For changes to SOPs, refer to SOP PE-QAD-014 Creation and Maintenance of SOPs. The SOP identified above also defines the process of changes to SOPs.

Forms, worksheets, work instructions and information are organized and maintained by the QA Department. A table of contents and electronic versions are kept on the QA department server. The procedure for the care of these documents is in SOP PE-QAD-010 Document Control.

6.4 OBSOLETE DOCUMENTS

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. At least one copy of the obsolete document is archived according to SOP PE-QAD-014 Creation and Maintenance of SOPs and SOP PE-QAD-010 Document Control.

SECTION 7

SERVICE TO THE CLIENT *(NELAC 5.4.7)*

7.1 OVERVIEW

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (% Recovery and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these regulatory and client requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica facility or to an outside firm, this will be documented and discussed with the client prior to contract approval. (Refer to Section 8 for Subcontracting Procedures.)

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or TestAmerica, are documented in writing.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

7.2 REVIEW SEQUENCE AND KEY PERSONNEL

Appropriate personnel will review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the Project Manager (PM) is considered adequate. The PM confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements and that the lab has the capacity to meet the clients turn around needs. It is recommended that, where there is a sales person assigned to the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

For new, complex or large projects, the proposed contract is given to the National Account Director, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in TestAmerica's Corporate SOP CA-L-P-002, Contract Compliance Policy.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (not necessarily in the order below):

- Legal & Contracts Director
- General Manager
- Client Services Manager
- Corporate Technical Director
- Industrial Hygiene Program/Technical Manager
- Laboratory Department Managers
- Laboratory and/or Corporate Information Technology Managers/Directors
- Corporate Sales and Marketing representatives
- Laboratory and/or Corporate Quality Assurance
- Laboratory and/or Corporate Environmental Health and Safety Coordinator/Director
- The Business Development Manager reviews the formal laboratory quote and makes final acceptance for the facility.

The National Account Director, Legal Contracts Director, or local account representative then submits the final proposal to the client.

In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements.

The Legal & Contracts Director maintains copies of all signed contracts. The Business Development Manager or the Project Manager maintains the local copies of the contracts.

7.3 DOCUMENTATION

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes. Those records are maintained locally as needed.

The contract will be distributed to and maintained by the appropriate sales/marketing personnel. A copy of the contract and formal quote will be filed with the laboratory Project Manager (PM).

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps a phone log of conversations with the client. Client correspondence and internal communications regarding projects are kept in the project file.

7.3.1 Project-Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, the laboratory assigns a PM to each client. It is the PM's responsibility to ensure that project specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA Department involvement may be needed to assist in the evaluation of custom QC requirements.

PMs are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during status meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes (e.g., use of a non-standard method or modification of a method) and approvals must be documented prior to implementation. Documentation pertains to any document, e.g., letter, e-mail, variance, contract addendum, which has been signed by both parties.

Such changes are also communicated verbally to the laboratory during status meetings. Such changes are updated to the project notes and are introduced to the managers at these meetings. The laboratory staff is then introduced to the modified requirements via the PM or the individual laboratory Department Manager. After the modification is implemented into the laboratory process, documentation of the modification is made in the case narrative of the data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 SPECIAL SERVICES

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 15 and 25).

Note: ISO 17025/NELAC 2003 states that a laboratory "shall afford clients or their representatives cooperation to clarify the client's request".

The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

- Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.
- Assist client-specified third party data validators as specified in the client's contract.
- Supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

7.5 CLIENT COMMUNICATION

Project Managers are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project Management will maintain ongoing client communication throughout the entire client project.

Department Managers are available to discuss any technical questions or concerns that the client may have.

7.6 REPORTING

The laboratory works with our clients to produce any special communication reports required by the contract.

7.7 CLIENT SURVEYS

The laboratory solicits and assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service.

TestAmerica's Sales and Marketing teams periodically develops lab and client specific surveys to assess client satisfaction.

SECTION 8

SUBCONTRACTING OF TESTS *(NELAC 5.4.5)*

8.1 OVERVIEW

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the TestAmerica laboratories. The phrase "work sharing" refers to internal transfers of samples between the TestAmerica laboratories. The term outsourcing refers to the act of subcontracting tests.

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and will meet the same commitments we have made to the client. Refer to TestAmerica's Corporate SOPs on Subcontracting Procedures (CA-L-S-002) and the Work Sharing Process (CA-C-S-001).

When outsourcing analytical services, the laboratory will assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in NELAC/AIHA/ISO 17025 and/or the client's Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client's analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-NELAC/AIHA accredited work where required.

Project Managers (PMs), Customer Service Manager (CSM), or Account Executives for the Export Lab are responsible for obtaining client approval prior to outsourcing any samples. The laboratory will advise the client of a subcontract or work sharing arrangement in writing and when possible approval from the client shall be retained in the project folder.

Note: In addition to the client, some regulating agencies, such as the US Army Corps of Engineers and the USDA, require notification prior to placing such work.

8.2 QUALIFYING AND MONITORING SUBCONTRACTORS

Whenever a PM, Account Executive or CSM becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory;
- Firms specified by the client for the task (Documentation that a subcontractor was designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder).
- Firms listed as pre-qualified and currently under a subcontract with TestAmerica. A listing of all approved subcontracting laboratories and supporting documentation is available on the TestAmerica intranet site. Verify necessary accreditation, where applicable, (e.g., on the

subcontractors NELAC, AIHA accreditation or State Certification).

- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses.
- NELAC or AIHA accredited laboratories.
- In addition, the firm must hold the appropriate certification/accreditation to perform the work required. For NELAC and AIHA accreditation, this would include accreditation to the same Field of Testing.

All TestAmerica laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approved sending samples to that laboratory. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. (Corporate SOP CA-C-S-001, Work Sharing Process).

When the potential sub-contract laboratory has not been previously approved, Account Executives or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director. The Laboratory Director requests that the QA Manager begin the process of approving the subcontract laboratory as outlined in Corporate SOP CA-L-S-002, Subcontracting Procedures. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented)

8.2.1 Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to Corporate Contracts for formal contracting with the laboratory. They will add the lab to the approved list on the intranet site along with the associate documentation and notify the finance group for JD Edwards entry.

8.2.2 The client will assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are known to meet minimal standards. TestAmerica does not certify laboratories. The subcontractor is on our approved list and can only be recommended to the extent that we would use them.

8.2.3 The status and performance of qualified subcontractors will be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified will be brought to the attention of TestAmerica's Corporate Finance or Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation and corrective action will be maintained in the subcontractor's file on the intranet site. Complaints are posted using the Vendor Performance Report (Form CW-F-WI-009).
- Information shall be updated on the intranet when new information is received from the subcontracted laboratories.

- Subcontractors in good standing will be retained on the intranet listing. The QA Manager will notify all TestAmerica laboratories, Corporate Quality and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all Lab Directors, QA Managers and Sales Personnel.

8.3 OVERSIGHT AND REPORTING

The PM, CSM or Account Executive must request that the selected subcontractor be presented with a subcontract, if one is not already executed between the laboratory and the subcontractor. The subcontract must include terms which flow down the requirements of our clients, either in the subcontract itself or through the mechanism of work orders relating to individual projects. A standard subcontract and the Lab Subcontractor Vendor Package (posted on the intranet) can be used to accomplish this, and the Legal & Contracts Director can tailor the document or assist with negotiations, if needed. The PM, CSM or Account Executive responsible for the project must advise and obtain client consent to the subcontract as appropriate, and provide the scope of work to ensure that the proper requirements are made a part of the subcontract and are made known to the subcontractor.

Prior to sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. The information is documented on the Client Approved Subcontracted Sample Form, PX-PDM-012 and the form is retained in the project folder. The form is not required if the need to subcontract the analysis has been identified in the project quote. For TestAmerica laboratories, certifications can be viewed on the company's TotalAccess Database.

The Sample Control department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

All subcontracted samples must be accompanied by a Chain of Custody (COC). A copy of the original COC sent by the client must be included with all samples subbed within TestAmerica. Additionally, if the samples are sent to another TestAmerica Laboratory a Work Share Agreement (figure 8-1) is completed and attached to the COC.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

Non-NELAC or non-AIHA accredited work must be identified in the subcontractor's report as appropriate. If NELAC or AIHA accreditation is not required, the report does not need to include this information.

Reports submitted from subcontractor laboratories are not altered and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the laboratories EDD (i.e., imported), the report must explicitly indicate which lab produced the data for which methods and samples.

Note: The results submitted by a TestAmerica work sharing laboratory may be transferred electronically and the results reported by the TestAmerica work sharing lab are identified on the

final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4 CONTINGENCY PLANNING

The Laboratory Director may waive the full qualification of a subcontractor process temporarily to meet emergency needs. In the event this provision is utilized, the QA Manager will be required to verify certifications. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

Figure 8-1

Example Work Share Agreement

TestAmerica	Work Sharing Agreement (Include with every sample shipment)		Exporting Lab	
			Project Name	
Import Lab Information			Export Lab Information	
Lab Name			PM Contact Name	
PM Contact Name			Backup Contact Name	
Backup Contact Name			Agreement Date	
Pricing Information			Project Information	
QA/QC (i.e. MS/MSD) Billable?	No		Client Company Name	
Raw Data Surcharge		%	Date First Samples to Arrive	
EDD Surcharge		%	Est. Duration of Sampling Event	
TAT Surcharges		%		
Penalty Terms	None			
Other Charges Not in Unit Price? (i.e. canisters, Level IV III, shipping, bottles)	None		Quote or Contract Reference ID	
Project Details				
Non-Standard Work Product	No			
Quality Assurance Plan	No			
List Certifications Required				
Analyte/Cmpd. List with RLs Attached	No			
Results Dry-Weight Corrected	No			
Special Method Holding Times	None			
Internal Chain of Custody Required	No			
Known Hazards/High Analyte Level	No			
Saturday/Special Delivery Options	None			
Special Instructions	None			
Reporting Limit Value Convention	Report to MDL with "J" Values up to	"Non-Detect" Presentation Convention		U

Deliverable Requirements		Transmittal medium	Format Column	Date Due to Export Lab	Import and Export Lab Agreement
Preliminary Report:	No				*Import lab must acknowledge* receipt of Agreement and samples *via E-Mail*
Final Report:	No				
EDD:	No		Type Format Name		
Total Access Reporting	No	NA	NA		
Custom Forms:	No	NA	Type Format Name		
"Other" Deliverable Definitions or Notes					

Analysis	Method	Matrix	# of Samples	Import Lab's Unit Price	Unit Price w/Surcharges	Extended Price
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					$ -	$ -
					Approximate Total Project Value	$ -

Work Instruction No. CA-WI-010/B-10/08

SECTION 9

PURCHASING SERVICES AND SUPPLIES *(NELAC 5.4.6)*

9.1 OVERVIEW

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment which may affect quality conform to specified requirements, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with TestAmerica's Corporate Capital Expenditure Request and Controlled Purchases Procedure, SOP CW-F-S-007.

Contracts will be signed in accordance with TestAmerica's Corporate Company Wide Authorization Matrix, Policy CW-F-P-002. Request for Proposals (RFP's) will be issued where more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts Policy (CW-F-P-004). RFP's allow TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the TestAmerica facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 GLASSWARE

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

9.3 REAGENTS, STANDARDS & SUPPLIES

Purchasing guidelines for equipment and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with TestAmerica's Corporate SOP on Solvent & Acid Lot Testing & Approval, SOP CA-Q-S-001.

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination. This information is contained in the method SOP.

For any order, the assigned analyst (generally one person per department is assigned to order supplies) places an order request in the JD Edwards purchasing system and must provide the

item number, item description, package size, and the quantity needed when completing the order in JD Edwards.. The corporate purchasing manager then places the order once the order request has been approved. Alternatively, an analyst may check the item out of the on-site consignment system that contains items approved for laboratory use.

9.3.2 Receiving

It is the responsibility of the warehouseman to receive the shipment. It is the responsibility of the warehouseman to date the material when received and compare the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. The laboratory department receiving the item confirms that the quality of the item received meets the level specified. Material Safety Data Sheets (MSDSs) are available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals. Any MSDS should be given to EHS for review. The intranet is checked to determine if the MSDS is already available. If it is not an electronic copy of the MSDS is sent to corporate EHS where it is added to the Company's intranet.

9.3.3 Specifications

All methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, it may be assumed that it is not significant in that procedure and, therefore, any grade reagent may be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five year expiration date on inorganic dry chemicals unless noted otherwise by the manufacturer or by the reference source method. Chemicals should not be used past the manufacturer's or SOPs expiration date unless 'verified' (refer to item 3 listed below).

- An expiration date can not be extended if the dry chemical is discolored or appears otherwise physically degraded, the dry chemical must be discarded.

- Expiration dates can be extended if the dry chemical is found to be satisfactory based on acceptable performance of quality control samples (Continuing Calibration Verification (CCV), Blanks, Laboratory Control Sample (LCS), etc.).

- If the dry chemical is used for the preparation of standards, the expiration dates can be extended 6 months if the dry chemical is compared to an unexpired independent source in performing the method and the performance of the dry chemical is found to be satisfactory. The comparison must show that the dry chemical meets CCV limits. The comparison studies are maintained in the QA office.

- Note: The five year expiration date applies to all Industrial Hygiene standards that are considered 'neat'.

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

Compressed gases in use are checked for pressure and secure positioning daily. The minimum total pressure must be 500 psig or the tank must be replaced. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of standards or reagents must have a specific conductivity of less than 1- mmho/cm (or specific resistivity of greater than 1.0 megaohm-cm) at 25°C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the appropriate Department Managers must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified "clean" by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased VOA vials must be certified clean and the certificates must be maintained. If uncertified VOA vials are purchased, all lots must be verified clean prior to use. This verification must be maintained.

Records of manufacturer's certification and traceability statements are maintained in files or binders in each laboratory section or are entered into LIMS. These records include date of receipt, lot number (when applicable), and expiration date (when applicable).

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Environmental Health & Safety Manual (CW-E-M-001) and method SOPs or manufacturer instructions.

9.4 PURCHASE OF EQUIPMENT/INSTRUMENTS/SOFTWARE

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or Department Manager makes a supply request to the Laboratory Director. If they agree with the request, the procedures outlined in TestAmerica's Corporate Policy CA-T-P-001, Qualified Products List, are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The appropriate written requests are completed and purchasing places the order.

Upon receipt of a new or used piece of equipment, an identification name is assigned and added to the equipment list. IT must also be notified so that they can synchronize the instrument for back-ups. Its capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated, followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 19). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department. Software certificates supplied by the vendors are filed with the local IT Department. The manufacturer's operation manual is retained at the bench.

9.5 SERVICES

Service to analytical instruments (except analytical balances) is performed on an as needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is determined by analysts and/or Department Managers. The service providers that perform the services are approved by the Department Managers or Laboratory Director.

9.6 SUPPLIERS

TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Corporate Finance documents on Vendor Selection (SOP CW-F-S-018) and Procurement & Contracts Policy (Policy CW-F-P-004). The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The JD Edwards purchasing system includes all suppliers/vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report (CW-F-WI-009).

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

As deemed appropriate, the Vendor Performance Reports will be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors.

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the JD Edwards purchasing system.

9.6.1 New Vendor Procedure

TestAmerica employees who wish to request the addition of a new vendor must complete a JDE Vendor Add Request Form (CW-F-WI-007) available on the company intranet site.

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with TestAmerica employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department and/or the Laboratory Director are consulted with vendor and product selection that have an impact on quality.

SECTION 10

COMPLAINTS *(NELAC 5.4.8)*

10.1 OVERVIEW

The laboratory considers an effective client complaint handling processes to be of significant business and strategic value. Listening to and documenting client concerns captures 'client knowledge' that enables our operations to continually improve processes and client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of our business services (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and SOP PE-QAD-027 Procedures to Address Customer Complaints. It is documented following laboratory SOP PE-PMD-002 Project Management Communication and Documentation including entry into LIMS.

10.2 EXTERNAL COMPLAINTS

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to SOPs PE-QAD-027 Procedures to Address Customer Complaints and PE-PMD-002 Project Management Communication and Documentation.

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints should be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Complaint Investigation and Service Recovery
- Process Improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.3 INTERNAL COMPLAINTS

Internal complaints include, but are not limited to: errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and shall follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing and IT may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 12.

10.4 MANAGEMENT REVIEW

The number and nature of client complaints is reported by the QA Manager to the laboratory and QA Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Review (Section 16).

SECTION 11

CONTROL OF NON-CONFORMING WORK *(NELAC 5.4.9)*

11.1 OVERVIEW

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the corrective action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. When an analyst encounters such a situation, the problem is presented to the Department Manager for resolution. The Department Manager may elect to discuss it with the Laboratory Director and/or the QA Manager or have a representative contact the client to decide on a logical course of action. Once an approach is agreed upon, the analyst documents it in the analytical data. This information can then be supplied to the client in the form of a footnote or a case narrative with the report.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 19. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Laboratory Director and QA Manager, documented and included in the project folder. Deviations **must** also be noted on the final report with a statement that the compound is not reported in compliance with NELAC (or the analytical method) requirements and the reason. Data being reported to a non-NELAC state would need to note the change made to how the method is normally run.

11.2 RESPONSIBILITIES AND AUTHORITIES

TestAmerica's Corporate SOP entitled Internal Investigation of Potential Data Discrepancies and Determination for Data Recall (SOP CA-L-S-001) outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

Under certain circumstances, the Laboratory Director, a Department Manager, or a member of the QA team may authorize departures from documented procedures or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc. In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must

be well documented using the laboratory's corrective action procedures. This information may also be documented in logbooks and/or data review checklists as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to facility Senior Management within 24-hours. The Senior Management staff is comprised of the Laboratory Director, the QA Manager, the Client Services Manager and the Department Managers. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an Ethics and Compliance Officer (ECO), the Director of Quality & Client Advocacy and the laboratory's Quality Director within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

The Laboratory Director, QA Manager, ECOs, Corporate Quality, the COO, General Managers and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work. Any employee has the right to stop their work if they feel the quality may be compromised or cannot be completed as required.

11.3 EVALUATION OF SIGNIFICANCE AND ACTIONS TAKEN

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

TestAmerica's Corporate Internal Investigation of Potential Data Discrepancies and Determination for Data Recall procedure (SOP CA-L-S-001) distinguishes between situations when it would be appropriate for laboratory management to make the decision on the need for client notification (written or verbal) and data recall (report revision) and when the decision must be made with the assistance of the ECO's and Corporate Management. Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/corrective action reporting in lieu of the data recall determination form contained in TestAmerica's Corporate SOP CA-L-S-001.

11.4 PREVENTION OF NONCONFORMING WORK

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's corrective action system. On a monthly basis, the QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's corrective action process may be followed.

11.5 METHOD SUSPENSION/RESTRICTION (STOP WORK PROCEDURES)

In some cases, it may be necessary to suspend/restrict the use of a method or target compound which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 5.

Prior to suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the Laboratory Director.

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases, that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line.

The QA Manager will also initiate a corrective action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed upon steps should be faxed or e-mailed by the laboratory to the appropriate General Manager and member of Corporate QA. This fax/e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the internet. It is the responsibility of the Laboratory Director to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction (e.g., Project Management, Log-in, etc…). Clients will NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (Laboratory Director, QA Manager, Department Managers and Client Services Manager) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management, the Client Services Manager and the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete. This approval is given by final signature on the completed corrective action report.

SECTION 12

CORRECTIVE ACTION *(NELAC 5.4.10)*

12.1 OVERVIEW

A major component of TestAmerica's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the corrective action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Non-conformance events and corrective actions are documented using Corrective Action Reports (CAR) (refer to Figure 12-1).

12.2 GENERAL

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc.

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility(s) for investigating.
- Resolve non-conformance events and assign responsibility for any required corrective action.
- Identify Systematic Problems before they become serious.
- Identify and track client complaints and provide resolution.

12.2.1 Corrective Action Report (CAR) - is used to document the following types of non conformance events and corrective actions (refer to SOP PE-QAD-007 Corrective Actions):

- Deviations from an established procedure or SOP
- QC outside of limits (non-matrix related)
- Isolated reporting / calculation errors
- Systematic reporting / calculation errors
- Client complaints
- Reissued reports
- Data recall
- Questionable trends that are found in the monthly review of CARs
- Issues found while reviewing CARs that warrant further investigation
- Internal and external audit findings
- Failed or unacceptable PT results
- Corrective actions that cross multiple departments in the laboratory

12.3 CLOSED LOOP CORRECTIVE ACTION PROCESS

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term and may include Root Cause Analysis), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. A CAR must be initiated, someone is assigned to investigate the issue and the event is investigated for cause. Table 12-1 provides some general guidelines on determining responsibility for assessment.
- The cause analysis step is the key to the process as a long term corrective action cannot be determined until the cause is determined.
- If the cause is not readily obvious, the Department Manager, Laboratory Director or QA Manager (or QA designee) is consulted.

12.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.
- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.
- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The CAR is used for this documentation.

12.3.3 Root Cause Analysis

Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness.

Systematically analyze and document the Root Causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the Root Cause data from these incidents to identify Root Causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

Identify the one event associated with problem and ask why this event occurred. Brainstorm the root causes of failures by asking why events occurred or conditions existed; and then why the cause occurred 5 consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and continue to plague the laboratory or operation.

12.3.4 Monitoring of the Corrective Actions

- The Laboratory Director, Department Manager and/or QA Manager are responsible to ensure that the corrective action taken was effective.
- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Department Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- The QA Manager reviews CARs monthly for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA Manager and shall be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements.
- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

(Also refer to Section 15.1.4, Special Audits.)

12.4 TECHNICAL CORRECTIVE ACTIONS

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and quality control have occurred (refer to Section 11). The documentation of these procedures is through the use of a CAR.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs. The laboratory may also maintain Work Instructions on these items that are available upon request.

Table 12-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in Method SOPs, Work Instructions and QAM Sections 19 and 20. All corrective actions are reviewed monthly, at a minimum, by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by a CAR and appropriate corrective action (e.g., reanalysis) is taken and documented.

12.5 BASIC CORRECTIONS

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g. no white-out)], and the correct value entered alongside. All such corrections shall be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original “uncorrected” file must be maintained intact and a second “corrected” file is created.

This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

Figure 12-1

Corrective Action Report

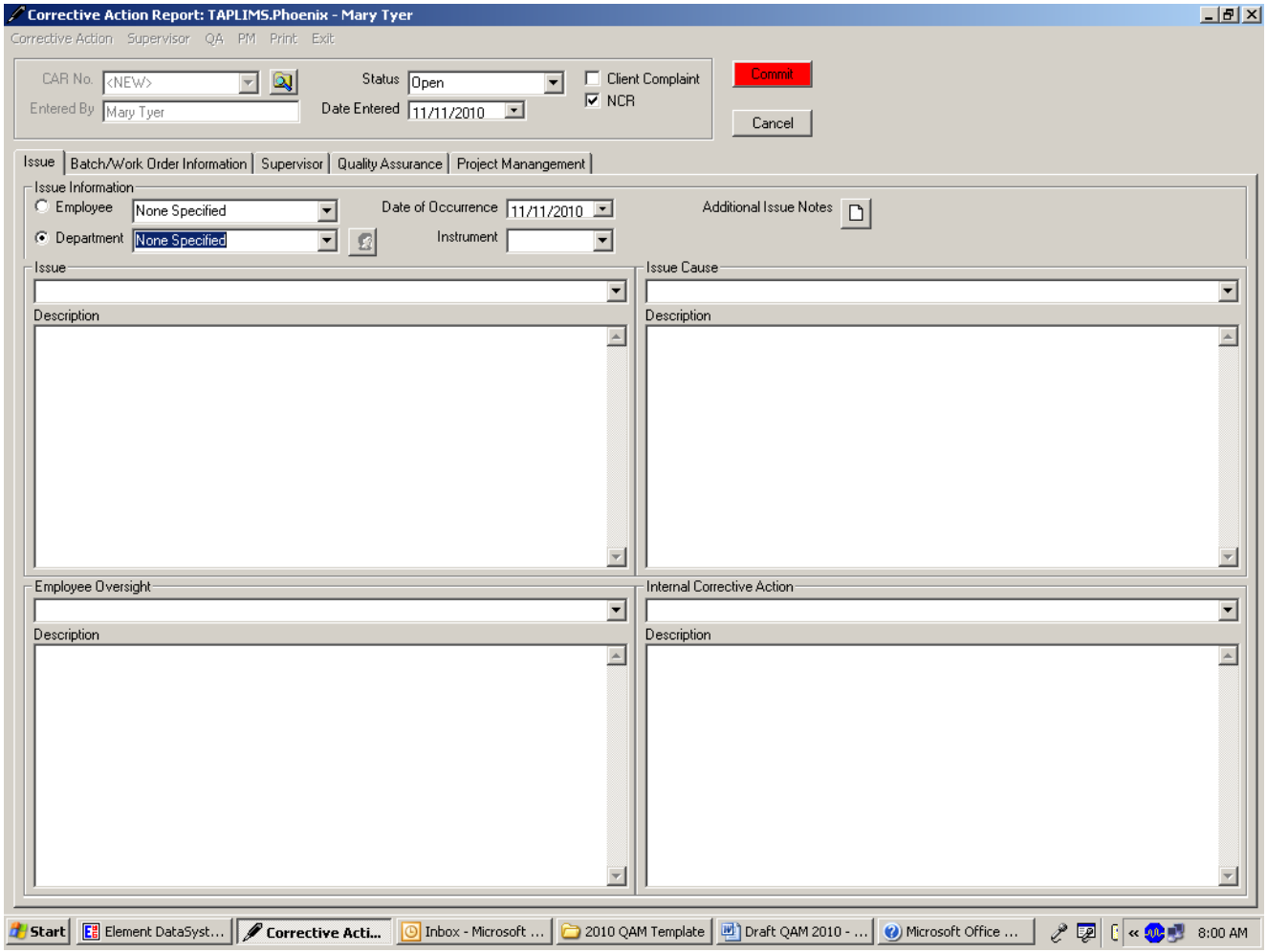


Table 12-1.

General Corrective Action Procedures for Quality System Activities

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Proficiency Testing (PT) Samples *(QA Manager, Department Manager/Supervisor)*	- Criteria supplied by PT Supplier.	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.
Internal / External Audits *(QA Manager, Department Manager/Supervisor, Laboratory Director/Manager)*	- Defined in Quality System documentation such as SOPs, QAM, etc.	- Non-conformances must be investigated through CAR system and necessary corrections must be made.
Reporting / Calculation Errors (*Depends on issue – possible individuals include: Analysts, Data Reviewers, Project Managers, Department Manager/ Supervisor, QA Manager, Corporate QA, Corporate Management*)	- SOP CA-L-S-001, Internal Investigation of Potential Data Discrepancies and Determination for Data Recall.	- Corrective action is determined by type of error. Follow the procedures in SOP CA-L-S-001 or PE-QAD-007.
Client Complaints (*Project Managers, Lab Director/Manager, Business Development Manager and Client Services Manager).*	- SOP PE-QAD-027, Procedures to Address Customer Complaints	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., database needs to be updated).
QA Monthly Report (Refer to Section 16 for an example) (*QA Manager, Lab Director/Manager, Department Supervisors/Managers*)	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated.

Table 12-1 continued.

General Corrective Action Procedures for General Chemistry Methods: Titration (Alkalinity & Acidity), Method SM 2320 B

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	No analyte detected ≥ reporting limit.	Rerun all samples associated with unacceptable blank.*
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within 90-100%.	If not within laboratory control limits, rerun all associated samples.**
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within 90-110 %.	If not within laboratory control limits, rerun all associated samples.**
Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	RPD ≤ 20%.	Reanalyze once, evaluate. Flag data if reanalysis remains out of control outside of limit.
ICAL	Daily, 3 point calibration of pH meter.	r ≥ 0.995.	Check buffers, perform instrument maintenance, repeat calibration.
ICV/ICB	Start of every sequence, following ICAL.	± 10% of true value for ICV, ICB – No analytes detected ≥ MDL.	Evaluate standards, recalibrate, reanalyze affected samples.
CCV/CCB	Every 10 samples and end of sequence.	± 10% of true value for ICV, CCB – No analytes detected ≥ MDL.	Evaluate standards, recalibrate, reanalyze affected samples.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

* *It may not necessary to re-analyze samples with concentrations > 10X the concentration found in the method blank.*

** *Re-analysis may not be necessary if the LCS/LCSD recovery is high and the sample is non-detect.*

Table 12-1 continued.

General Corrective Action Procedures for General Chemistry Methods: Colorimetric Methods, HACH 8167, SM 3500 CR D, SM 4500 CN B,C,E, & G, EPA 9010, EPA 9013, EPA 9014, SM 5220D, SM 4500 P,E, SM 4500 S D.

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	Refer to Method/SOP.	Rerun all samples associated with unacceptable blank.*
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits.	If not within laboratory control limits, rerun all associated samples.**
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits; RPD must be within laboratory control limits.	If not within laboratory control limits, rerun all associated samples.**
Matrix Spike	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits.	Evaluate MSD.
Matrix Spike Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits; RPD must be within laboratory control limits.	Reanalyze once, evaluate. Flag data if reanalysis remains out of control.
Duplicate	As requested by client or required by specific method. Sometimes not necessary as MSD fulfills the requirement.	RPD must meet method limits.	Flag data outside of limit.
Post-Spike/MSA (CR6+ only)	Minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits	Evaluate acidity; see MSD.
ICAL	Multi-level calibration with blank, repeated quarterly or following maintenance.	$r \geq 0.995$.	Evaluate data, correct problem, reanalyze.
ICV/ICB	Start of every sequence, following ICAL.	± 10% of true value for ICV, < RL for ICB (1/2 RL for Cyanide).	Evaluate data, correct problem, reanalyze.
CCV/CCB	Every 10 samples and end of analysis.	± 10% of true value for CCV, < RL for CCB (1/2 RL for Cyanide).	Evaluate data; reanalyze affected samples with good CCV/CCB.
Other (Cyanide Methods)	Distill high and low standard with every batch.	± 10% of true value.	Evaluate data, correct problem, reanalyze.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

* *It may not necessary to re-analyze samples with concentrations > 10X the concentration found in the method blank.*

** *Re-analysis may not be necessary if the LCS/LCSD recovery is high and the sample is non-detect.*

Table 12-1 continued.

General Corrective Action Procedures for General Chemistry Methods: Ion Chromatography, EPA 300.0, EPA 9056, EPA 314.0.

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	<RL; (<1/2 RL for 314.0).	Rerun all samples associated with unacceptable blank.*
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	90-100% recovery (85-115% for 314.0).	If not within laboratory control limits, rerun all associated samples.**
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	80-120% recovery (85-115% for 314.0) 15% RPD.	If not within laboratory control limits, rerun all associated samples.**
Matrix Spike	1 per 10 samples, minimum of one per batch of samples processed.	Aqueous: 80-120% recovery. Soil: 80-120% recovery; (75-125% for 314.0).	Evaluate MSD.
Matrix Spike Duplicate	1 per 10 samples, minimum of one per batch of samples processed.	Aqueous: 80-120% recovery; RPD 20% (15% for 314.0). Soil: 80-120% recovery; (75-125% for 314.0); RPD 20%.	Reanalyze once, evaluate. Flag data if reanalysis remains out of control.
Duplicate	As requested by client or required by specific method (1 dup every 10 samples for 9056). Sometimes not necessary as MSD fulfills the requirement.	RPD must meet method limits.	Flag data outside of limit.
ICAL	5 levels plus a blank, repeated quarterly or following maintenance.	$r \geq 0.995$; (Air methods, before and after sample analysis, pre- and post- must be within ± 5% of mean),	Perform instrument maintenance, repeat calibration.
ICV/ICB	Start of every sequence, following ICAL.	± 10% of true value for ICV, < RL for ICB (1/2 RL for 314.0),	Evaluate standards, recalibrate or reanalyze.
CCV/CCB	Every 10 samples and at the end of the analytical sequence.	± 10% of true value for CCV (±15% for 314.0); < RL for CCB (1/2 RL for 314.0).	Evaluate standards, recalibrate or reanalyze.
MCT (314.0)	Daily, prior to sample analysis.	± 20% of true value.	Correct problem, recalibrate if needed.
ICCS (314.0)	Daily, prior to sample analysis.	± 25% of true value.	Correct problem, recalibrate if needed.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

*****It may not necessary to re-analyze samples with concentrations > 10X the concentration found in the method blank.*

*** Re-analysis may not be necessary if the LCS/LCSD recovery is high and the sample is non-detect.*

Table 12-1 continued.

General Corrective Action Procedures for General Chemistry Methods: Conductivity, SM 2510 B, EPA 9050A

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	Refer to Method/SOP.	Rerun all samples associated with unacceptable blank.*
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits.	If not within laboratory control limits, rerun all associated samples.**
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits.	If not within laboratory control limits, rerun all associated samples.**
Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	RPD must meet method limits.	Flag data outside of limit.
ICAL	1 level to determine cell constant, daily, prior to analysis.		
ICV/ICB	Start of every sequence, following ICAL.	± 10% of true value for ICV, < ± RL from zero for ICB.	Evaluate standards, recalibrate as needed, reanalyze.
CCV/CCB	Every 10 samples and end of sequence.	± 10% of true value for ICV, < ± RL from zero for CCB.	Evaluate standards and samples, reanalyze affected samples.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

*****It may not necessary to re-analyze samples with concentrations > 10X the concentration found in the method blank.*

*** Re-analysis may not be necessary if the LCS/LCSD recovery is high and the sample is non-detect.*

Table 12-1 continued.

General Corrective Action Procedures for General Chemistry Methods: Ion Specific Electrode, SM 4500 NH3 D, SM 4500 Norg C.

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	No analyte detected ≥ reporting limit.	Rerun all samples associated with unacceptable blank*.
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be 90 – 100%.	If not within laboratory control limits, rerun all associated samples.**
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be 90 – 100%.	If not within laboratory control limits, rerun all associated samples.**
Matrix Spike	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits.	Evaluate MSD.
Matrix Spike Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits; RPD must be within laboratory control limits.	Reanalyze once, evaluate. Flag data if reanalysis remains out of control.
Duplicate	As requested by client. MSD may fulfill the requirement.	RPD must meet method limits.	Flag data outside of limit.
ICAL	Daily, 3 levels.	$r \geq 0.995$.	Check standards and probe, replace as needed, recalibrate.
ICV/ICB	Start of every sequence, following ICAL	± 10% of true value for ICV, < ± RL from zero for ICB.	Check standards and probe, replace as needed, recalibrate.
CCV/CCB	Every 10 samples.	± 10% of true value for ICV, < ± RL from zero for CCB.	Evaluate date, reanalyze affected samples and CCV.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

*****It may not necessary to re-analyze samples with concentrations > 10X the concentration found in the method blank.*

*** Re-analysis may not be necessary if the LCS/LCSD recovery is high and the sample is non-detect.*

Table 12-1 continued.

General Corrective Action Procedures for General Chemistry Methods: pH, SM 4500 H+ B, EPA 9040B, EPA 9041A, EPA 9045D

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	± 0.1 pH unit.	If not within laboratory control limits, rerun all associated samples.
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	± 0.1 pH unit.	If not within laboratory control limits, rerun all associated samples.
Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Agree within ± 0.1 pH unit.	Flag data outside of limit.
ICAL	Daily. Meter: 2 level calibration that bracket the expected pH of the sample; Autoanalyzer: 3 levels at pH 4, 7, and 10.	± 0.05 pH units of true value (meter), r ≥ 0.995 (autoanalyzer).	Evaluate buffers and probe, replace as needed and recalibrate.
ICV	Daily, prior to sample analysis, single buffer check.	± 0.1 pH unit.	Evaluate buffers and probe, replace as needed and recalibrate.
CCV	Following every 10 samples and at the end of the run.	± 0.1 pH unit.	Evaluate affected samples, reanalyze affected samples and CCV.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

Table 12-1 continued.

General Corrective Action Procedures for General Chemistry Methods: Total Organic Carbon, EPA 9060, & SM 5310 C

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	No analyte detected ≥ reporting limit.	Rerun all samples associated with unacceptable blank.*
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits.	If not within laboratory control limits, rerun all associated samples.**
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits.	If not within laboratory control limits, rerun all associated samples.**
Matrix Spike	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits.	Evaluate MSD.
Matrix Spike Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits; RPD must be within laboratory control limits.	Reanalyze once, evaluate. Flag data if reanalysis remains out of control.
Duplicate	As requested by client or required by specific method. Sometimes not necessary as MSD fulfills the requirement.	RPD must meet method limits.	Flag data outside of limit.
ICAL	4 levels plus a blank (5 levels for solid) recalibrated quarterly or following maintenance	r ≥ 0.995.	Evaluate standards and instrument, perform maintenance, recalibrate.
ICV/ICB	Start of every sequence, following ICAL.	Aqueous: ± 10% of true value for ICV, < RL for ICB. Solid: ± 15% of true value for ICV, < RL for ICB.	Evaluate standards and instrument, re-prepare, recalibrate.
CCV/CCB	Every 10 samples.	± 10% of true value for CCV, < RL for CCB.	Evaluate samples, reanalyze affected samples.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

*****It may not necessary to re-analyze samples with concentrations > 10X the concentration found in the method blank.*

*** Re-analysis may not be necessary if the LCS/LCSD recovery is high and the sample is non-detect.*

Table 12-1 continued.

General Corrective Action Procedures for General Chemistry Methods: Turbidity, EPA 180.1

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	No analyte detected ≥ reporting limit.	Rerun all samples associated with unacceptable blank.
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits.	If not within laboratory control limits, rerun all associated samples.
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits.	If not within laboratory control limits, rerun all associated samples.
Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	RPD must be within laboratory control limits.	Flag data outside of limit.
ICAL	Daily, prior to analysis, 4 levels plus a blank.	$r \geq 0.995$	Evaluate instrument and standards, recalibrate.
ICV/ICB	Start of every sequence, following ICAL.	± 10% of true value for ICV, < ± RL from zero for ICB.	Evaluate instruments and standards, reanalyze, recalibrate.
CCV/CCB	Every 10 samples and end of sequence.	± 10% of true value for CCV, < ± RL from zero for CCB.	Evaluate affected samples, reanalyze.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

Table 12-1 continued.

General Corrective Action Procedures for General Chemistry Methods: Residue, SM 2540 B, C, D and F

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	No analyte detected ≥ reporting limit.	Rerun all samples associated with unacceptable blank
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within 80 – 120%.	If not within laboratory control limits, rerun all associated samples
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within 80 – 120%, RPD ≤ 20%.	If not within laboratory control limits, rerun all associated samples
Duplicate	As requested by client or required by specific method.	RPD ≤ 20% for samples > 5x RL.	Flag data outside of limit.
Balance Calibration Check	Daily, before use, with weights bracketing the masses to be measured.	Refer to SOP PE-QAD-016	Have balance serviced.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

Table 12-1 continued.

General Corrective Action Procedures for Metals Methods: Mercury, EPA 245.1, EPA 7470A & EPA 7471A

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	Concentration less than reporting limit.	Rerun all samples associated with unacceptable blank.*
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Rerun all samples associated with unacceptable LCS.**
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits.	If not within laboratory control limits, rerun all associated samples.**
Matrix Spike	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Flag data associated with unacceptable MS.
Matrix Spike Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery & RPD must be within laboratory (or method, as applicable) control limits.	Flag data associated with unacceptable MSD.
ICAL	As needed, 5 levels plus blank (ICAL is digested with samples).	$r \geq 0.995$.	Evaluate instrument and standards, re-digest calibration and repeat.
ICV/ICB	Following ICAL, prior to sample analysis.	245.1: ICV ± 5% of true value, ICB < ± RL 7470/7471: ICV ± 10% of true value, ICB < ± RL	Evaluate standards, remake/re-digest as needed.
CCV/CCB	Every 10 samples and end of run.	245.1: CCV ± 10% of true value, CCB < ± RL 7470/7471: CCV ± 20% of true value, CCB < ± RL	Evaluate affected samples, reanalyze samples and standards.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

*****It may not necessary to re-analyze samples with concentrations > 10X the concentration found in the method blank.*

*** Re-analysis may not be necessary if the LCS/LCSD recovery is high and the sample is non-detect.*

Table 12-1 continued.

General Corrective Action Procedures for Metals Methods: Trace Metals, EPA 200.7, EPA 200.8, EPA 6010B and EPA 6020

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	Concentration less than reporting limit.	Rerun all samples associated with unacceptable blank.*
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Rerun all samples associated with unacceptable LCS.**
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed	Percent recovery must be within laboratory control limits.	If not within laboratory control limits, rerun all associated samples.**
Matrix Spike	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Flag data associated with unacceptable MS.
Matrix Spike Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery & RPD must be within laboratory (or method, as applicable) control limits.	Flag data associated with unacceptable MSD.
Post-digestion Spike (EPA 6020 only)	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Dilute and reanalyze.
Serial Dilution (EPA 6020 only)	1 with each batch of samples processed not to exceed 20 samples.	± 10% Difference.	Flag data associated with unacceptable Serial Dilution, no further action unless client specified.
ICAL	Daily, As needed, 1 level and blank.	Rerun high calibration standard: verify quantitation at ± 5% of true value	Evaluate standards and instrument, perform maintenance, recalibrate.
ICV/ICB	Following ICAL, prior to samples.	200.7: ICV ± 5% of true value 200.8 / 6010 /6020: ICV ± 10% 200.7 / 6010: ICV RSD < 5% from replicate; All: ICB < RL.	Evaluate standards.
CCV/CCB	Every 10 samples and end of run.	± 10% of true value; CCV RSD < 5% from replicate (ICP); CCB < RL.	Evaluate standards and samples, reanalyze affected samples.
ICSA/ICSAB	Analyze at beginning of run.	Refer to laboratory SOP.	

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Initial Tuning (ICPMS only)	Before instrument is brought on-line, then as needed.	Initial tuning standard deviation ≤ 5% for four replicates; Mass calibration ≤ 0.1 amu from true; Resolution ≤ 0.75 amu full width at 5% peak height.	Perform maintenance and repeat.
Interelement Correction Factors (ICP only)	Semi-annually.		
IDLs	Annually (ICP) Semi-Annually (ICPMS)		

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

*****It may not necessary to re-analyze samples with concentrations > 10X the concentration found in the method blank.*

*** Re-analysis may not be necessary if the LCS/LCSD recovery is high and the sample is non-detect.*

Table 12-1 continued.

General Corrective Action Procedures for Organics Methods: HEM - Oil & Grease, and SGT-HEM, EPA 1664A

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	Refer to Method/SOP	Rerun all samples associated with unacceptable blank
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits	If not within laboratory control limits, rerun all associated samples
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits	If not within laboratory control limits, rerun all associated samples
Matrix Spike	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory control limits	If LCS/LCSD recover within criteria, flag data for matrix interference
Balance Calibration Check	Daily, before use, with weights bracketing the masses to be measured. Additionally, with 2 and 1000 mg weights.	Refer to SOP PE-QAD-016 for daily check. HEM Specific: 1.8 – 2.2 mg and 995-1005 mg.	Have balance serviced.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

Table 12-1 continued.

General Corrective Action Procedures for Organics Methods: GC/HPLC, EPA 8015B, 8015D, 8015AZ R1, EPA 8081A, EPA 8082, EPA 8141, EPA 8310, EPA 608, EPA 8021B, EPA, 8151A, EPA 1657, EPA TO-10A, CA-LUFT

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed*	Concentration less than reporting limit	Rerun/re-extract all samples associated with unacceptable blank***
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed*	Percent recovery must be within laboratory (or method, as applicable) control limits	Rerun/re-extract all samples associated with unacceptable LCS****
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed*	Percent recovery must be within laboratory control limits	If not within control limits, rerun all associated samples****
Matrix Spike	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits	Flag data associated with unacceptable MS.
Matrix Spike Duplicate	1 per 20 samples, minimum of one per batch of samples processed*	Percent recovery & RPD must be within laboratory (or method, as applicable) control limits	Flag data associated with unacceptable MSD
Surrogates (QC Samples)	Surrogates are spiked into method blank and all samples (QC included).	Percent recovery must be within laboratory (or method, as applicable) control limits	All surrogates must be within laboratory established control limits before sample analysis may proceed.
Surrogates (Field Samples)	Surrogates are spiked into method blank and all samples (QC included).	Percent recovery must be within laboratory (or method, as applicable) control limits	Re-prepare and reanalyze samples or flag sample data not meeting surrogate criteria
ICAL	As needed, minimum of 3 levels for 608*, 5 levels for other methods. See method SOP for multi-eluting compounds. **	Average RF $\leq$ 20%, or linear/non-linear regression $r^2 \leq 0.995$ (8000B, 1657, 608) or linear/ non-linear regression $r^2 < 0.99$ (8000C, TO-10A)	Perform maintenance, reanalyze.
ICV	Second source mid-point standard run immediately following ICAL.	All components % drift $\leq$ laboratory criteria.	Evaluate ICAL and ICV standards
CCV	Midpoint calibration standard following every 10 samples (or other interval as specified in method/SOP) and end of run.	All components % drift $\leq$ method criteria.	Stop analysis sequence, perform any needed maintenance, reanalyze CCV and affected samples.

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
PEM (8081A)	With ICAL, once every 12 hours during analysis.	% breakdown (DDT, Endrin) ≤ 15%, (8081A) or ≤ 20%, (608)	Stop analysis sequence, perform any needed maintenance, reanalyze PEM and affected samples.
RT Window Mixture (Hydrocarbons)	With ICAL, more frequently as required by specific method.	Refer to Method SOP.	Perform maintenance, reanalyze.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

**Method 608 requires 1 in every 10 samples*
***Method 608 only requires 3 ICAL levels. Five levels are recommended.*
****It may not necessary to re-analyze samples with concentrations > 10X the concentration found in the method blank.*
***** Re-analysis may not be necessary if the LCS/LCSD recovery is high and the sample is non-detect.*

Table 12-1 continued.

General Corrective Action Procedures for Organics Methods: GCMS Internal Standard, EPA 8260, EPA 8270, EPA TO-15

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	Concentration less than reporting limit	Rerun/Re-extract all samples associated with unacceptable blank
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Rerun/Re-extract all samples associated with unacceptable LCS
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed	Percent recovery & RPD must be within laboratory control limits.	If not within laboratory control limits, rerun/re-extract all associated samples
Matrix Spike	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Flag data associated with unacceptable MS.
Matrix Spike Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery & RPD must be within laboratory (or method, as applicable) control limits.	Flag data associated with unacceptable MSD
Surrogates (QC Samples)	In each QC sample.	Percent recovery must be within laboratory (or method, as applicable) control limits.	All surrogates must be within laboratory established control limits before sample analysis may proceed.
Surrogates (Field Samples)	In each field (client-submitted) sample.	Percent recovery must be within laboratory (or method, as applicable) control limits	Re-prepare and reanalyze samples or flag sample data not meeting surrogate criteria
Internal Standards	Internal Standards are added to all samples (QC samples included).	Refer to Method SOP.	Evaluate data and instrument. If no instrument issue found, flag data.
ICAL	Minimum of 5 levels, As needed.	Refer to Method SOP.	Perform maintenance, reanalyze.
ICV	Mid-level second source standard immediately following calibration curve.	Refer to Method SOP.	Evaluate ICAL and ICV standards.

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
CCV	Mid-level standard every 12 hours (after tuning), prior to sample analysis. TPH only: At end of run.	Refer to Method SOP.	Evaluate instrument, perform maintenance as needed. Reanalyze affected samples.
Tuning Check (Full Scan Methods)	BFB or DFTPP tuning at the beginning of every shift, (as defined in method SOP) including before ICAL	Refer to Method SOP.	Evaluate instrument and reanalyze. Perform maintenance as needed.

General Corrective Action Procedures for Organics Methods: GCMS Internal Standard, EPA 8260, EPA 8270, EPA TO-15 Continued

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Tuning Check SIM Methods	"Autotune" function of instrument.	Refer to Method SOP.	Evaluate instrument and reanalyze. Perform maintenance as needed.
Tailing (method 8270C)	At the beginning of every shift (as defined in the method SOP) including before ICAL	Refer to Method SOP.	Evaluate instrument and reanalyze. Perform maintenance as needed.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

*****It may not necessary to re-analyze samples with concentrations > 10X the concentration found in the method blank.*

*** Re-analysis may not be necessary if the LCS/LCSD recovery is high and the sample is non-detect.*

Table 12-1 continued.

General Corrective Action Procedures for Organics Methods: GCMS Internal Standard, EPA 624, EPA 625

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	Concentration less than reporting limit	Rerun/Re-extract all samples associated with unacceptable blank
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Rerun/Re-extract all samples associated with unacceptable LCS
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed	Percent recovery & RPD must be within laboratory (or method, as applicable) control limits.	If not within laboratory control limits, rerun/re-extract all associated samples
Matrix Spike	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Flag data associated with unacceptable MS
Matrix Spike Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery & RPD must be within laboratory (or method, as applicable) control limits.	Flag data associated with unacceptable MSD
Surrogates (QC Samples)	In each QC sample.	Percent recovery must be within laboratory (or method, as applicable) control limits.	All surrogates must be within laboratory established control limits before sample analysis may proceed.
Surrogates (Field Samples)	In each field (client-submitted) sample.	Percent recovery must be within laboratory (or method, as applicable) control limits	Re-prepare and reanalyze samples or flag sample data not meeting surrogate criteria
Internal Standards	Internal Standards are added to all samples (QC samples included).	Refer to Method SOP.	Evaluate data and instrument. If no instrument issue found, flag data.
ICAL	Minimum of 3 levels *, As needed.	Refer to Method SOP.	Perform maintenance, reanalyze.
ICV	Mid-level second source standard immediately following calibration curve.	Refer to Method SOP.	Evaluate ICAL and ICV standards.
CCV	Mid-level standard every 24 hours (after tuning), prior to sample analysis. (At end of run).	Refer to Method SOP.	Evaluate instrument, perform maintenance as needed. Reanalyze affected samples.
Tuning Check (Full Scan Methods)	BFB or DFTPP tuning at the beginning of every shift, (as defined in method SOP) including before ICAL	Refer to Method SOP.	Evaluate instrument and reanalyze. Perform maintenance as needed.
Tailing Factor (method 625)	At the beginning of every clock	Refer to Method SOP.	Evaluate instrument and reanalyze. Perform maintenance as needed.

- *Three levels are required, a minimum of five levels is recommended.*

Table 12-1 continued.

General Corrective Action Procedures for Organics Methods: GCMS Isotope Dilution, EPA 8260B Modified, EPA 8270C Modified

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Method Blank	1 per 20 samples, minimum of one per batch of samples processed.	Concentration less than reporting limit	Rerun/Re-extract all samples associated with unacceptable blank*
Laboratory Control Sample	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Rerun/Re-extract all samples associated with unacceptable LCS**
Laboratory Control Sample Duplicate	1 per 20 samples, minimum of one per batch of samples processed	Percent recovery & RPD must be within laboratory (or method, as applicable) control limits.	If not within laboratory control limits, rerun/Re-extract all associated samples**
Matrix Spike	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Flag data associated with unacceptable MS.
Matrix Spike Duplicate	1 per 20 samples, minimum of one per batch of samples processed.	Percent recovery & RPD must be within laboratory (or method, as applicable) control limits.	Flag data associated with unacceptable MSD
Internal Standards	Labeled Isotopes are added to all samples (QC samples included).	Percent recovery must be within method control limits.	Evaluate data. Re-extract.
Cleanup Standards	Labeled Isotopes are added to all samples (QC samples included), as specified by source method.	Percent recovery must be within laboratory (or method, as applicable) control limits.	Evaluate data. Re-extract.
Mass Resolution Check	Prior to analysis, end of analysis as defined by method SOP.	Refer to Method SOP.	Evaluate data, perform maintenance and reanalyze if adverse impact.
ICAL	5 levels (+ window defining solution, if applicable).	% RSD ≤ method criteria, ion ratios meet method criteria.	Perform maintenance, reanalyze.
ICV	Second source mid-point stand run following ICAL.	RFs with %D ≤ from ICAL within method/SOP criteria	Evaluate ICAL and ICV standards.
CCV	1 level every 12 hours after window performance mix (if applicable to method)	Refer to Method SOP	Evaluate instrument, perform maintenance as needed. Reanalyze affected samples.
Ending	See Method SOP, not applicable to all methods.	Refer to Method SOP.	Evaluate instrument, perform maintenance as needed. Reanalyze affected samples.

General Corrective Action Procedures for Organics Methods: GCMS Isotope Dilution, EPA 8260B Modified, EPA 8270C Modified Continued

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Window Performance Mix	Method specific, refer to method SOP.	Refer to Method SOP.	Evaluate instrument, perform maintenance as needed. Recalibrate and reanalyze affected samples.
Tailing (method 8270C)	At the beginning of each clock	Refer to Method SOP.	Evaluate instrument and reanalyze. Perform maintenance as needed.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods.

*****It may not necessary to re-analyze samples with concentrations > 10X the concentration found in the method blank.*

*** Re-analysis may not be necessary if the LCS/LCSD recovery is high and the sample is non-detect.*

Table 12-1 continued.
General Corrective Action Procedures for Industrial Hygiene Methods, FOTs: GC, HPLC, UV/VIS Spectrometer, IC, Gravimetric, CVAA.

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Minimum of 3 Point Calibration Curve	When an opening or continuous CCV fails	Coefficient of determination $r \geq 0.995$	1) Re-inject curve 2) Prepare new standards 3) Perform maintenance, if needed.
Primary Source CCV at Highest Calibration Concentration:	Every 10 samples and at the end of the analysis.	Within 80 –120% of expected value	1) Re-inject CCV 2) Re-inject curve 3) Prepare new standards 4) Run new curve 5) Perform maintenance, if needed.
Independently Prepared or Second Source ICV at Reporting Level:	Immediately following calibration standards and also at beginning of analysis if re-calibration is not being performed.	Within 60 – 140% of expected value	1) Re-inject ICV 2) Re-inject curve 3) Prepare new standards 4) Run new curve 5) Perform maintenance, if needed.
Method Blank	One per batch of samples	< Report Limit is preferable	1) Subtract blank from client and QC samples
LCS/LCSD (Independently Prepared or Second Source) 1. Duplicate spikes near RL	Every batch of samples	Within 75 – 125% recovery and $\leq$ 30% RPD	1) Re-inject LCS/LCSD and/or qualify report 2) Perform maintenance, if needed.
Calibration Blank	Beginning, every 10 samples, and end of each analysis day, before or after ICV	< Report Limit is expected	1) Subtract, if necessary and/or qualify and report 2) Recalibrate and reanalyze all samples since last compliant calibration blank, if needed.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods. Frequency, acceptance criteria and corrective actions may vary.

Table 12-1 continued.

General Corrective Action Procedures for Industrial Hygiene Methods, FOTs: ICP and ICP-MS.

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Blank and Three Point Calibration Curve (Minimum)	Each day of analysis	$r \geq 0.995$ Blank $\leq$ RL	Reanalyze curve Prepare new standards and reanalyze curve
Initial Calibration Verification/Reporting Level Check (ICV/RL)	Immediately following calibration standards and also at beginning of analysis if re-calibration is not being performed	25 - 175% of predicted response following calibration	Recalibrate and reanalyze previous set of samples
Continuing Calibration Verification (CCV)	Every 10 samples and at the end of the analysis	Within 90 – 110% of expected value	Reanalyze CCV, if acceptable, continue. Otherwise – Recalibrate and reanalyze previous set of samples
Interference Check Standard (ICS & ICSAB) ICP only	Beginning, every 8 hours and the end of the analytical run	80 - 120% recovery of the true value	Recalibrate and reanalyze all samples
Calibration Blank	Beginning, every 10 samples, and end of each analysis day before or after ICV	< RL	Recalibrate and reanalyze all samples since last compliant calibration blank.
Internal Standard	Each sample and MBLK, LCS/LCSD	Acceptable recovery is 70 – 130% of true value for ICP, 60-125% for ICP-MS	Dilute the sample and flag data with appropriate qualifier
Method Blank (MB)	Every sample batch of up to 20 samples	< RL	Report Method Blank result. Flag data with appropriate qualifier and fill out CAR
Laboratory Control Sample/Laboratory Control Sample Duplicate (LCS/LCSD)	Every sample batch of up to 20 samples	Acceptable recovery is 80 - 120% of true value, and $\leq$ 20% RPD	Report result. Flag data with appropriate qualifier and fill out CAR

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods. Frequency, acceptance criteria and corrective actions may vary.

Table 12-1 continued.

General Corrective Action Procedures for Industrial Hygiene Methods, FOTs: GC-MS.

QC Activity	Frequency	Acceptance Criteria	Recommended Corrective Action
Instrument Performance Check Standard	The GC/MS system must meet the mass spectral ion abundance acceptance criteria for the instrument performance check standard containing BFB.	Every 24 hours	1) Prepare new Instrument Performance Check Standard. 2) Perform maintenance, if needed.
At least a 3-point Initial Calibration which brackets the expected reporting levels	The calculated %RSD for the relative response factor (RRF) for each compound in the calibration table must be less than 30% with at most two exceptions up to a $r^2 \geq 0.990$ if linear curve used	When an opening or continuous CCV fails.	Re-inject curve. Prepare new standard. Perform maintenance, if needed.
Continuing Calibration Verification (partial list secondary source) at 10 ppbv	The %RSD of the response; Within 70 – 130% of expected value	Immediately following calibration standards and at beginning of analysis if recalibration is not being performed. At a minimum, every 24 hours.	1) Re-inject curve. 2) Prepare new standards. 3) Run new curve. 4) Perform maintenance, if needed.
Closing Calibration Verification at the reporting level, 5 ppbv	The %RSD of the response; Within 65 – 135% of expected value	At the end of the analysis.	1) Re-inject CCV. 2) Prepare new standard and re-inject. 3) Run new curve. 4) Perform maintenance, if needed. 5) Flag and report if possible.
Method Blank (Laboratory / System Blank)	< Reporting Levels	Every batch of samples	1) Flag and report.
Laboratory Control Sample/Laboratory Control Sample Duplicate at 10 ppbv	Within 65 – 135% recovery and ≤ 30% RPD	Every batch of samples	1) Re-inject LCS and/or LCSD 2) Prepare new LCS and/or LCSD and inject 3) Perform maintenance, if needed. 4) Flag and report if possible.

Note: Refer to the analysis method/laboratory SOP for specific QC requirements. Not all QC samples listed here are required for all methods. Frequency, acceptance criteria and corrective actions may vary.

SECTION 13

PREVENTIVE ACTION *(NELAC 5.4.11)*

13.1 OVERVIEW

The laboratory's preventive action programs improve, or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive continuous process improvement activity that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, customer service and satisfaction can be improved through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered during management reviews, the QA Metrics Report, internal or external audits, proficiency testing performance, client complaints, staff observation, etc.

The monthly QA Metrics Report shows performance indicators in all areas of the quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, ethics training, etc. These metrics are used to help evaluate quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

The laboratory's corrective action process is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action provides a valuable mechanism for identifying preventive action opportunities.

13.1.1 The following elements are part of a preventive action system:

- Identification of an opportunity for preventive action
- Process for the preventive action
- Define the measurements of the effectiveness of the process once undertaken
- Execution of the preventive action
- Evaluation of the plan using the defined measurements
- Verification of the effectiveness of the preventive action
- Close-Out by documenting any permanent changes to the Quality System as a result of the Preventive Action. Documentation of Preventive Action is incorporated into the monthly QA reports, corrective action process and management review.

13.1.2 Any Preventive Actions undertaken or attempted shall be taken into account during the Annual Management Review (Section 16). A highly detailed recap is not required; a simple recount of success and failure within the preventive action program will provide management a measure for evaluation.

SECTION 14

CONTROL OF RECORDS *(NELAC 5.4.12)*

The laboratory maintains a record system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued.

14.1 OVERVIEW

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. Quality records are maintained by the QA Department which is backed up as part of the regular laboratory backup. Records are of two types; either electronic or hard copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by the QA Department and Corporate IT Department.

Table 14-1. Record Index[1]

	Record Types [1]:	**Retention Time:**
Technical Records	- Raw Data - Logbooks[2] - Standards - Certificates - Analytical Records - Lab Reports	5 Years from analytical report issue*
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals	5 Years from document retirement date*
QA Records	- Internal & External Audits/Responses - Certifications - Corrective/Preventive Actions - Management Reviews - Method & Software Validation / Verification Data - Data Investigation	5 Years from archival* **Data Investigation:** 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)
Project Records	- Sample Receipt & COC Documentation - Contracts and Amendments - Correspondence - QAPP - SAP - Telephone Logbooks - Lab Reports	5 Years from analytical report issue*

	Record Types [1]:	Retention Time:
Administrative Records	Finance and Accounting	10 years
	EH&S Manual, Permits, Disposal Records	7 years
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	7 Years (HR Personnel Files must be maintained indefinitely)
	Administrative Policies Technical Training Records	7 years

[1] Record Types encompass hardcopy and electronic records.
[2] Examples of Logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).
* Exceptions listed in Table 14-2.

14.1.1 All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or an offsite location that provides a suitable environment to prevent damage or deterioration and to prevent loss. All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees. Records archived off-site are stored in a secure location where a record is maintained of any entry into the storage facility. Whether on-site or off-site storage is used, logs are maintained in each storage area to note removal and return of records. Retention of records is maintained on-site at the laboratory for approximately 2 years after their generation and moved offsite for the remainder of the required storage time. Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention shall be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 14-2 have lengthier retention requirements and are subject to the requirements in Section 14.1.3.

14.1.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Table 14-2. Example: Special Record Retention Requirements

Program	Retention Requirement
Drinking Water – All States	10 years (project records)
Drinking Water Lead and Copper Rule	12 years (project records)

[1]Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hard copy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 19.14 for more information. See SOPs PE-ADM-002 Data Back-up Procedures and PE-QAD-017 Record Archiving.

14.1.4 The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data (records stored off site should be accessible within 2 days of a request for such records). The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory's copy of the COC is stored with the invoice and the work order sheet generated by the LIMS. The chain of custody would indicate the name of the sampler. If any sampling notes are provided with a work order, they are kept with this package.

- All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.

- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set as defined by method SOPs). Instrument data is stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; a copy of each day's run long or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is recorded in logbooks or entered into the LIMS for each method as required.

- Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in electronic audit trails.

- The reason for a signature or initials on a document is clearly indicated in the records such as "sampled by," "prepared by," "reviewed by", or "analyzed by".

- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.

- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data is lost and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard copy that was scanned. The procedure for this verification can be found in SOP PE-PMD-001 Data Reporting, Validation and Distribution.

- Also refer to Section 19.14.1 'Computer and Electronic Data Related Requirements'.

14.2 TECHNICAL AND ANALYTICAL RECORDS

14.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement. The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records shall include the identity of laboratory personnel responsible for sampling, performance of each analysis and reviewing results.

14.2.2 Observations, data and calculations are recorded in real-time and are identifiable to the specific task.

14.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

- Laboratory sample ID code;
- Date of analysis; time of analysis is also required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook or on a bench sheet.
- Instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available or indicated in method SOPs.
- Analysis type;
- All manual calculations and manual integrations;
- Analyst's or operator's initials/signature;
- Sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;

- Test results;
- Standard and reagent origin, receipt, preparation, and use;
- Calibration criteria, frequency and acceptance criteria;
- Data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;
- Quality control protocols and assessment;
- Electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected quality control requirements. These are indicated both in the LIMS and on specific analytical report formats.

14.3 LABORATORY SUPPORT ACTIVITIES

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- All original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records);
- A written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value;
- Copies of final reports;
- Archived SOPs;
- Correspondence relating to laboratory activities for a specific project;
- All corrective action reports, audits and audit responses;
- Proficiency test results and raw data; and
- Results of data review, verification, and crosschecking procedures.

14.3.1 Sample Handling Records

Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include but are not limited to records pertaining to:

- Sample preservation including appropriateness of sample container and compliance with holding time requirement;
- Sample identification, receipt, acceptance or rejection and login;
- Sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- Procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.4 ADMINISTRATIVE RECORDS

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 14-1.

14.5 RECORDS MANAGEMENT, STORAGE AND DISPOSAL

14.5.1 All records (including those pertaining to test equipment), certificates and reports are safely stored, held secure and in confidence to the client. Certification related records are available upon request.

14.5.2 All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

14.5.3 Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access.

14.5.4 The laboratory has a record management system (a.k.a. document control) for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. Laboratory notebooks are issued on a per analysis basis, and are numbered sequentially. All data are recorded sequentially within a series of sequential notebooks. Bench sheets are filed sequentially. Standards are maintained in the LIMS – no logbooks are used to record that data. Records are considered archived when moved from current storage within the laboratory department.

14.5.5 Transfer of Ownership

In the event that the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

14.5.6 Records Disposal

14.5.6.1 Records are removed from the archive and destroyed after 5 years unless otherwise specified by a client or regulatory requirement. On a project specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration. (Refer to Tables 14-1 and 14-2).

14.5.6.2 Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

14.5.6.3 If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required.

SECTION 15

AUDITS *(NELAC 5.4.13)*

15.1 INTERNAL AUDITS

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and, when requested, to corporate management.

Audits are conducted and documented as described in the TestAmerica Corporate SOP on performing Internal Audits, SOP CA-Q-S-004. The types and frequency of routine internal audits are shown in Table 15-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems	QA Department or Designee	All areas of the laboratory annually
QA Technical Audits - Evaluate raw data versus final reports - Analyst integrity - Data authenticity	QA Department or Designee	All methods within a 2-year period, with at least 15% of methods every quarter
SOP Method Compliance	Department Manager	- All SOPs within a 2-year period - All new analysts or new analyst/methods within 3 months of IDOC
Special	QA Department or Designee	Surveillance or spot checks performed as needed
Performance Testing	Analysts/Department Managers with QA oversight	Two successful per year for each NELAC field of testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, the laboratory's Data Integrity and Ethics Policies, NELAC quality systems, AIHA Site Assessors checklist, client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to data review, quality controls, preventive action and corrective action. The completeness of earlier corrective actions is assessed. The audit is divided into modules for each operating or support area of the lab, and each module is

comprehensive for a given area. The area audits may be done on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

15.1.2 QA Technical Audits

QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, MintMiner is used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the Department Manager at least every two years. The work of each newly hired analyst is assessed within 3 months of working independently, (e.g., completion of method IDOC). In addition, as analysts add methods to their capabilities, (new IDOC) reviews of the analyst work products will be performed within 3 months of completing the documented training.

15.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

15.1.5 Performance Testing

The laboratory participates annually or semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: Water Supply, Water Pollution, Underground Storage Tank, Hazardous Waste, Air, AIHA IHPAT, AIHA WASP and other Round Robin studies.

It is TestAmerica's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Written responses to unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

15.2 EXTERNAL AUDITS

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time allotted by the client or agency performing the audit. A copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2003 NELAC standards.

15.3 AUDIT FINDINGS

Audit findings are documented using the corrective action process and database. The laboratory's corrective action responses for both types of audits may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must set and agreed to by operations management and the QA Manager.

Developing and implementing corrective actions to findings is the responsibility of the Department Manager where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. A copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory shall take timely corrective action, and shall notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24-hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

SECTION 16

MANAGEMENT REVIEWS *(NELAC 5.4.14)*

16.1 QUALITY ASSURANCE REPORT

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, Laboratory Management (Program/Department managers), their Quality Director as well as the General Manager. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director, General Manager or Corporate QA may request that additional information be added to the report.

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Senior Management Team and General Managers.

16.2 ANNUAL MANAGEMENT REVIEW

The senior lab management team (Laboratory Director, Program Manager, Business Develop Manager, Department Managers, and QA Manager) conducts a review at least annually of its quality systems and LIMS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining quality goals & objectives. Corporate Operations and Corporate QA personnel may be included in this meeting at the discretion of the Laboratory Director and/or QA Manager. The LIMS review consists of examining any audits, complaints or concerns that have been raised throughout the year that are related to the LIMS. The laboratory will summarize any critical findings that can not be solved by the lab and report them to Corporate IT.

This management systems review (Corporate SOP No. CA-Q-S-008 uses information generated during the preceding year to assess the "big picture" by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective; therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

- Matters arising from the previous annual review.
- Prior Monthly QA Reports issues.
- Laboratory QA Metrics, which include:
  - Internal audit results.
  - Corrective and preventive actions.
  - External audit reports.
  - PT program performance.
  - Employee training status.

- Review of report reissue requests.
- Review of client feedback and complaints.
- Issues arising from any prior management or staff meetings.
- Minutes from prior senior lab management meetings. Issues that may be raised from these meetings include:
  - Adequacy of staff, equipment and facility resources.
  - Adequacy of policies and procedures.
  - Future plans for resources and testing capability and capacity.
  - Recommendations to improve laboratory performance.
- Compliance to the Ethics Policy and Data Integrity Plan. Including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity.

A report is generated by the QA Manager and management. The report is distributed to the appropriate General Manager and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants.
- A reference to the existing data quality related documents and topics that were reviewed.
- Quality system or operational changes or improvements that will be made as a result of the review [e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)].

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

Results of the annual management review shall be shared with laboratory personnel, as appropriate.

16.3 POTENTIAL INTEGRITY RELATED MANAGERIAL REVIEWS

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. TestAmerica's Corporate Data Investigation/Recall SOP shall be followed (SOP CA-L-S-001). All investigations that result in finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

TestAmerica's COO, VP of Client & Technical Services, General Managers and Quality Directors receive a monthly report from the Director of Quality & Client Advocacy summarizing any current data integrity or data recall investigations. The General Manager's are also made aware of progress on these issues for their specific labs.

SECTION 17

PERSONNEL *(NELAC 5.5.2)*

17.1 OVERVIEW

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the organization chart in Figure 4-1.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training shall be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

17.2 EDUCATION AND EXPERIENCE REQUIREMENTS FOR TECHNICAL PERSONNEL

The laboratory makes every effort to hire analytical staffs that possess a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. There are competent analysts and technicians in the industry who have not earned a college degree. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are

located on the TestAmerica intranet site's Human Resources web-page (Also see Section 4 of this manual for position descriptions/responsibilities).

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc., are also considered).

As a general rule for analytical staff, the qualifications listed in Table 17-1 apply.

Table 17-1. Personnel Educational Requirements/Experience: Environmental Laboratory

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO, etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
GFAA, CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC)	A college degree in an applied science or 2 years of college and at least 1 year of college chemistry	Or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, Herbicides, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	Or 5 years of prior analytical experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	And 2 years relevant experience Or 5 years of prior analytical experience
Department Managers	Bachelors Degree in an applied science or engineering	And 5 years experience in environmental analysis of representative analytes for which they will oversee

Table 17-1. Personnel Educational Requirements/Experience: Industrial Hygiene

Specialty	Education	Experience
Technician - Industrial Hygiene	H.S. Diploma or equivalent	On the job training (OJT Demonstrated and documented ability to produce reliable results through accurate analysis of certified reference materials (CRMs), proficiency testing samples, or in-house quality control samples (IDOCs). This demonstration shall be done at a minimum of every six (6) months and documented.
Analyst - Industrial Hygiene	Bachelors Degree in Chemistry or related science	One year or more prior analytical laboratory experience desired. Demonstrated and documented ability to produce reliable results through accurate analysis of certified reference materials (CRMs), proficiency testing samples, or in-house quality control samples (IDOCs). This demonstration shall be done at a minimum of every six (6) months and documented.
Technical Director – Industrial Hygiene * The TM shall be present on site at least 20 hours per week or 50 percent of the laboratory operating hours (whichever is less) to address technical issues for laboratory staff and customers.	Bachelors Degree in an applicable physical or biological science An advanced (MS, PhD.) degree may substitute for one year of experience	And a minimum of 3 years relevant nonacademic analytical chemistry experience which includes a minimum of 2 years industrial hygiene experience within the scope of accreditation

Specialty	Education	Experience
Quality Manager – Industrial Hygiene *The Quality Manager may be a part-time employee or a consultant.	Bachelors Degree in an applicable basic or applied science.	One year of nonacademic analytical or quality control experience appropriate to the types of analyses performed by the laboratory; or in lieu of a bachelor's degree, four years of nonacademic analytical or quality control experience. The Quality Manager shall have documented training in statistics or laboratory quality assurance/quality control. Appropriate documentation of training in statistics or laboratory quality assurance/quality control shall include at least one of the following: 1) College level course in statistics; 2) Continuing education in laboratory quality assurance/quality control (e.g., AIHA-LAP, LLC or equivalent course); or 3) Relevant experience – documented examples of the level of quality assurance/quality control used in applicable work experience.
LIIMS Specialist	Bachelor's degree and/or appropriate laboratory and/or computer skills and education.	And 2 years relevant experience

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Department Manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data in addition to the second level review and associated corrective actions.

17.3 TRAINING

The laboratory is committed to furthering the professional and technical development of employees at all levels.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Examples of various areas of required employee training are listed in Table 17-2.

Table 17-2. Personnel – Required Training

Required Training	Time Frame	Employee Type
Environmental Health & Safety	Prior to lab work	All
Ethics – New Hires	1 week of hire	All
Ethics – Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All
Ethics – Refresher	Annually (Training sessions presented throughout the year)	All
Initial Demonstration of Capability (IDOC)	Prior to unsupervised method performance	Technical
Complete a training course (an in-house course is acceptable) for the applicable analysis. Courses on sample preparation and instrument analysis may be taken separately or combined.	Prior to performing unsupervised analysis on laboratory samples.	Industrial Hygiene Technician/Analyst
Minimum of twenty (20) business days of hands-on experience conducting analyses in an industrial hygiene laboratory	Before initiation of independent work on customer samples.	Industrial Hygiene Technician/Analyst

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to "Demonstration of Capability" in Section 19.

The training of technical staff is kept up to date by:

- Each employee must have documentation in their training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs and the QAM are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics is maintained in their training file.
- Documentation of proficiency (refer to Section 19).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics). This information is maintained in the employee's secured personnel file.

Further details of the laboratory's training program are described in the SOP PE-QAD-008 Personnel Certification and Training.

17.4 DATA INTEGRITY AND ETHICS TRAINING PROGRAM

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica. It is a formal part of the initial employee orientation within 1 week of hire, followed by technical data integrity training within 30 days comprehensive training within 90 days, and refresher sessions through out the year for all employees. Senior management at each facility performs the ethics training for their staff.

In order to ensure that all personnel understand the importance TestAmerica places on maintaining high ethical standards at all times; TestAmerica has established a Corporate Ethics Policy (Policy CA-L-P-001) and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on Government contracts, and for that reason, TestAmerica has a Zero Tolerance approach to such violations.

Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.
- Ethics Policy.
- How and when to report ethical/data integrity issues. Confidential reporting.
- Record keeping.
- Discussion regarding data integrity procedures.
- Specific examples of breaches of ethical behavior (e.g. peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion).
- Internal monitoring. Investigations and data recalls.
- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution.
- Importance of proper written narration / data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient.

Additionally, a data integrity hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

SECTION 18

ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS *(NELAC 5.5.3)*

18.1 OVERVIEW

The laboratory is a 24,000 ft^2 secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc., OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity controlled), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, sample preparation, volatile organic sample analysis, non-volatile organic sample analysis, inorganic sample analysis, microbiological sample analysis, and administrative functions.

18.2 ENVIRONMENT

Laboratory accommodation, test areas, energy sources, lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage, temperature, and vibration levels in the laboratory.
When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and LIMS are regulated to protect against raw data loss.

18.3 WORK AREAS

There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

- Microbiological culture handling and sample incubation areas.
- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.

Access to and use of all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory.

Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory.
- Sample receipt areas.
- Sample storage areas.
- Chemical and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

Refer to Standard Methods, 20th Ed., 9020B, Section 2 for specific requirements for microbiological laboratory facility requirements.

18.4 FLOOR PLAN

A floor plan can be found in Appendix 1.

18.5 BUILDING SECURITY

Magnetic building keys and alarm codes are distributed to employees as necessary. Access to the laboratory is controlled to prevent entry by non-laboratory personnel.

Visitors to the laboratory sign in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed.

Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook.

SECTION 19

TEST METHODS AND METHOD VALIDATION *(NELAC 5.5.4)*

19.1 OVERVIEW

The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.2 STANDARD OPERATING PROCEDURES (SOPS)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Uncontrolled copies are available to all staff via the company intranet servers.
- Procedures for writing a SOP are incorporated by reference to TestAmerica's Corporate SOP CW-Q-S-002 entitled 'Writing a Standard Operating Procedure (SOP)', or the laboratory's SOP PE-QAD-014 Creation and Maintenance of SOPs.
- SOPs are reviewed at a minimum of every 2 years (annually for Drinking Water SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

19.3 LABORATORY METHODS MANUAL

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains a SOP for both technical and non-technical procedures. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

19.4 SELECTION OF METHODS

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists), the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.4.1 Sources of Methods

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in a SOP and available to clients and/or the end user of the data.

The analytical methods used by the laboratory are those currently accepted and approved for example by the U. S. EPA, OSHA, NIOSH and the state or territory from which the samples were collected. Reference methods include but are not limited to:

- *Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM); Non-polar Material) by Extraction and Gravimetry, EPA-821-R-98-002, February 1999.*
- *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, US EPA, January 1999.*
- *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and Appendix A-C; 40 CFR Part 136, USEPA Office of Water. Revised as of July 1, 1995, Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA 600 Series*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.*
- *Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.*

- *Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992. Supplement III EPA/600/R-95/131 - August 1995 (EPA 500 Series) (EPA 500 Series methods)*
- *Handbook for Analytical Quality Control in Water and Wastewater Laboratories, EPA 600/4-79-019, EPA, March 1979.*
- *Technical Notes on Drinking Water Methods, EPA-600/R94-173, October 1994*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.*
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.*
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)*
- *Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261*
- *NIOSH Manual of Analytical Methods (NMAM®), 4th ed.*
- *DHHS (NIOSH) Publication 94-113 (August, 1994), 1st Supplement Publication 96-135, 2nd Supplement Publication 98-119,3rd Supplement 2003-154 Schlecht, P.C. & O'Connor, P.F. (pfo1@cdc.gov), Eds.*
- *Index of Sampling & Analytical Methods, U.S. Department of Labor, Occupational Safety & Health Administration, Revision Date: 21 November 2001.*
- *8015AZ R1, C10 – C32 Hydrocarbons in Soil, Arizona Department of Health Services, Revision 1, September 25th, 1998.*
- *VOCs in Vapor by 8260B AZ Method, Arizona Department of Health Services, Revision 0.0, April 4th 2009.*
- *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA-625/R96/010b, January 1999.*

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory shall inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it will be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly perform the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

A demonstration of capability is performed whenever there is a change in instrument type (e.g., new instrumentation), method or personnel.

The initial demonstration of capability must be thoroughly documented and approved by the Laboratory Director, Department Manager and/or Technical Manager along with the QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures.

The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study and/or desorption Efficiency/Validation study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default reporting limit (RL) is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL).
- The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted: *Reporting Limit based on the low standard of the calibration curve.*

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

Prior to reporting any data, each analyst must have on file with the QA office information demonstrating proficiency with the analytical technique. Both precision and accuracy are measured for the target analytes.

19.4.3.1 The spiking standard used must be prepared independently from those used in instrument calibration.

19.4.3.2 The analyte(s) shall be diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified by a method or the laboratory SOP.

19.4.3.3 At least four aliquots shall be prepared (including any applicable clean-up procedures) and analyzed according to the test method (either concurrently or over a period of days).

19.4.3.4 Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations for each parameter of interest.

19.4.3.5 When it is not possible to determine the mean and standard deviations, such as for presence, absence and logarithmic values, the laboratory will assess performance against criteria described in the Method SOP.

19.4.3.6 Compare the information obtained above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory generated acceptance criteria (LCS or interim criteria) if there is no mandatory criteria established. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

19.4.3.7 When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to either option listed below:

- Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with 19.4.3.3 above.
- Beginning with 19.4.3.3 above, repeat the test for all parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with 19.4.3.1 above.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

19.4.3.8 For AIHA Demonstration of Proficiency, all analysts and technicians shall have demonstrated ability to produce reliable results through accurate analysis of certified reference materials (CRMs), proficiency testing samples, or in-house quality control samples. This demonstration shall be done at a minimum of every six (6) months and documented.

A certification statement (refer to Figure 19-1) shall be used to document the completion of each initial demonstration of capability for all NELAC and AIHA listed methods. A copy of the certification is archived in the analyst's training folder.

Methods on line prior to the effective date of this Section shall be updated to the procedures outlined above as new analysts perform their demonstration of capability. A copy of the new record will replace that which was used for documentation in the past. At a minimum, the precision and accuracy of four mid-level laboratory control samples (LCS) must have been compared to the laboratory's quality control acceptance limits. For AIHA, refer to the individual analytical SOP for precision and accuracy demonstration.

19.4.3.9 For additional information see the laboratory SOP PE-QAD-015 Initial Demonstration of Capability.

19.5 LABORATORY DEVELOPED METHODS AND NON-STANDARD METHODS

Any new method developed by the laboratory must be fully defined in a SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method.

19.6 VALIDATION OF METHODS

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

All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 Method Validation and Verification Activities for All New Methods

While method validation can take various courses, the following activities can be required as part of method validation. Method validation records are designated QC records and are archived accordingly.

19.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

19.6.1.2 Determination of Method Sensitivity

Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed.

19.6.1.3 Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)

An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The QL is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the

estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

19.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

19.6.1.5 Determination of Range

Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or QL cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of bias and precision.

19.6.1.6 Determination of Accuracy and Precision

Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

19.6.1.7 Documentation of Method

The method is formally documented in a SOP. If the method is a minor modification of a standard laboratory method that is already documented in a SOP, a SOP Attachment describing the specific differences in the new method is acceptable in place of a separate SOP.

19.6.1.8 Continued Demonstration of Method Performance

Continued demonstration of Method Performance is addressed in individual SOPs. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS, method blanks or PT samples.

19.7 METHOD DETECTION LIMITS (MDL)/ LIMITS OF DETECTION (LOD)

Method detection limits (MDL) are initially determined in accordance with 40 CFR Part 136, Appendix B or alternatively by other technically acceptable practices that have been accepted by regulators. MDL is also sometimes referred to as Limit of Detection (LOD). The MDL theoretically represents the concentration level for each analyte within a method at which the Analyst is 99% confident that the true value is not zero. The MDL is determined for each analyte initially during the method validation process and updated as required in the analytical methods, whenever there is a significant change in the procedure or equipment, or based on project specific requirements (refer to 19.7.10). Generally, the analyst prepares at least seven replicates of a solution spiked at one to five times the estimated method detection limit (most often at the lowest

standard in the calibration curve) into the applicable matrix with all the analytes of interest. Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples. Where possible, the seven replicates should be analyzed over 2-4 days to provide a more realistic MDL. Drinking Water method MDLs must be analyzed over a period of 3 or more days.

Refer to the Corporate SOP CA-Q-S-006 Detection Limits or the laboratory's SOP PE-QAD-019 Determination of Method Detection Limits for details on the laboratory's MDL process.

19.8 INSTRUMENT DETECTION LIMITS (IDL)

The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in demonstration of instrument performance in other areas.

IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using 7 replicate spike analyses, like MDL but without sample preparation, or by the analysis of 10 instrument blanks and calculating 3 x the absolute value of the standard deviation.

If the IDL is > than the MDL, it may be used as the reported MDL.

19.9 VERIFICATION OF DETECTION AND REPORTING LIMITS

Once an MDL is established, it must be verified, on each instrument, by analyzing a quality control sample (prepared as a sample) at approximately 2 - 3 times the calculated MDL for single analyte analyses (e.g. most wet chemistry methods, Atomic Absorption, etc.) and 1 - 4 times the calculated MDL for multiple analyte methods (e.g. GC, GCMS, ICP, etc.). The analytes must be qualitatively identified. This verification does not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDL does not verify, then the lab will not report to the MDL, or redevelop their MDL or use the level where qualitative identification is established. MDLs must be verified at least annually

When the laboratory establishes a quantitation limit, it must be initially verified by the analysis of a low level standard or QC sample at 1 - 2 the reporting limit and annually thereafter. The annual requirement is waved for methods that have an annually verified MDL. The laboratory will comply with any regulatory requirements. Unless there are requirements to the contrary the acceptance criteria is ± 50%.

19.10 RETENTION TIME WINDOWS

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis or as specified in the reference method, each analyte will have a specific time of elution from the column to the detector. This is known as the analyte retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept with the files associated with an instrument for later quantitation of the analytes. Complete details are available in the laboratory SOPs.

19.11 EVALUATION OF SELECTIVITY

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical, atomic absorption or fluorescence profiles, co-precipitation evaluations and specific electrode response factors.

19.12 ESTIMATION OF UNCERTAINTY OF MEASUREMENT

19.12.1 Uncertainty is "a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand" (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result's validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an "expanded uncertainty": the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor k=2.

19.12.2 Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

19.12.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.12.4 To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent a 99%-certain range for the reported result. As an example, suppose that the result reported is 1.0 mg/l, and the LCS percent recovery range is 50 to 150%. The uncertainty range would be 0.5 to 1.5 mg/l, which could also be written as 1.0 ± 0.5 mg/l.

19.12.5 In the case where a well recognized test method specifies limits to the values of major sources of uncertainty of measurement (e.g., 524.2, 525, etc.) and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

19.12.6 The laboratory provides measurement uncertainty data only at client request. An additional fee is charged for the reporting of measurement uncertainty

19.13 SAMPLE REANALYSIS GUIDELINES

Because there is a certain level of uncertainty with any analytical measurement, a sample reanalysis may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats. **Client specific Contractual Terms & Conditions for reanalysis protocols may supersede the following items.**

- Homogenous samples: If a reanalysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within ± 1 reporting limit for samples ≤ 5x the reporting limit, the original analysis will be reported. At the client's request, both results may be reported on the same report but not on two separate reports.

- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and reanalyze the sample a third time for confirmation if sufficient sample is available.

- Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.

- Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Department Manager or Laboratory Director if unsure.

19.14 CONTROL OF DATA

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.14.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. More detail is outlined in SOP PE-ADM-001 Computer Security. The laboratory is currently running the Element LIMS which is a 3rd party LIMS system that has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes Sequel Server / Access database which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

19.14.1.1 Maintain the Database Integrity: Assurance that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure.

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use.

19.14.1.2 **Ensure Information Availability:** Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.14.1.3 **Maintain Confidentiality:** Ensure data confidentiality through physical access controls, and encryption when electronically transmitting data.

19.14.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the Department Manager or alternate analyst prior to updating the data in LIMS. The spreadsheets, or any other type of applicable documents, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s).

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP CA-Q-S-002, Acceptable Manual Integration Practices and the laboratory SOP PE-QAD-009 Manual Integration / Data Integrity.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.14.2.1 All raw data must be retained in the worklist folder, computer file (if appropriate), and/or runlog. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). It must be easily identifiable who performed which tasks if multiple people were involved.

19.14.2.2 In general, concentration results are reported in milligrams per liter (mg/l) or micrograms per liter (µg/l) for liquids and milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg) for solids. For values greater than 10,000 mg/l, results can be reported in percent, i.e., 10,000 mg/l = 1%. Units are defined in each lab SOP.

19.14.2.3 In reporting, the analyst or the instrument output records the raw data result using values of known certainty plus one uncertain digit. If final calculations are performed external to

LIMS, the results should be entered in LIMS with at least three significant figures. In general, results are reported to 2 significant figures on the final report.

19.14.2.4 For those methods that do not have an instrument printout or an instrumental output compatible with the LIMS System, the raw results and dilution factors are entered directly into LIMS by the analyst, and the software calculates the final result for the analytical report. LIMS has a defined significant figure criterion for each analyte.

19.14.2.5 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the LIMS, the raw results and dilution factors are transferred into LIMS electronically after reviewing the quantitation report, and removing unrequested or poor spectrally-matched compounds. The analyst prints a copy of what has been entered to check for errors. This printout and the instrument's printout of calibrations, concentrations, retention times, chromatograms, and mass spectra, if applicable, are retained with the data file. The data file is stored in a monthly folder on the instrument computer; periodically, this file is transferred to the server and, eventually, to a tape file.

19.14.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out 'real time' and have enough information on them to trace the events of the applicable analysis/task. (e.g. calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.)

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.
- Unused portions of pages must be Z'd out, signed and dated.
- Worksheets are created with the approval of the Department Manager / QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

19.14.4 Review / Verification Procedures

Review procedures are out lined in the following SOPs to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data is reported:

- PE-QAD-024 General Data Review
- PE-QAD-018 Use of Data Qualifiers
- PE-SMP-001 Sample Control
- PE-PMD-001 Data Reporting, Validation and Distribution
- PE-QAD-006 Logbook Documentation
- PE-QAD-007 Corrective Actions
- PE-QAD-022 Good Calibration Practices

The laboratory also has an SOP discussing Manual Integrations to ensure the authenticity of the data (SOP PE-QAD-009 Manual Integration / Data Integrity). The general review concepts are discussed below, more specific information can be found in the SOPs.

19.14.4.1 The data review process at the laboratory starts at the Sample Control level. Sample Control personnel review chain-of-custody forms and input the sample information and required analyses into the laboratory LIMS program. The Project Managers perform final review of the chain-of-custody forms and inputted information.

19.14.4.2 The next level of data review occurs with the Analysts. As results are generated, analysts review their work to ensure that the results generated meet QC requirements and relevant methodologies. The Analysts transfer the data into the LIMS and add data qualifiers if applicable. To ensure data compliance, a different analyst performs a second level of review. Second level review is accomplished by checking reported results against raw data and evaluating the results for accuracy. During the second level review, blank runs, QA/QC check results, initial and continuing calibration results, laboratory control samples, sample data, qualifiers and spike information are evaluated. Where calibration is not required on a daily basis, secondary review of the initial calibration results may be conducted at the time of calibration. Approximately 15% of all sample data from manual methods and from automated methods, all GC/MS spectra and all manual integrations are reviewed. For some methods, manual integrations are also electronically reviewed utilizing auditing software to help ensure compliance to ethics and manual integration policies. Issues that deem further review include the following:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data does not match with reported results
- Unusual detection limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors
- Results outside of calibration range

19.14.4.3 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, Project Manager, Quality Assurance Manager, or Department Manager for further investigation. Corrective action is initiated whenever necessary.

19.14.4.4 The results are then entered or directly transferred into the computer database and a hard copy (or .pdf) is printed for the client.

19.14.4.5 As a final review prior to the release of the report, the Project Manager reviews the results for appropriateness and completeness. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The process includes, but is not limited to, verifying that chemical relationships are evaluated, COC

is followed, cover letters/ narratives are present, flags are appropriate, and project specific requirements are met.

19.14.4.6 Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable quality control requirements. The Project Manager then signs the final report. The accounting personnel also check the report for any clerical or invoicing errors. When complete, the report is sent out to the client.

19.14.4.7 A visual summary of the flow of samples and information through the laboratory, as well as data review and validation, is presented in Figure 19-2.

19.14.5 Manual Integrations

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP CA-Q-S-002 as the guideline for the laboratory's internal SOP PE-QAD-009 Manual Integration / Data Integrity.

19.14.5.1 The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.14.5.2 Analysts shall not increase or decrease peak areas for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principals and policy and is grounds for immediate termination.

19.14.5.3 Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

19.14.5.4 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale "after" chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale "before" chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 19-1. Demonstration of Capability Documentation

TestAmerica Laboratories, Inc.
Industrial Hygiene and/or NELAC Demonstration of Capability
Authorization/Certification Statement

Date:

Laboratory Name: TestAmerica Laboratories, Inc.
Laboratory Address: 4625 East Cotton Center Boulevard, Suite 189
Phoenix, AZ 85040

Analyst Name:

Matrix:

Method Number:

SOP No.:

Rev. No.:

Analyte, or Class of Analytes or Measured Parameters:

We, the undersigned, CERTIFY that:
1. The analyst 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/or the American Industrial Hygiene Association (AIHA) Accreditation Program, has met the Demonstration of Capability and is authorized to perform the above named analysis on the date listed.
2. The test method(s) was performed by the analyst identified on this certification.
3. A copy of the test method(s) and the SOP(s) are available for all personnel on-site.
4. The data associated with the demonstration of capability are true, accurate, and complete.
5. 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.

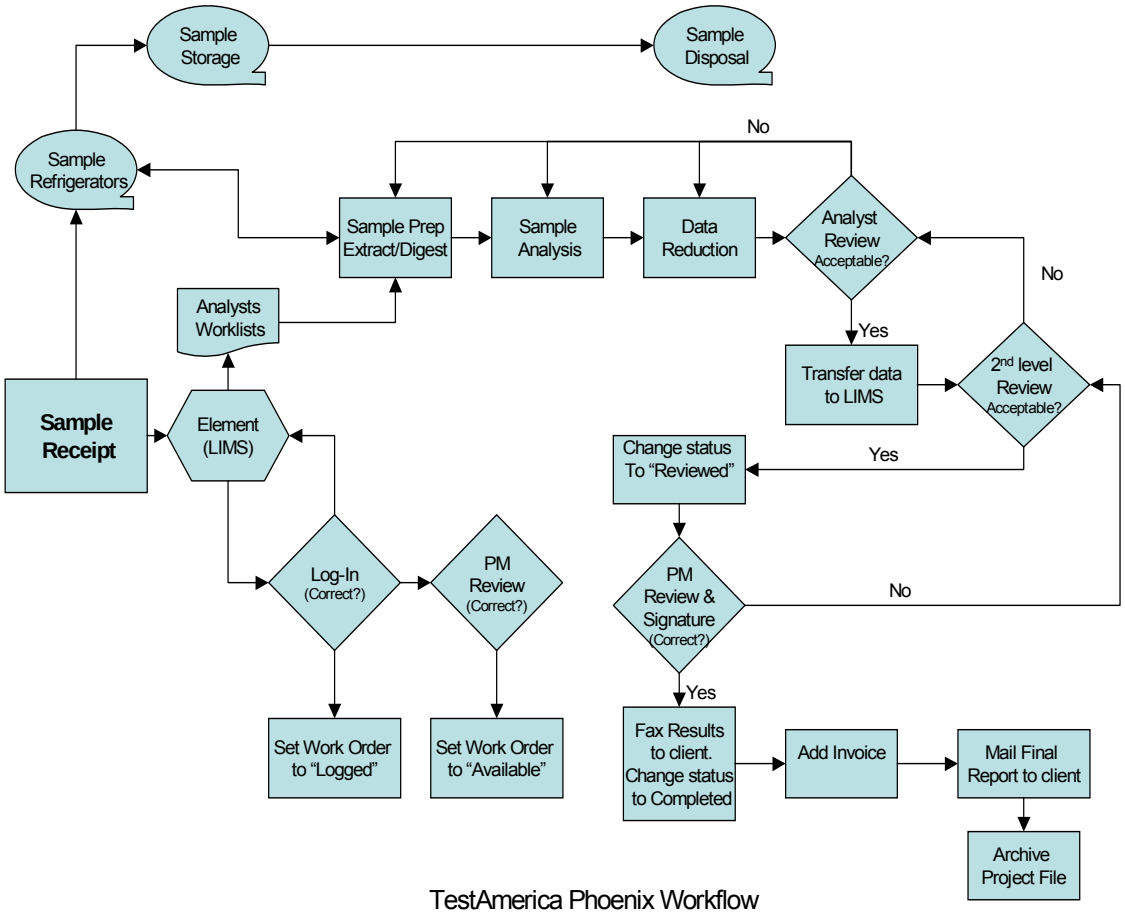
_____	_____	_____
Analyst Supervisor Name and Title	Signature	Date
_____	_____	_____
Quality Assurance Officer's Name	Signature	Date

This certification form must be completed each time a NELAC and/or AIHA demonstration of capability study is completed.

True: Consistent with supporting data.
Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.
Complete: Includes the results of all performance testing.

Comments:

Figure 19-2. Work Flow



SECTION 20

EQUIPMENT (AND CALIBRATIONS) *(NELAC 5.5.5)*

20.1 OVERVIEW

The laboratory purchases the most technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in the Corporate SOP CA-Q-S-005 Calibration Curves (General), laboratory SOPs and in SOP PE-QAD-022 Good Calibration Procedures. A list of laboratory instrumentation is presented in Table 20-1.

Equipment is only operated by authorized and trained personnel. Manufacturers' instructions for equipment use are readily accessible to all appropriate laboratory personnel.

20.2 PREVENTIVE MAINTENANCE

The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

Routine preventive maintenance procedures and frequency, such as cleaning and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Department Manager to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures are also outlined in analytical SOPs or instrument manuals. Table 20-3 outlines many of the preventative maintenance procedures followed in the laboratory. Note: Multiple pieces of equipment requiring infrequent maintenance (e.g. ovens, incubators, refrigerators)may share the same log as long as it is clear as to which instrument is associated with an entry.

Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of

electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.

- Each entry in the instrument log includes the Analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control. e.g. CCV run on *'date'* was acceptable, or instrument recalibrated on *'date'* with acceptable verification, etc.) must also be documented in the instrument records.

- When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This stapled in page must be signed across the page entered and the logbook so that it is clear that a page is missing if only half a signature is found in the logbook.

If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it shall be taken out of operation and tagged as out-of-service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory shall examine the effect of this defect on previous analyses.

In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Back up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the back up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

If an instrument is sent out for service or transferred to another facility, it must be recalibrated and verified (including new initial MDL study) prior to return to lab operations.

20.3 SUPPORT EQUIPMENT

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, field sampling devices, temperature measuring devices, thermal/pressure sample preparation devices and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance. For information on the periodic calibrations associated with this equipment see Table 20-4.

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked prior to initial serviceable use with at least two certified ASTM type 1 weights spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). ASTM type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or other purposes other than calibration are examined annually for wear and compared against the ASTM type 1 calibration only set; they are also sent out every 5 years for calibration to an outside calibration laboratory.

All balances are serviced annually by a qualified service representative accredited to ISO 17025, who supplies the laboratory with a certificate that identifies traceability of the calibration to NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file in QA. For additional information, reference laboratory SOP PE-QAD-016 Balance Calibration and Documentation.

20.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one µmhos/cm.

Turbidity meters are also calibrated before each use.

All of this information is documented in logbooks or on bench sheets.

Consult the pH, Conductivity, and Turbidity SOPs for further information.

20.3.3 Thermometers

All thermometers are verified on at least an annual basis with a NIST-traceable thermometer. IR thermometers are verified semi- annually, digital thermometers are verified quarterly.

The NIST thermometer(s) are recalibrated every five years (unless a thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service accredited to ISO 17025 and the provided certificate of traceability is kept on file in QA. The NIST thermometer(s) have increments of 0.2°C or smaller, and have ranges applicable to method and certification requirements. The NIST traceable thermometer(s) are used for no other purpose than to verify other thermometers.

All of this information is documented in logsheets. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in LIMS,

instrument or method-specific logbooks or logsheets. More information on this subject can be found in the SOP PE-QAD-004 Thermometer Calibration.

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored each working day.

Ovens, waterbaths and incubators are monitored on days of use.

All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

Sample storage refrigerator temperatures are kept between > 0ºC and ≤6 ºC.

Specific temperature settings/ranges for other refrigerators, ovens, waterbaths, and incubators can be found in method specific SOPs.

All of this information is documented in Daily Temperature Logsheets located in the QA office or in the Microbiology laboratory.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices including burettes (except Class A Glassware) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis. Glass micro-syringes are considered the same as Class A glassware. The laboratory maintains a sufficient inventory of autopipettors and dilutors of differing capacities that fulfill all method requirements.

Any non Class A Glassware device not regularly verified can not be used for any quantitative measurements. Refer to SOP PE-QAD-002 Pipette Calibration for more information.

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. The laboratory keeps on file an “Accuracy and Precision Statement of Conformance” from Hamilton attesting established accuracy.

20.3.6 Field Sampling Devices (Auto Samplers)

Each Auto Sampler is assigned a unique identification number in order to keep track of the calibration. This number is also recorded on the sampling documentation.

The Auto Sampler is calibrated monthly by setting the sample volume to 100ml and recording the volume received. The results are filed in a logbook/binder. The Auto Sampler is programmed to run three (3) cycles and each of the three cycles is measured into a graduated cylinder to verify 100ml are received.

If the RSD (Relative Standard Deviation) between the 3 cycles is greater than 10%, the procedure is repeated and if the result is still greater than 10%, then the Auto Sampler is taken out of service

until it is repaired and calibration verification criteria can be met. The results of this check are kept in a logbook/binder. (Please reference Table 20-5 for additional information.)

20.4 INSTRUMENT CALIBRATIONS

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day.

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, type of calibration (Avg RF, curve, or other calculations that may be used to reduce instrument responses to concentration).

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

If the initial calibration results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 12).

Note: Instruments are calibrated initially and as needed after that and at least annually (the annual requirement does not apply to Isotope dilution).

20.4.1 CALIBRATION STANDARDS

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP.

Standards for instrument calibration are obtained from a variety of sources. If available, standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample).

The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to 3 significant figures) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exception to these rules is ICP methods or other methods where the referenced method does not specify two or more standards

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.4.1.1 Calibration Verification

The calibration relationship established during the initial calibration must be verified at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods, NELAC (2003) standard, Section 5.5.5.10 and AIHA Industrial Hygiene Laboratory Accreditation Program (IHLAP). The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. . Initial calibration is with a standard source secondary (second source standard) , when available (or vendor certified different lot if a second source is not available). For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst at a different time or a different preparation would be considered a second source, to the calibration standards, but continuing calibration verifications may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, i.e., RPD, per NELAC (2003) Standard, Section 5.5.5.10.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Note: If an internal standard calibration is being used (basically GCMS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

Generally, the initial calibrations must be verified at the beginning of each 12-hour analytical shift during which samples are analyzed. (Some methods may specify more or less frequent verifications). The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample, QC, or standard that can be injected within 12 hours of the beginning of the shift.

A continuing instrument calibration verification (CCV) must be repeated at the beginning and, for methods that have quantitation by external calibration models, at the end of each analytical

batch. Some methods have more frequent CCV requirements; see specific SOPs. Most Inorganic methods require the CCV to be analyzed after ever 10 samples or injections, including matrix or batch QC samples.

20.4.1.2 Verification of Linear and Non-Linear Calibrations

Calibration verification for calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. (These calculations are available in the laboratory method SOPs. Verification standards are evaluated based on the % Difference from the average CF or RF of the initial calibration or based on % Drift or % Recovery if a linear or quadratic curve is used.

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

- When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

- When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted. Alternatively, a reporting limit standard may be analyzed to demonstrate that the laboratory can still support non-detects at their reporting limit.

20.5 TENTATIVELY IDENTIFIED COMPOUNDS (TICS) – GC/MS ANALYSIS

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Data system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification.

20.6 GC/MS TUNING

Prior to any GCMS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

Prior to tuning/auto-tuning the mass spec, the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally don't need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

Table 20-1. Laboratory Equipment and Instrumentation List

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
Volatiles:					
GCMS 1 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Hewlett Packard Agilent Tekmar Varian	6890 5973 3000 Archon	US00007754 US70810388 95325005 13624	1997	-
GCMS 2 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Hewlett Packard Hewlett Packard OI OI	5890 5971 4560 Archon	3033A30276 2950A00789 224071 13559	2001	-
GCMS 4 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Hewlett Packard Hewlett Packard OI OI	5890 5971 4560 Archon	3240618320 3234A04143 N124460502 13025	2001	-
GCMS 6 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Agilent Agilent Tekmar Varian	6850 5973 3000 Archon	US00002193 US10440932 96055001 13472	2001	-
GCMS 7 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Agilent Agilent Tekmar Tekmar	5890 5972 3100 2016	3336A60504 3524A03129 US01281001 95298002	--	-
GCMS 9 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Hewlett Packard Hewlett Packard OI Analytical Varian	5890 5972 4660 Archon	- 3307A00428 D611466185P 14623	--	-
GCMS 13 Gas Chromatograph Mass Spectrometer P&T Concentrator Autosampler	Hewlett Packard Hewlett Packard Tekmar EST	5890 5972 3000 Centurion	3133A37877 3549A03207 97223016 CENTS120100709	--	-
GCMS 10 Gas Chromatograph Mass Spectrometer Autosampler Preconcentrator Canister Cleaner Dynamic Diluter *(Shared with IH)*	Agilent Agilent Entech Entech Entech Entech	6890 5973 7032L 7100 3100 4600	U50039506 U503960554 0043 0162 0103 0041	--	-
GCMS 11 Gas Chromatograph Mass Spectrometer Autosampler Preconcentrator Canister Cleaner *(Shared with IH)*	Agilent Agilent Entech Entech Entech	6890N 5973 7032L 7100 3100	U510133093 U510461255 0061 0259 0155	--	-

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
Semi-Volatiles:					
Gas Chromatograph 1:					
(*shared with IH)*	Agilent	5890	2750A18397		
ALS Tower	Agilent	18593B	3108A25342		
ALS Tray	Agilent	18596B	3106A24228		
Controller Box	Agilent	18594B	3018A22248		
FPD1	Agilent	19256A	NA		
FPD2	Agilent	19256A	NA	1990	--
Gas Chromatograph 2	Agilent	5890 Series II	3108A34049		
ALS Tower	Agilent	18593B	3508A41897		
ALS Tray	Agilent	18596C	US30608322		
Controller Box	Agilent	G1512A	CN00003596		
ECD1	Agilent	G1223A	K0668		
ECD2	Agilent	G1223A	F5823	1988	--
Gas Chromatograph 3	Agilent	5890 Series II	3336A51039	1995	
Linkbox	OI Analytical	600 Series	5192110120		
ALS	EST Analytical	CentWS	CENTS138022210	2010	
Concentrator	EST Analytical	Encon EV	EV39012910		
PID Lam Power Source	OI Analytical	4430	B348430309	1995	
ECD/PID	OI Analytical	NA	NA		
Gas Chromatograph 4	Agilent	5890 Series II	2950A26451		
Concentrator	OI Analytical	4560	D309335		
ALS	OI Analytical	MPM16	91-369		
PID Lamp Power Source	OI Analytical	4430	91-171		
ECD/PID	OI Analytical	NA	NA	1995	
Gas Chromatograph 5	Agilent	5890	2643A9891	1990	
ALS Tower	Agilent	18593B	3042A23537		
ALS Tray	Agilent	18596M	3251A30857		
Controller Box	Agilent	18594B	3239A30053		
FID	Agilent	NA	NA	2005	
MACH	Agilent (former RVM Scientific	NA	NA		
MACH Power Box	Agilent	LTMA58/A68PS	G E-01		--
Gas Chromatograph 7					
(shared with IH)	Agilent	6890	US00000197		
ALS Tower	Agilent	G2613	CN33832614		
ALS Tray	Agilent	G2614A	US91605057		
u-ECD1	Agilent	G2397A	U129C		
u-ECD2	Agilent	G2397A	U6313	2003	--
Gas Chromatograph 11	Agilent	5890A	3140A38412		
ALS Tower	Agilent	18593B	3048A24494		
ALS Tray	Agilent	18596B	3246A30486		
Controller Box	Agilent	18594A	2929A15556		
ECD1	Agilent	G1223A	F5885		
ECD2	Agilent	G1223A	F6883	1990	--
Gas Chromatograph 12	Agilent	6890	US00001438		
ALS Tower	Agilent	G1513A	US05012072		
ALS Tray	Agilent	18596M	3530A39334		
Controller Box	Agilent	G1512A	3530A02441		
u-ECD1	Agilent	G2397A	U129C		
u-ECD2	Agilent	G2397A	U6313	1997	

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
High-Performance Liquid Chromatograph 3				2004	New
ALS	Agilent	G131A	DE23922078		
COL COM	Agilent	G1316A	DE23930798		
FLD	Agilent	G1321A	DE92001260	2009	
Dual-DAD	Agilent	G1315B	DE30518838	2004	
DEGASSER	Agilent	G1379A	JP13205067		
QUAD PUMP	Agilent	G1311A	DE23920683		
GCM12					
Gas Chromatograph	Agilent	G1530A	US00040094		
Mass Spectrometer	Agilent	G2578A	US21853018		
ALS Tower	Agilent	G2613A	US93909504		
ALS Tray	Agilent	G2614A	US92905661	2000	--
GCMS14					
Gas Chromatograph	Agilent	G1530N	CN10430038		
Mass Spectrometer	Agilent	G3172A	US54431689		
ALS Tower	Agilent	G2913A	CN81247973		
ALS Tracy	Agilent	G2614A	CN80647378	2004	--
Extractions:					
Accelerated Solvent Extractor 1	Dionex	200	95080583	1999	--
Accelerated Solvent Extractor 2	Dionex	200	96100208	2001	--
Accelerated Solvent Extractor 3	Dionex	200	99030374	2003	--
Accelerated Solvent Extractor #1	Dionex	ASE 200	97040459	2002	--
Accelerated Solvent Extractor #2	Dionex	ASE 200	3040683	2005	--
Nanopure Water System	Barnstead	4741	747940357923	1998	--
TurboVap Concentrator	Zymark	Turbovap	TV9531N6309	2000	--
Muffle Furnace	Thermolyne	62700	627970243372	1999	--
BL006: Analytical Balance *(Shared with IH)*	Sartorius	CP225D	14204830	--	--
Refrigerator Recirculator	Neslab	CFT-75	87KML60200-20	1999	--
Metals:					
ICP *(Shared with IH)*	Perkin Elmer	5300DV	077C7070202	2006	New
ICP *(Shared with IH)*	Perkin Elmer	5300DV	077N6041401	2006	New
ICP/MS *(Shared with IH)*	Perkin Elmer	ELAN 6100	G2700107	2001	New
ICP/MS *(Shared with IH)*	Thermo	X - Series	X0376		Used
Mercury Analyzer	Perkin Elmer	FIAS 400	135951	2000	--
Mercury Analyzer *(Shared with IH)*	Perkin Elmer	Fims 100	101S4080502	2004	New
Hot Block Digestor *(Shared with IH)*	Environ. Expr.	SC154	944CEC1006	--	--
Hot Block Digestor *(Shared with IH)*	Environ. Expr.	SC154	528CEC0747		
Hot Block Digestor *(Shared with IH)*	Environ. Expr.	SC154	2484CEC1296		
Hot Block Digestor *(Shared with IH)*	Environ. Expr.	SC154	1423CEC1099		

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
Hot Block Digestor *(Shared with IH)*	Environ. Expr.	SC154	424CEC0592	2003	New
Hot Block Digestor *(Shared with IH)*	Environ. Expr.	SC154	1944CEC1006	2001	New
Hot Block Digestor *(Shared with IH)*	Environ. Expr.	SC100	615CEC0860	2001	New
TCLP Rotator	Environ. Expr.	--	--	--	--
TCLP Rotator	Environ. Expr.	--	--	--	--
Wet Chemistry:					
Ion Chromatograph 3	Dionex	ICS1000	04050018	2004	New
Autosampler	Dionex	AS40	95090256	1995	--
Ion Chromatograph 4	Dionex	ICS2000	05090476	2005	New
Autosampler	Dionex	AS40	05090256	2005	New
Ion Chromatograph 5	Dionex	ICS2000	04050699	2006	New
Autosampler	Dionex	AS40	94110334	1994	--
Ion Chromatograph 6	Dionex	ICS2000	07020086	2007	New
Autosampler	Dionex	AS40	04040861	2004	New
PC Titrator 1					
PC Titrate Interface Module	ManTech	PC-1000-102/4	MS-0A4-357	2003	New
Titra-Sip Titration Module	ManTech	PC-1300-475	MS-0D4-634	2003	New
Burivar I/2 Buret Module	ManTech	PC-1104-00	MS-9B9-399	2003	New
Titra-Rinse/A Module	ManTech	PC-1000-408	MS-0J3-167	2003	New
Conductivity Meter	Jenway	4510	1106	2003	New
Autosampler	ManTech	--	270J3XB590	2003	New
PC Titrator 2					
Titra-Sip SA Interface Module	ManTech	PC-1075-00	MS-1H0-105	2010	New
Titra-Sip Titration Module	ManTech	PC-1300-475	MS-1F0-817	2010	New
Titra-Rinse/A Module	ManTech	PCM-1000-470	MS-0F4-191	2010	New
Titra-Rinse/A Module	ManTech	PCM-1000-400	MS-0J2-535	2010	New
Autosampler	ManTech	PC-1000-681	190A3032	2010	New
BOD Auto-Analyzer					
Interface Module	ManTech	PC-1085-00	MS-1B0-136	2010	New
Titra-Rinse/A Module	ManTech	PC-1000-480	MS-0F5-243	2010	New
Titra-Rinse/A Module	ManTech	PC-1000-443	MS-1A0-111	2010	New
Sensor &Stirrer Control	ManTech	PB-10030	MS-1B0-106	2010	New
Inhibitor Pump	ManTech	PC-1000-475	MS-1B0-118	2010	New
Rinse Pump	ManTech	PC-1000-470	MS-1B0-113	2010	New
Dissolved Oxygen Meter 2	YSI	52CE	03J0616	2003	New
Autosampler	ManTech	PBM-1000-688	260A8N025	2010	New
Total Organic Carbon Analyzer	Shimadzu	TOC-V-CSH	40D91227	2002	--
Autosampler	Shimadzu	ASI-V	H52104100104	2002	--
Pensky-Martins Flash Tester	Fisher Scientific	--	20800023	--	--
UV-Vis Spectrophotometer	Shimadzu	UV Pharma Spec 1700	A11024136179 CS	2003	New
Turbidimeter	HF Scientific	Micro-100	200702190	2007	New
Dissolved Oxygen Meter	YSI	5000	99D0533	--	--
pH / ISE Meter 3	Thermo/Orion	710A	060237	--	--
pH / ISE Meter 4	Orion	420A	014395	--	--
pH / ISE Meter 5	Orion	420A	24440	--	--
Conductivity / pH Meter	Hach	HQ30d	060600000983	2006	New
Conductivity Meter	Control Company		98291048	--	--
COD Block Reactor 3	Hach	45600-00	010700022054	--	--

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
COD Block Reactor 4	Hach	LTG082.54.42001	1218899	2006	NEW
COD Block Reactor	Hach	LTG082.54.44001	1156212	2007	NEW
TKN Digestion System Block Controller	 Aim Lab Aim Lab	 AIM600 AIM 600	 4904A14055 4906A14087	 2008 2008	 New New
Cyanide MIDI - Distillation System	Lab Crest	110-10-REG	SNA4U0072	--	--
Cyanide MIDI - Distillation System	Lab Crest	110-10-R	A9P0209	--	--
Hot Block Digestor	Environ. Expr.	SC100	615CEC0860	--	--
BOD Incubator 04	VWR	2020	05103004	--	--
BOD Incubator 05	Revco	--	--	--	--
BOD Incubator 06	Lab Line	3554-40	1097-001	--	--
Analytical Balance 009	Ohaus	Scout Pro SP601	7122181160	--	--
Analytical Balance 012	Mettler Toledo	AX205	1122481540	--	--
Analytical Balance 017	Sartorius	A1205-**D20	39050003	--	--
Analytical Balance 019	Mettler	AE260-5	G31175	--	--
Drying Oven 004	VWR	1305U	0705590	--	--
Drying Oven 006	VWR	1320	0800599	--	--
Drying Oven 007	Blue M	OV-500C-2	OV3-24912		
Drying Oven 010	Fisher Scientific	630G	20400063	--	--
Muffle Furnace 01	ThermoLyne	62700	--	--	--
E-Pure System	Barnsted	D4641	1090050246637	--	--
Centrifuge	Beckman	TJ-6	0A058	--	--
Reciprocal Shaker	Lab Line	3506	0793-0453	--	--
Mini Vortexer	VWR	VM3000	25347	--	--
Microbiology :					
Quanti Tray Sealer	Idexx	2020	--	2002	Used
Quanti Tray Sealer	Idexx	QT001	4120	2005	Used
Water Bath 8	Precision	51221033	601121635	2002	New
Water Bath 6	Boekel	GD100L	GL054300	--	New
Water Bath 5	Boekel	GD100L	GL0450003	--	New
Incubator 4	Thermo	3973	304764	2005	New
Incubator 5	VWR	1915	--	1992	New
Analytical Balance	Ohaus	Adventuer-Pro	8026421198	2005	New
Microscope	Nikon	Nme	135387	--	New
Microscope	Leica	Zoom 2000	132DEZ	--	New
Industrial Hygiene:					
HPLC2 High Performance Liquid Chromatograph 1100 ALS	Agilent	G1313A G1322A G1311A G1316A G1321A G1315B	DE91610196 JP73020320 DE11114347 DE91612722 DE92001665 DE11112225	--	--
HPLC4 High Performance Liquid Chromatograph 1100 ALS / LCQ Advantage Mass Spectrometer w/ DAD and Fluorescence Detectors	Agilent / Thermo -Finnigan	G1313A G1322A G1311A G1316A G1321A G1315A LCQADV	DE11115352 JP05029135 DE91608229 DE11120753 DE11103117 DE91607422 LAD00192	--	--

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
GC1: Controller 7673 Autosampler Injector 7673 Gas Chromatograph w/ dual FPD Detectors *(Shared with SVOA)*	Agilent	7673 18596 B 7673 5890	3018A22248 3106A24228 3108A25342 7750A18397	-- -- -- 1990	--
GC14: Controller Autosampler Injector Gas Chromatograph w/ dual FID Detectors	Agilent	7673 18596 B 7673 5890 Series II	3007A20952 3201A27340 3237A32148 3140A39271	-- -- -- --	--
GC13: Controller Injector Gas Chromatograph w/ FID and TCD Detectors	Agilent	7673 7673 5890 Series II	3113A25897 3048A24489 3140A38303	-- -- -- --	--
GC9: Controller Autosampler Injector Gas Chromatograph w/ FID Detector	Agilent	7673 18596 B 7673 5890 Series II	3251A30932 3334A32981 3120A26800 3118A35369	-- -- -- --	--
GC7: Autosampler Injector Gas Chromatograph w/ dual ECD Detectors *(Shared with SVOA)*	Agilent	G2614A 7683 6890	US91605057 CN33832614 US00000197	-- -- -- --	--
GC-MS 8: Gas Chromatograph Mass Spectrometer ATD	Hewlett Packard Agilent Perkin Elmer	6890 5973 TurboMatrix 650	3235A44760 3329A00483 TD650L0605128	2010	Used
GCMS 10 Gas Chromatograph Mass Spectrometer Autosampler Preconcentrator Canister Cleaner Dynamic Diluter *(Shared with VOA)*	Agilent Agilent Entech Entech Entech Entech	6890 5973 7032L 7100 3100 4600	U50039506 U503960554 0043 0162 0103 0041		
GCMS 11 Gas Chromatograph Mass Spectrometer Autosampler Preconcentrator Canister Cleaner *(Shared with VOA)*	Agilent Agilent Entech Entech Entech Entech	6890 5973 7032L 7100 3100 4600	U50039506 U503960554 0043 0162 0103 0041		
ICP *(Shared with Metals)*	Perkin Elmer	5300DV	077C7070202	2006	New
ICP *(Shared with Metals)*	Perkin Elmer	5300DV	077N6041401	2006	New
ICP/MS *(Shared with Metals)*	Perkin Elmer	ELAN 6100	G2700107	2001	New
ICP/MS *(Shared with Metals)*	Thermo	X - Series	X0376		Used
Mercury Analyzer *(Shared with Metals)*	Perkin Elmer	Fims 100	101S4080502	2004	New
Hot Block Digestor *(Shared with Metals)*	Environ. Expr.	SC154	944CEC1006	--	--

Instrument Type	Manufacture	Model Number	Serial Number	Year Put into Service	Condition When Received
Hot Block Digestor *(Shared with Metals)*	Environ. Expr.	SC154	528CEC0747		
Hot Block Digestor *(Shared with Metals)*	Environ. Expr.	SC154	2484CEC1296		
Hot Block Digestor *(Shared with Metals)*	Environ. Expr.	SC154	1423CEC1099		
Hot Block Digestor *(Shared with Metals)*	Environ. Expr.	SC154	424CEC0592	2003	New
Hot Block Digestor *(Shared with Metals)*	Environ. Expr.	SC154	1944CEC1006	2001	New
Hot Block Digestor *(Shared with Metals)*	Environ. Expr.	SC100	615CEC0860	2001	New
IC2: Ion Chromatograph Interface AS-40 Autosampler	Dionex PE Nelson Dionex	DX-120 900 AS-40	97070800 1036512763 94120305	-- -- --	Used
IC7: Ion Chromatograph Pump TC VWD Pneumatic Controller Autosampler	Dionex	ICS 3000 ICS 3000 ICS 3000 ICS 3000 PC-10 AS-40	-- 08050969 08041101 08050957 063334 08051080	2008 2008 2008 2008 2008 2008	New New New New New New
SPEC2: Spectrophotometer	Turner	SP-830	1102980604474	--	--
BL006 : Analytical Balance *(Shared with SVOA)*	Sartorius	CP225D	14204830	--	--
BL020: Analytical Balance	Denver Instrument	XL-3100	0079735	2010	Used
Danby Refrigerator	Danby	DCR432W	0102090100793	--	--

Table 20-2. Schedule of Routine Maintenance

Instrument	Procedure	Frequency
Mercury Analyzer	Check tubing for wear Fill rinse tank with 10% HCl Insert clean drying tube filled with Magnesium Perchlorate Fill reductant bottle with 10% Stannous Chloride	Daily Daily Daily Daily
ICP	Check pump tubing Check liquid argon supply Check fluid level in waste container Check filters Clean or replace filters Check torch Check sample spray chamber for debris Clean and align nebulizer Check entrance slit for debris Change printer ribbon Replace pump tubing	Daily Daily Daily Weekly As required Daily Monthly Monthly Monthly As required As required
ICP MS	Change pump tubing Clean torch Check / clean nebulizer Clean cones Check air filters Check multiplier voltages & do cross calibration Replace sample uptake tubing Check rotary pump oil Check oil mist filters Check chiller water level	Weekly Weekly Weekly Daily Weekly Weekly Monthly Monthly Monthly Monthly
UV-Vis Spectrophotometer	Clean ambient flow cell Precision check/alignment of flow cell Wavelength verification check	As required As required Semi-annually
Auto Analyzers	Clean sampler Check all tubing Clean inside of colorimeter Clean pump well and pump rollers Clean wash fluid receptacle Oil rollers/chains/side rails Clean optics and cells	Daily Daily Daily Quarterly Weekly Weekly Quarterly
Hewlett Packard GC/MS	Ion gauge tube degassing Pump oil-level check Pump oil changing Analyzer bake-out Analyzer cleaning Resolution adjustment COMPUTER SYSTEM AND PRINTER: Air filter cleaning Change data system air filter Printer head carriage lubrication Paper sprocket cleaning Drive belt lubrication	As required Monthly Annually As required As required As required As required As required As required As required As required

Instrument	Procedure	Frequency
Gas Chromatograph	Compare standard response to previous day or since last initial calibration Check carrier gas flow rate in column Check temp. of detector, inlet, column oven Septum replacement Check system for gas leaks with SNOOP Check for loose/frayed wires and insulation ½"Bake injector/column Change/remove sections of guard column Replace connectors/liners Change/replace column(s)	Daily Daily via use of known compound retention Daily As required W/cylinder change as required Monthly As Required As Required As Required As Required
Electron Capture Detector (ECD)	Detector wipe test (Ni-63) Detector cleaning	Semi-annually As required
Flame Ionization Detector (FID)	Detector cleaning	As required
Flame Photoionization Detector (FPD)	Clean and/or Replace Lamp	As required
Photoionization Detector (PID)	Change O-rings Clean lamp window	As required As required
HPLC	Change guard columns Change lamps Change pump seals Replace tubing Change fuses in power supply Filter all samples Change autosampler rotor/stator	As required As required Semi-annually or as required As required As required Daily As required
Balances	Class "S" traceable weight check Clean pan and check if level Field service	Daily, when used Daily At least Annually
Conductivity Meter	0.01M KCl calibration Conductivity cell cleaning	Daily As required
Turbidimeter	Check light bulb	Daily, when used
Deionized/Distilled Water	Conductivity Point Sources Daily conductivity check Check deionizer light Monitor for VOA's System cleaning Replace cartridge & large mixed bed resins	Water Quality Daily Daily As required As required
Drying Ovens	Temperature monitoring Temperature adjustments	Daily As required
Refrigerators/ Freezers	Temperature monitoring Temperature adjustment Defrosting/cleaning	Daily As required As required
Vacuum Pumps/ Air Compressor	Drained Belts checked Lubricated	As required As required Semi-annually

Instrument	Procedure	Frequency
pH/Specific Ion Meter	Calibration/check slope Clean electrode	Daily As required
BOD Incubator	Temperature monitoring Coil and incubator cleaning	Daily Monthly
Water baths	Temperature monitoring Water replaced	Daily Monthly or as needed

Table 20-3. Preventative Maintenance for Laboratory Equipment

Instrument/ Equipment Type	Preventative Maintenance	Frequency
Gas Chromatograph	Replace Gas line dryers and filters	As needed
	Replace Gas cylinders	As needed
	Check or adjust column gas flow and/or detector make-up flow	As needed
	Replace Injection port Septa	As needed
	Replace Injection port liners/re-silonize liners	GC, As needed; GC/MS, Daily
	Replace Injection port liner o-ring	GC, As needed; GC/MS, Daily
	Replace inlet seal and ring	GC, As needed, GC/MS, Daily
	Replace column ferrules	GC, As needed; *
	Clip column (injector and detector end)	GC, As needed; GC/MS, Daily
	Replace syringes on autosamplers	As needed
	Replace heated-zones heaters and sensors	As needed
	Replace inlet assembly	As needed
	Empty solvent rinse and solvent rinse-waste vials (on autosampler tower)	Daily or as needed
	Replace column	As needed
Flame Ionization Detector (FID)	Clean/replace jet	As needed
	Clean collector	As needed
	Check and/or adjust gas flows	As needed
	Replace graphite ferrule	After each cleaning (OI detectors only)
Photoionization Detector (PID)	Clean window	As needed
	Replace o-ring seat	As needed
	Replace Lamp	As needed
	Check and/or adjust gas flows	As needed
	Adjust Lamp power supply intensity	As needed
Flame Photometric Detector (FPD)	Clean mirrors/lenses	As needed
	Replace mirrors/lenses	As needed
	Replace o-rings	As needed
Mass Spectrometer (MS)	Clean source, replace source parts, replace filaments	As needed

Instrument/ Equipment Type	Preventative Maintenance	Frequency
	Clean analyzer	As needed
	Replace electron multiplier	As needed
	Clean or replace glass jet separator, replace transfer line from jet separator to MS	As needed
	Change rough pump oil	As needed
	Refill calibration compound (PFTBA) vial	As needed
Purge and Trap Equipment	Refill rinse water supply/Empty rinse water waste	Weekly or as needed
	Refill spiking solutions vials	As needed
	Rinse sparge tubes	Daily
	Clean or replace 6-port valve	As needed
	Replace Transfer lines (from Autosampler to LSC and from LSC to GC)	As needed
	Adjust gas flows and pressures	As needed
	Perform leak check	As needed
Inductively Coupled Plasma, Atomic Emission Spectrometer (ICP-AES)	Replace Peristaltic pump tubing	As needed
	Clean autosampler, change tubing	As needed
	Clean nebulizer and torch assembly	As needed
	Replace nitrogen and argon tanks	As needed
	Refill rinse water receptacle	Daily
	Empty waste receptacle	Daily
	Check for internal standard and sample flow through peristaltic pump tubing	As often as possible
	Replace internal standard solution receptacle	As needed
	Operate and check vents	Daily
	Perform Hg alignment	Daily
	Check water level and water filter on recirculating-cooling unit, refill and replace filter	Check daily, refill and replace as needed
	Check purge windows	Daily, replace as needed
	Replace nebulizer and o-rings	As needed
	Replace torch	As needed
	Drain air compressor	Weekly
	Replace mixing chambers	As needed
	Clean or replace air filters	Weekly
	Check pneumatic filters	Weekly, replace as needed
	Perform wave calibration (UV and Vis)	Quarterly*
High Pressure Liquid Chromatography (HPLC)	Calibrate Detector	As needed
	Replace pre-column filter	As needed
	Refill Solvent reservoirs	Daily or as needed
	Reverse column and rinse with solvents	Daily or as needed*
	Replace column	As needed

Instrument/ Equipment Type	Preventative Maintenance	Frequency
	Clean solvent reservoir filters	As needed
	Replace Guard Column	As needed
	Replace solvent reservoir frits	As needed
	Replace ball-valve cartridges on high pressure pump	As needed*
	Replace DAD flow cell windows	As needed*
	Check system solvent pressure	Daily
pH Meters	Clean or replace electrode	As needed
	Refill electrode electrolyte	As needed
Balance	Clean pan and platform	After each use
	Check Level bubble	Daily
	Check calibration	Daily
	Check sensitivity	Weekly
	Cleaning and calibration by authorized service	Annually
Conductivity Meter	Clean probe	As needed
Dissolved Oxygen Meter	Replace membrane	As needed
	Clean probe	As needed
ZHE vessels	Replace o-rings and screens	As needed
ZHE and TCLP Tumblers	Check Rotation Rate	Monthly
Spectrophotometers	Clean and check tubing	As needed
Burettes and Pipettes	Clean and check calibration	Quarterly
Thermometers	Check calibration	Annually, Quarterly for Digitals and IR Thermometer
Ovens	Check and/or adjust temperature, record temperature on log sheet	Daily
Refrigerators and Freezers	Check and/or adjust temperature, record temperature on log sheet	Daily
	Defrost freezers	As needed
Mercury Analyzer	Change Argon supply tank	As needed
	Change drying tube	Daily or as needed
	De-clog drying tube and/or reductant tubing	Daily or as needed
	Change system tubing	2-3 weeks
	Rinse tubing prior to operation and following operation	Daily
	Clean optical cell	As needed (when aperture is out of line)

Table 20-4. Periodic Calibrations

Instrument	Type of Calibration/ Number of Standards	Frequency	Acceptance Limits	Corrective Action
Analytical Balance	Accuracy determined using NIST calibrated weights. Minimum of 2 standards bracketing the weight of interest. Annually inspected and calibrated by ISO accredited firm.	Daily	See logbook	Clean, check level, insure lack of drafts, and that unit is warmed up, recheck. If fails, call service or replace.
Top Loading Balance	Accuracy determined using NIST calibrated weights. Minimum of 2 standards bracketing the weight of interest. Annually inspected and calibrated by ISO accredited firm.	Daily	See logbook	Clean. If fails, call service or replace.
NIST Weights	Accuracy determined by accredited weights and measurement laboratory.	5 year	As per certificate.	Replace.
Working Weights	Examine for wear, compare against NIST weights.	Annually	ASTM Type 1, Class 1 or 2 standards	Replace.
NIST-Traceable Thermometer	Accuracy determined by accredited weights and measurement laboratory.	5 years	As per certificate.	Replace.
Working Thermometers	Against NIST-traceable thermometer	Yearly (or more frequently e.g. digital are checked quarterly) at appropriate temperature range for intended use	± 1.0°C	Replace.
InfraRed Temperature Guns	Against calibrated liquid thermometer at ambient and storage temps Against NIST-traceable thermometer	Daily Semi-annually at appropriate temperature range for intended use.	± 0.5°C ± 2.0°C	Repair/replace. Repair/replace.

Instrument	Type of Calibration/ Number of Standards	Frequency	Acceptance Limits	Corrective Action
Dial-type Thermo-meters	Against NIST-traceable thermometer	Quarterly at appropriate temperature range for intended use.	± 1.0°C	Replace.
Refrigerator	Temperature checked using NIST-traceable thermometer.	Daily. If out of range, recheck in two hours.	0 to ≤ 6°C	Adjust. Repair. While waiting for repair, seal door, attach "Out of Service" sign, move items to functional unit. Notify Department Manager.
Freezer	Temperature checked using NIST-traceable thermometer	Daily. If out of range, recheck in two hours.	≤ (-10)°C	Adjust. Repair. While waiting for repair, seal door, attach "Out of Service" sign, move items to functional unit. Notify Department Manager.
Oven	Temperature checked using NIST-traceable thermometer.	When in use.	104 ± 1°C (drying) 180 ± 2°C (TDS); or as per method.	Adjust. Replace.
Incubator	Temperature checked using NIST-traceable thermometer.	When in use. For micro-biology, twice daily when in use.	BOD: 20 ± 1.0°C Micro: 35 ± 0.5°C	Adjust. Replace.
Water Bath	Temperature checked using NIST-traceable thermometer.	When in use.	44.5 ± 0.2°C in Micro	Adjust. Replace.
Volumetric Dispensing Devices (Eppendorf ® pipette, automatic dilutor or dispensing devices)	One delivery by weight. Using DI water, dispense into tared vessel. Record weight with device ID number. See SOP.	Monthly	± 2% Calculate accuracy by dividing weight by stated volume times 100 for percent.	Adjust. Replace.

Instrument	Type of Calibration/ Number of Standards	Frequency	Acceptance Limits	Corrective Action
Glass Microliter Syringes	None	Hamilton syringes are ordered with a certificate attesting to their accuracy.	Re-verified.	Replaced.
Conductivity Meter	Cell impedance calibrated with three KCl standards.	Each use.	r ≥ 0.99	Recalibrate.
Nanopure Water	Check in-line conductivity meter on system with conductivity meter in Inorganics Department.	Each day of use.	<10 µmhos/cm^2	Record in logbook. Report discrepancies to the Department Manager.
	Check for compliance with Standard Methods reagent water requirements	Monthly	Ammonia <.01mg/L Res. Cl <0.01 mg/L pH 5.5 – 7.5 SU TOC <1 mg/L HPC <1000 CFU/mL	Record in logbook. Report discrepancies to the Department Manager.

Table 20-5. Preventative Maintenance for Field Equipment

Instrument/ Equipment Type	Activity	Frequency	Maintenance
Automatic Sampler – ISCO 3710/3910	Check tubing and connections through pump head	Before and after use	Replace tubing when necessary
	Check battery power and program	Before and after use	Replace battery when necessary
	Clean tubing in pump head	After each use	Replace pump head tubing when necessary
	Clean tubing for sample collection	After each use	Not applicable
	Check functionality – manual sample; program sample	Prior to use	Not applicable
	Check sample container for breakage, etc.	Prior to use	Replace if needed

SECTION 21

MEASUREMENT TRACEABILITY *(NELAC 5.5.6)*

21.1 OVERVIEW

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices. (Refer to Section 20.3). With the exception of Class A Glassware (including glass microliter syringes that have a certificate of accuracy), quarterly accuracy checks are performed for all mechanical volumetric devices. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A Glassware should be routinely inspected for chips, acid etching or deformity. If the Class A glassware is suspect, the accuracy of the glassware will be assessed prior to use.

21.2 NIST-TRACEABLE WEIGHTS AND THERMOMETERS

Reference standards of measurement shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), APLAC (Asia-Pacific Laboratory Accreditation Cooperation), or EA (European Cooperation for Accreditation). A certificate and scope of accreditation is kept on file at the laboratory.

21.3 REFERENCE STANDARDS / MATERIALS

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared standard materials are purchased from vendors accredited by A2LA, NVLAP, or other ISO 17025 accreditation with an accompanying Certificate of Analysis that documents the standard purity. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. The receipt of all reference standards must be documented. Reference standards are labeled with a unique Standard Identification Number as assigned in as assigned in Element and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the 'true' value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. This standard is known as the Initial Calibration Verification (ICV) or Quality Control Standard (QCS). In cases where a second standard manufacturer is not available, a vendor certified different lot

is acceptable for use as a second source. For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an ICV or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g. calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. Refer to the Corporate Environmental Health & Safety Manual or laboratory SOPs. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual and facility addendum.

21.4 DOCUMENTATION AND LABELING OF STANDARDS, REAGENTS, AND REFERENCE MATERIALS

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company wide purchase. (Refer to TestAmerica's Corporate SOP CA-Q-S-001, Solvent and Acid Lot Testing and Approval.)

All manufacturer or vendor supplied Certificates of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained in Element LIMS. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on receipt, documentation and labeling of laboratory standards, reagents, and reference materials; please refer to SOPs PE-QAD-012 Receipt Process for General Supplies and Chemicals and PE-QAD-013 Reagent and Standard Preparation, Control and Documentation.

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc.., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96% a correction will be made to concentrations applied to solutions prepared from the stock commercial material.

21.4.1 All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into the laboratory's LIMS system, and are assigned a unique identification number. The following information is typically recorded in the electronic database within the LIMS.

- Standard ID
- Description of Standard
- Department
- Preparer's name
- Final volume and number of vials prepared
- Solvent type and lot number

- Preparation Date
- Expiration Date
- Standard source type (stock or daughter)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained electronically for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

21.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Expiration Date
- Standard ID (generated from LIMS)
- Special Health/Safety warnings if applicable

21.4.3 In addition, the following information may be helpful:

- Date of receipt for commercially purchased items or date of preparation for laboratory prepared items
- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include a preparation date, expiration date and an ID number to trace back to preparation.

Procedures for preparation of reagents can be found in the Method SOPs.

Standard ID numbers must be traceable through associated logbooks, worksheets and raw data.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods as specified in the laboratory SOP.

SECTION 22

SAMPLING *(NELAC 5.5.7)*

22.1 OVERVIEW

The laboratory provides sampling services. Sampling procedures are described in SOP PE-SMP-004 Field Sampling for:

- Groundwater Sampling
- Wastewater Sampling
- Soil Sampling

22.2 SAMPLING CONTAINERS

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Any certificates of cleanliness that are provided by the supplier are maintained at the laboratory. Additional information is available in SOP PE-SMP-005 Bottle Preparation.

For Industrial Hygiene, at the client's request, sample media and sampling instructions can be provided. Sample media is shipped to the client via either TestAmerica's courier service or a commercial courier service. Sampling instructions, if requested, are shipped to the client with the sample media.

22.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In some cases containers may be purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

- Ammonium Chloride – ACS Grade or equivalent
- Ascorbic Acid – ACS Grade or equivalent
- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- MCAA (Chloroacetic Acid) = ACS Grade or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Sulfite – ACS Grade or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent
- Zinc Acetate – ACS Grade or equivalent

22.2.2 Industrial Hygiene Sampling Equipment

In addition to providing clients with sample media and sampling instructions, the laboratory offers sampling equipment for client loan or rental. Loan and rental equipment includes air sampling pumps, impingers, and cyclones. The air sampling pumps are calibrated according to the procedures outlined in SOP PE-SMP-007 – Calibrating Sampling Pumps.

22.3 DEFINITION OF HOLDING TIME

The date and time of sampling documented on the COC form will be used to establish the zero (start) date and time at which point the holding time commences. As a general rule, when the maximum allowable holding time is expressed in "days" (e.g., 14 days, 28 days), the holding time is based on each calendar day measured. Holding times expressed in "hours" (e.g., 6 hours, 24 hours, etc.) are measured from the zero date and time listed on the COC. The first day of holding time ends twenty-four hours after sampling. Holding times for analysis include any necessary reanalysis. However there are some programs that determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of how long the holding time is.

22.3.1 Semi-Volatiles - Holding times for sample preparation for semi-volatile organics are measured from the sampling date (and time where applicable) until the day (and time where applicable) extraction. If a sample is to be extracted on the day of expiration, the actual time of extraction must be recorded on the sample preparation worksheet. Holding times for analysis are measured from the date (and time where applicable) of initiation of extraction to the time of injection into the gas chromatograph.

22.3.2 Volatiles - Holding times for volatile organics are measured from the date (and time where applicable) of sampling to the date and time of injection into the gas chromatograph. The data systems record the start of the chromatographic run. Extractions, e.g., for high-level soils, must be completed in time to allow for analysis to be initiated within the maximum allowable holding time. Holding time is regulatory program driven.

22.3.3 Inorganics - For inorganic and metals analysis, the preparation/digestion/distillation must be started within the maximum holding time as measured from the sampling date (and time where applicable).

22.4 SAMPLING CONTAINERS, PRESERVATION REQUIREMENTS, HOLDING TIMES

The preservation and holding time criteria specified in Tables 22-1 to 22-7 are derived from the source documents for the methods. If method required holding times or preservation requirements are not met, the reports will be qualified using a flag, footnote or case narrative. As soon as possible or "ASAP" is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 SAMPLE ALIQUOTS / SUB-SAMPLING

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need

consideration when sub-sampling for sample preparation. It is the laboratory's responsibility to take a representative sub-sample or aliquot of the sample provided for analysis.

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis.

Guidelines on taking sample aliquots & subsampling are located in SOP PE-QAD-003 Sub-sampling.

Table 22-1.

Holding Times, Preservation and Container Requirements: Drinking Water (SDWA)

PARAMETER	CONTAINER	PRESERVATION[1,2] Temp. [23]	Chemical	HOLDING TIME[3]	SAMPLE VOLUME
Asbestos	Plastic/Glass	4ºC	None	48 hours[5]	1 L
Coliforms (Total and Fecal)	Plastic/Glass[20]	10°C	$Na_2S_2O_3$	30 hours[21]	120 mL
Cyanide	Plastic/Glass	4ºC	NaOH to pH >12 Ascorbic acid[9] or Sodium arsenite[9]	14 days	500 mL
Fluoride	Plastic/Glass	None	None	None	250 mL
Heterotrophic Plate Count	Plastic/Glass[20]	10°C	$Na_2S_2O_3$	8 hours (24 hours[22])	120 mL
Mercury	Plastic/Glass	None	HNO_3 to pH<2	28 days	250 mL
Metals[4]	Plastic/Glass	None	HNO_3 to pH<2[24]	6 months	250 mL
Nitrate	Plastic/Glass	4ºC	None	48 hours[6]	250 mL
Nitrate-Nitrite	Plastic/Glass	None	H_2SO_4 to pH<2	28 days	250 mL
Nitrite	Plastic/Glass	4ºC	None	48 hours	250 mL
THMs Only	Glass[8]	4ºC	$Na_2S_2O_3$[9] HCl to pH <2 may also be used	14 days	3 X 40 mL
Volatile Organic Compounds	Glass[8]	4ºC	HCl to pH <2 $Na_2S_2O_3$[9] or Ascorbic acid[9]	14 days	3 X 40 mL
EDB, DBCP, 1,2,3-TCP (EPA 504.1)	Glass[8]	4ºC	$Na_2S_2O_3$	14 days	3 X 40 mL
Organochlorine Pesticides/PCBs (EPA 505)[10]	Glass[8]	4ºC	$Na_2S_2O_3$	14 days[11]	3 X 40 mL
Nitrogen and Phos. Pesticides (EPA 507)	Glass-Amber[8]	4ºC	$Na_2S_2O_3$	14 days[12]	1 L
Total PCBs (EPA 508A)	Glass-Amber[8]	4ºC	None	14 days[13]	1 L
Pesticides and PCBs (EPA 508.1)[14]	Glass-Amber[8]	4ºC	HCl to pH <2 $Na_2S_2O_3$[9, 25]	14 days[13]	1 L
Chlorinated Acids (EPA 515.1)	Glass-Amber[8]	4ºC	$Na_2S_2O_3$	14 days[12]	1 L
Chlorinated Acids (EPA 515.4)	Glass-Amber[8]	4ºC	Na_2SO_3	14 days[12]	250 mL
Semivolatiles (EPA 525.2)	Glass-Amber[8]	4ºC	HCl to pH <2 Na_2SO_3[9]	14 days[13]	1 L
N-Methylcarbamoyloxamines and N-Methcarbamates (EPA 531.1)	Glass[8]	4ºC	$Na_2S_2O_3$, Monochloroacetic Acid buffer to pH<3	28 days	3 X 60 mL
Glyphosate (EPA 547)	Glass[8]	4ºC	$Na_2S_2O_3$	14 days	3 X 60 mL

PARAMETER	CONTAINER	PRESERVATION[1,2] Temp.[23]	Chemical	HOLDING TIME[3]	SAMPLE VOLUME
Endothall (EPA 548)	$Na_2S_2O_3$	4ºC	None	7 days[15]	1 L
Diquat/Parquat (EPA 549.1)	Glass-Amber[8] (Silanized or PVC amber)	4ºC	H_2SO_4 to PH <2 $Na_2S_2O_3$[9]	7 days[16]	1 L
Chlorinated Disinfection Byproducts, Chlorinated Solvents, and Halogenated Pesticides/Herbicides (EPA 551)	Glass[8]	4ºC	Phosphate Buffer and Ammonium Chloride[19]	14 days[17]	3 X 60 mL
Haloacetic Acids (EPA 552.1)	Glass-Amber[8]	4ºC	Ammonium Chloride	28 days[18]	250 mL

Key to Table

1. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
2. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
3. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
4. All metals except Hg.
5. Instructions for containers, preservation procedures and holding times as specified in Method 100.2 must be adhered to for all compliance analysis including those conducted with Method 100.1.
6. If the sample is chlorinated, the holding time for an un-acidified sample kept at 4°C is extended to 14 days.
7. Nitrate-Nitrite refers to a measurement of total nitrate.
8. With Teflon lined septum.
9. If chlorinated add reagent prior to preservation (for Cyanide, add before NaOH).
10. Heptaclor has a 7 day hold time
11. 14 days until extraction. 24 hours after extraction.
12. 14 days until extraction. 28 days after extraction.
13. 14 days until extraction. 30 days after extraction.
14. For cyanazine, cool to 4°C only.
15. 7 days until derivitation. 1 day after derivatation.
16. 7 days until extraction. 21 days after extraction.
17. 14 days until extraction. 14 days after extraction.
18. 28 days until extraction. 48 hours after extraction.
19. Sodium Sulfite may be used as a dechlorinating agent in some instances. Verify with laboratory prior to sampling.
20. Sterilized. Plastic must be Polypropylene.
21. 40 CFR part 141.74 regulations to avoid filtration or disinfection state 8 hours (DW compliance testing). Most facilities are using either disinfection or filtration so the 8 would not apply in most cases.
22. 40 CFR part 141.74 regulations for Disinfection By-Product rule state 8 hours (DW compliance testing) where SM 9215 allows up to 24 hours if sample is stored between > 0 and ≤ 4° C.
23. For samples with a temperature requirement of 4°C, a sample temperature of just above the water freezing temperature to < 6°C is acceptable.
24. Acid preservation may be omitted for shipping and laboratory will acidify at least 24 hours prior to analysis.
25. TAI Irvine add Na_2SO_3 instead of $Na_2S_2O_3$

Table 22-2.

Holding Times, Preservation and Container Requirements: NPDES – Bacteria, Protozoa, Toxicity Tests

PARAMETER	CONTAINER [1]	PRESERVATION[2,3] Temp.	Chemical	HOLDING TIME[4]	SAMPLE VOLUME
Total, Fecal, and E. coli Coliforms	Plastic/Glass	10ºC	0.0008 % $Na_2S_2O_3$[6]	6 hours	100 mL
Fecal Streptococci	Plastic/Glass	10ºC	0.0008 % $Na_2S_2O_3$[6]	6 hours	100 mL
Enterococci	Plastic/Glass	10ºC	0.0008 % $Na_2S_2O_3$[6]	6 hours	100 mL
Cryptosporidium	LPDE Plastic	0-8ºC	None	96 Hours	500 mL
Giardia	LPDE Plastic	0-8ºC	None	96 Hours	500 mL
Toxicity – Acute/Chronic	Plastic/Glass	≤ 6ºC[5]	None	36 Hours	2 L

Key to Table

1. Plastic should be Polypropylene or other sterilizable plastic.
2. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
3. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
4. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
5. Samples must not be frozen. Sufficient ice should be placed with the samples in the shipping container to ensure that ice is still present when the samples arrive at the laboratory. However, even if ice is present, when samples arrive, it is necessary to measure the temperature of the samples and confirm that the ≤ 6°C temperature has not been exceeded.
6. Should only be used in the presence of residual chlorine.

Table 22-3

Holding Times, Preservation and Container Requirements: NPDES – Inorganic

PARAMETER	CONTAINER [1]	PRESERVATION[2,3] Temp.[14]	Chemical	HOLDING TIME[4]	SAMPLE VOLUME
Acidity	Plastic/Glass	≤ 6ºC	None	14 days	100 mL
Alkalinity	Plastic/Glass	≤ 6ºC	None	14 days	100 mL
Ammonia	Plastic/Glass	≤ 6ºC	H_2SO_4 to pH<2	28 days	400 mL
BOD 5 Day	Plastic/Glass	≤ 6ºC	None	48 hours	1000 mL
Boron	Plastic[5]	None	HNO_3 to pH<2	6 months	200 mL
Bromide	Plastic/Glass	None	None	28 days	100 mL
CBOD 5 Day	Plastic/Glass	≤ 6ºC	None	48 hours	1000 mL
COD	Plastic/Glass	≤ 6ºC	H_2SO_4 to pH<2	28 days	100 mL
Chloride	Plastic/Glass	None	None	28 days	50 mL
Chlorine, Residual	Plastic/Glass	None	None	15 min.[6]	200 mL
Color	Plastic/Glass	≤ 6ºC	None	48 hours	50 mL
Cyanide –Total[16,17]	Plastic/Glass	≤ 6ºC	NaOH to pH >12, 0.6 g Ascorbic Acid[7]	14 days	100 mL
Cyanide, Amenable[16,17]	Plastic/Glass	≤ 6ºC	NaOH to pH >12, 0.6 g ascorbic Acid[7]	14 days	100 mL
Fluoride	Plastic	None	None	28 days	300 mL
Hardness	Plastic/Glass	None	HNO_3 to pH<2[8]	6 months	100 mL
Hexavalent, Chromium	Plastic/Glass	≤ 6ºC	Ammonium sulfate buffer pH = 9.3 - 9.7	28 dys / 24 hrs[15]	200 mL
Hydrogen Ion (pH)	Plastic/Glass	None	None	15 min.[6]	200 mL
Kjeldahl and organic Nitrogen	Plastic/Glass	≤ 6ºC	H_2SO_4 to pH <2	28 days	500 mL
Mercury[11]	Plastic/Glass	None	HNO_3 to pH<2	28 days	200 mL
Metals[9,10]	Plastic/Glass	None	HNO_3 to pH<2[18]	6 months	200 mL
Nitrate	Plastic/Glass	≤ 6ºC	None	48 hours	100 mL
Nitrate-Nitrite	Plastic/Glass	≤ 6ºC	H_2SO_4 to pH <2	28 days	100 mL
Nitrite	Plastic/Glass	≤ 6ºC	None	48 hours	100 mL
Oil and Grease	Glass	≤ 6ºC	H_2SO_4 or HCl to pH <2	28 days	1 L

PARAMETER	CONTAINER [1]	PRESERVATION[2,3] Temp.[14]	Chemical	HOLDING TIME[4]	SAMPLE VOLUME
Organic Carbon (TOC)	Plastic/Glass	≤ 6ºC	H_2SO_4 or HCl to pH <2[12]	28 days	250 mL
Orthophosphate	Plastic/Glass	≤ 6ºC	Filter within 15 min.	48 hours	250 mL
Oxygen, Dissolved Probe	Glass[13]	None	None	15 min.[6]	200 mL
Oxygen, Winkler	Glass[13]	None	Fix on site and store in dark	8 hours	300 mL
Phenols	Glass	≤ 6ºC	H_2SO_4 to pH <2	28 days	500 mL
Phosphorus, Elemental	Glass	≤ 6ºC	None	48 hours	250 mL
Phosphorus, Total	Plastic/Glass	≤ 6ºC	H_2SO_4 to pH <2	28 days	250 mL
Residue, Total	Plastic/Glass	≤ 6ºC	None	7 days	1 L
Residue, Filterable	Plastic/Glass	≤ 6ºC	None	7 days	1 L
Residue, Non-Filterable	Plastic/Glass	≤ 6ºC	None	7 days	1 L
Residue, Settleable	Plastic/Glass	≤ 6ºC	None	48 hours	1 L
Residue, Volatile	Plastic/Glass	≤ 6ºC	None	7 days	1 L
Silica	Plastic[5]	≤ 6ºC	None	28 days	250 mL
Specific Conductance	Plastic/Glass	≤ 6ºC	None	28 days	250 mL
Sulfate	Plastic/Glass	≤ 6ºC	None	28 days	250 mL
Sulfide	Plastic/Glass	≤ 6ºC	Zinc acetate plus NaOH to pH>9	7 days	500 mL
Sulfite	Plastic/Glass	None	None	15 min.[6]	200 mL
Surfactants	Plastic/Glass	≤ 6ºC	None	48 hours	1 L
Temperature	Plastic/Glass	None	None	N/A	100 mL
Turbidity	Plastic/Glass	≤ 6ºC	None	48 hours	1 L

Key to Table

1. Plastic should be Polyethylene.
2. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at ≤ 6ºC until compositing and sample splitting is completed.

Key to Table

3. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
4. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
5. May also be collected in quartz or PFTE plastic.
6. For compliance testing, the analysis must be performed in the field at the time of analysis. If transported to the laboratory for analysis, the analysis will be performed as soon as practical (for waters – within 24 hours) and reported qualified.
7. Should only be used in the presence of residual chlorine. (Alternatively, sodium arsenite may be used)
8. H_2SO_4 to a pH <2 is also acceptable.
9. Except Mercury and Hexavalent Chromium.
10. For dissolved metals, samples must be filtered on site before adding HNO_3 preservative (or before shipping to laboratory).
11. Samples collected for determination of trace level mercury (100 ng/L) using EPA 1631 must be collected in tightly capped fluoropolymer or glad bottles and preserved with BrCl or HCl solution within 48 hours of sample collection. The time to preservation may be extended to 28 days if a sample is oxidized in the sample bottle. Samples collected for dissolved trace level mercury should be filtered in the laboratory. However, if circumstances prevent overnight shipping, samples should be filtered in a designated clean area in the field in accordance with procedures given in Method 1669. Samples that been collected for determination of total or dissolved trace level mercury must be analyzed within 90 days of sample collection.
12. Phosphoric acid (H_3PO_4) may also be used.
13. Should have glass lid or top.
14. Aqueous samples must be preserved at ≤ 6 °C unless otherwise indicated, and should not be frozen unless data demonstrating that sample freezing does not adversely impact sample integrity is maintained on file and accepted as valid by the regulatory authority. Also, for purposes of NPDES monitoring, the specification of "≤ °C" is used in place of the "4 °C" and "<4 °C" sample temperature requirements listed in some methods. It is not necessary to measure the sample temperature to three significant figures (1/100th of 1 degree); rather, three significant figures are specified so that rounding down to 6 °C may not be used to meet the ≤ 6 °C requirement. The preservation temperature does not apply to samples that are analyzed immediately (less than 15 minutes).
15. Holding time is 24 hours if pH adjustment is not performed.
16. In the Field: Samples are to be tested for sulfide using lead acetate paper prior to the addition of Sodium Hydroxide (NaOH). If sulfide is present, the sample must be treated with Cadmium Chloride and filtered prior to the addition of NaOH. If the sulfide test and treatment is not performed in the field, the lab will test the samples for sulfide using lead acetate paper at the time of receipt and if sulfide is present in the sample, the client will be notified and given the option of retaking the sample and treating in the field per the method requirements or the laboratory can analyze the samples as delivered (with sulfide treatment by laboratory) and qualify the results in the final report.
17. It is the responsibility of the client to notify the laboratory if thiosulfate, sulfite, or thiocyanate are known or suspected to be present in the sample. This notification may be on the chain of custody. The samples may need to be subcontracted to a laboratory that performs a UV digestion. If the lab does not perform the UV digestion on samples that contain these compounds, the results must be qualified in the final report.
18. Acid preservation may be omitted for shipping and laboratory will acidify at least 24 hours prior to analysis.

Table 22-4

Holding Times, Preservation and Container Requirements: NPDES – Organic

PARAMETER	CONTAINER	PRESERVATION[1,2] Temp.[15]	Chemical	HOLDING TIME[3]	SAMPLE VOLUME
Purgeable Halocarbons	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5]	14 days	40 mL
Purgeable Aromatic Hydrocarbons	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5], HCl to pH<2	14 days[6]	40 mL
Acrolein and Acrylonitrile	Glass[4]	≤ 6ºC	0.0008% $Na_2S_2O_3$[5]	3 days	40 mL
Phenols[9]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5]	7 days[8]	1 L
Benzidines[9]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5]	7 days[8, 11]	1 L
Phthalate esters[9]	Glass[4]	≤ 6ºC	None	7 days[8]	1 L
Nitrosamines[9,12]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5,13]	7 days[8]	1 L
PCBs[9]	Glass[4]	≤ 6ºC	None	1 year[8]	1 L
Nitroaromatics and Isophorone[9]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5,13]	7 days[8]	1 L
Polynuclear Aromatic Hydrocarbons[9]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5,13]	7 days[8]	1 L
Haloethers[9]	Glass[4]	≤ 6ºC	0.0008 % $Na_2S_2O_3$[5]	7 days[8]	1 L
Chlorinated Hydrocarbons[9]	Glass[4]	≤ 6ºC	None	7 days[8]	1 L
CDD/CDFs[9] – Aqueous: Field/Lab Preservation	Glass	≤ 6ºC	pH <9, 0.0008 % $Na_2S_2O_3$[5]	1 year	1 L
CDD/CDFs[9] – Solids/Mixed Phase/ - Field Preservation	Glass	≤ 6ºC	None	7 days	1 L
CDD/CDFs[9] – Tissue – Field Preservation	Glass	≤ 6ºC	None	24 hours	1 L
CDD/CDFs[9] – Solids/Mixed Phase/Tissue - Lab Preservation	Glass	≤ -10ºC	None	1 year	1 L
Pesticides[9]	Glass	≤ 6ºC	pH 5-9 [14]	7 days[8]	1 L

Key to Table

1. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at ≤ 6°C until compositing and sample splitting is completed.
2. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined

Key to Table

that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

3. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
4. With Teflon lined septum.
5. Should only be used in the presence of residual chlorine. Ascorbic may be used instead.
6. Samples receiving no pH adjustments must be analyzed within 7 days. If 2-chlorovinylethylether is a target analyte, the sample should not be acidified.
7. The pH adjustment is not required if acrolein is not being measured. Samples for acrolein receiving no pH adjustment must be analyzed within three days of sampling.
8. 7 days until extraction, 40 days after extraction. (PCB only – 1 year after extraction)
9. When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more categories, the sample may be preserved by cooling to $\leq 6^{o}C$ reducing residual chlorine with 0.0008 % sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9. Samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re the requirement for thiosulfate reduction of residual chlorine) and footnotes 10 and 11(re the analysis of Benzidine).
10. If 1,2-diphenylhydrazine is likely to be present, adjust pH of the sample to 4.0 ± 0.2 to prevent rearrangement to benzidine.
11. Extracts may be stored up to 30 days before analysis if storage temperature is $< 0^{o}C$.
12. For the analysis of diphenylnitrosamine, add 0.008 % $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.
13. Store in dark.
14. The pH adjustment may be performed upon receipt in the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.0008 % $Na_2S_2O_3$.
15. Aqueous samples must be preserved at ≤ 6 °C unless otherwise indicated, and should not be frozen unless data demonstrating that sample freezing does not adversely impact sample integrity is maintained on file and accepted as valid by the regulatory authority. Also, for purposes of NPDES monitoring, the specification of "≤ °C" is used in place of the "4 °C" and "<4 °C" sample temperature requirements listed in some methods. It is not necessary to measure the sample temperature to three significant figures (1/100th of 1 degree); rather, three significant figures are specified so that rounding down to 6 °C may not be used to meet the ≤ 6 °C requirement. The preservation temperature does not apply to samples that are analyzed immediately (less than 15 minutes).

Table 22-5.

Holding Times, Preservation and Container Requirements: NPDES – Radiological

PARAMETER	CONTAINER	PRESERVATION[1,2]		HOLDING TIME[3]	SAMPLE VOLUME
		Temp.	Chemical		
Alpha, Beta, Radium	Plastic/Glass	None	HNO_3 to pH<2	6 months	1 L

Key to Table

1. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
2. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater).
3. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.

Table 22-6.

Holding Times, Preservation and Container Requirements: RCRA – Aqueous

PARAMETER	CONTAINER [1]	PRESERVATION[2,3] Temp.[12]	Chemical	HOLDING TIME[4]	SAMPLE VOLUME
Chloride	Plastic/Glass	4ºC	None	28 days	100 mL
Cyanide -Total	Plastic/Glass	4ºC	NaOH to pH >12[5]	14 days	250 mL
Cyanide -Amenable	Plastic/Glass	4ºC	NaOH to pH >12[5]	14 days	250 mL
Hydrogen Ion (pH)	Plastic/Glass	4ºC	None	24 hours[11]	100 mL
Nitrate	Plastic/Glass	4ºC	None	48 hours	28 days
Oil and Grease	Glass	4ºC	HCl	28 days	1 L
Organic carbon (TOC)	Plastic/Glass	4ºC	pH to <2[6] Store in dark	28 days	28 days
Sulfate	Plastic/Glass	4ºC	None	28 days	400 mL
Sulfide	Plastic/Glass	4ºC	Add Zn Acetate	7 days	400 mL
Chromium VI	Plastic/Glass	4ºC	None	24 hours	250 mL
Mercury	Plastic/Glass	None	HNO_3 to pH<2	28 days	250 mL
Other Metals	Plastic/Glass	None	HNO_3 to pH<2	6 months	250 mL
Acrolein and Acrylonitrile	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7] If adjust pH to 4-5[13]	7 days 14 days	1 L
Benzidines	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7]	7 days[8]	1 L
Chlorinated Hydrocarbons	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7]	7 days[8]	1 L
Dioxins and Furans	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7]	7 days[8]	1 L
Haloethers	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7]	7 days[8]	1 L
Nitroaromatics and cyclic ketones	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7], store in dark	7 days[8]	1 L
Nitrosomines	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7], store in dark	7 days[8]	1 L
Organochlorine Pesticides	Glass[10]	4ºC	None	7 days[8]	1 L
Organophosphorus Pesticides	Glass[10]	4ºC	Adjust pH[9]	7 days[8]	1 L
PCBs	Glass[10]	4ºC	None	7 days[8]	1 L

PARAMETER	CONTAINER [1]	PRESERVATION[2,3] Temp.[12]	Chemical	HOLDING TIME[4]	SAMPLE VOLUME
Phenols	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7]	7 days[8]	1 L
Phthalate Esters	Glass[10]	4ºC	None	7 days[8]	1 L
Polynuclear Aromatic Hydrocarbons	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7], store in dark	7 days[8]	1 L
Purgeable Hydrocarbons	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7] Adjust pH <2[2]	14 days	40 mL
Purgeable Halocarbons	Glass[10]	4ºC	0.0008 % $Na_2S_2O_3$[7]	14 days	40 mL
Total Organic Halides (TOX)	Glass[10]	4ºC	Adjust pH to <2 with H_2SO_4	28 days	1 L
Radiological Tests (Alpha, Beta, Radium)	Plastic/Glass	None	HNO_3 to pH<2	6 months	250 mL

Key to Table

1. Plastic should be Polyethylene.
2. Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
3. When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 6-8, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).
4. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
5. If oxidizing agents are present, add 5 mL 0.1 N $NaAsO_2$ or 0.06 g of ascorbic acid per L. See Cyanide SOP for additional information about other interferences.
6. Adjust pH to <2 with H_2SO_4, HCl, or solid $NaHSO_4$. Free Chlorine must be removed prior to adjustment.
7. Free Chlorine must be removed by the appropriate addition of $Na_2S_2O_3$.
8. 7 days until extraction. 40 days after extraction.
9. Adjust pH to 5-8 using NaOH or H_2SO_4.
10. With Teflon lined septum.
11. Holding Time is listed as "As Soon as Possible" in SW 846. Per EPA MICE, the recommended maximum holding time for pH in water is 24 hours and pH in soil is 7 days. There are no mandated regulatory requirements.
12. For samples with a temperature requirement of 4°C, a sample temperature of just above the water freezing temperature to ≤ 6°C is acceptable.
13. Based on guidance from EPA MICE, if samples are received without pH adjustment, the holding time is 7 days.

Table 22-7.

Holding Times, Preservation and Container Requirements: RCRA – Non-Aqueous

PARAMETER	CONTAINER [1]	PRESERVATION Temp.[7]	PRESERVATION Chemical	HOLDING TIME[2]	SAMPLE WEIGHT
Chloride	Glass	4ºC	None	28 days	50 g
Cyanide -Total	Glass	4ºC	None	14 days	50 g
Cyanide -Amenable	Glass	4ºC	None	14 days	50 g
Hydrogen Ion (pH)	Glass	4ºC	None	7 days[6]	50 g
Nitrate	Glass	4ºC	None	N/A	50 g
Oil and Grease	Glass	4ºC	None	28 days	50 g
Sulfide	Glass	4ºC	Add Zn Acetate, zero headspace	7 days	50 g
Chromium VI	Glass	4ºC	None	24 hours	50 g
Mercury	Plastic/Glass	None	None	28 days	50 g
Other Metals	Plastic/Glass	None	None	6 months	50 g
Acrolein and Acrylonitrile	Glass[4]	4ºC	None	14 days	50 g
Benzidines	Glass[4]	4ºC	None	14 days[3]	50 g
Chlorinated Hydrocarbons	Glass[4]	4ºC	None	14 days[3]	50 g
Dioxins and Furans	Glass[4]	4ºC	None	14 days[3]	50 g
Haloethers	Glass[4]	4ºC	None	14 days[3]	50 g
Nitroaromatics and cyclic ketones	Glass[4]	4ºC	None	14 days[3]	50 g
Nitrosomines	Glass[4]	4ºC	None	14 days[3]	50 g
Organochlorine Pesticides	Glass[4]	4ºC	None	14 days[3]	50 g
Organophosphorus Pesticides	Glass[4]	4ºC	None	14 days[3]	50 g
PCBs	Glass[4]	4ºC	None	14 days[3]	50 g
Phenols	Glass[4]	4ºC	None	14 days[3]	50 g
Phthalate Esters	Glass[4]	4ºC	None	14 days[3]	50 g
Polynuclear Aromatic Hydrocarbons	Glass[4]	4ºC	None	14 days[3]	50 g
Purgeable Hydrocarbons	Glass[4]	4ºC	None	14 days[5]	50 g

PARAMETER	CONTAINER [1]	PRESERVATION Temp.[7]	PRESERVATION Chemical	HOLDING TIME[2]	SAMPLE WEIGHT
Purgeable Halocarbons	Glass[4]	4ºC	None	14 days[5]	50 g
Total Organic Halides (TOX)	Glass[4]	4ºC	None	28 days	50 g

Key to Table

1. Plastic should be Polyethylene.
2. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
3. 14 days until extraction. 40 days after extraction.
4. With Teflon Lined Septum
5. See Volatile SOP for more detailed preservation requirements.
6. Holding Time is listed as "As Soon as Possible" in SW 846. Per EPA MICE, the recommended maximum holding time for pH in water is 24 hours and pH in soil is 7 days. There are no mandated regulatory requirements.
7. For samples with a temperature requirement of 4°C, a sample temperature of just above the water freezing temperature to ≤ 6°C is acceptable.

Table 22-8.

Holding Times, Preservation and Container Requirements: Air Samples

PARAMETER	CONTAINER [1]	PRESERVATION Temp.	PRESERVATION Chemical	HOLDING TIME[2]	SAMPLE WEIGHT
Volatile Organics	Entech or Summa type Canister	None	None	30 days	6L or 1L
Volatile Organics	Tedlar Bag	None	None	72 hrs[3,4]	1 L
Organochlorine Pesticides TO-10A	PUF Tube, 76 mm	4ºC	None	7 Days	1 Tube

Key to Table

1. Plastic should be Polyethylene.
2. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.
3. Holding Time is based on SW 846 Method 0040 "SAMPLING OF PRINCIPAL ORGANIC HAZARDOUS CONSTITUENTS FROM COMBUSTION SOURCES USING TEDLAR® BAGS". Some states specifically enforce this holding time (e.g., Florida, New Jersey) and others have not specified this information in their regulatory requirements.
4. The holding time is 72 hours unless the laboratory has a documented validation study that indicates a longer HT is acceptable for the analytes of interest.

Table 22-9. Industrial Hygiene – Sample Receiving Guide

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
Acetaldehyde	OSHA 1007 (Modified)	AT N571 Passive Monitor	0.00977 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Acetone	NIOSH 1300	150-mg Charcoal Tube	0.01 - 0.2	0.5 - 3	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	OSHA 69	225-mg Anasorb CMS Tube	0.05	3	17 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0401	2 Hrs Max.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0152	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00160 (#546) 0.0106 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Acetonitrile	3M (Modified)	3M 3520	0.0482	2 Hrs	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Acetylene	EPA 3C/ASTM D1946	Entech Canister	400 ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	EPA 3C/ASTM D1946	Flex Foil Bag	1 L	Grab	5 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
Acrylonitrile	NIOSH 1604	150-mg Charcoal Tube	0.01 - 0.2	3.5 - 20	7 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0438	8 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Aldehydes	EPA TO-11A	DNPH-coated Silica Gel	0.1 - 1.5	1 - 15	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	EPA IP-6A (Modified)	DNPH-coated Silica Gel	0.1 - 1.5	1 - 15	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	EPA IP-6C (Modified)	SKC UMEx-100 Passive Badge	28.6	15 min. or 8 Hrs	21 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Aluminum	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 960 / 5 - 100	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Antimony	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 960 / 50 - 2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Arsenic	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	5-2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Barium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 960 / 50-2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Benzaldehyde	OSHA 1007 (Modified)	Assay N571 Passive Badge	0.00581 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
Benzene	NIOSH 1501	150-mg Charcoal Tube	< 0.2	5 - 30	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0355	8 Hrs Max.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0160	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00096 (#546) 0.00785 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Beryllium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	1250 - 2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Boron	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	25 - 2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Butane (n-Butane)	ASTM D1945-03	Entech Canister	0.01 - 1	1 L	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	ASTM D1945-03	Tedlar Bag	0.01 - 1	1 L	72 Hrs.	Should be stored at room temperature.	Back Counter IH/SVOA Lab
1-Butanol (n-butyl alcohol; n-butanol)	NIOSH 1401/1405	150-mg Charcoal Tube	0.01 - 0.2	2 - 10	Not Determined	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0343	8 Hrs.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
2-Butoxyethanol	NIOSH 1403	150-mg Charcoal Tube	0.01 - 0.05	2 - 10	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
(Butyl Cellosolve)	3M (Modified)	3M Badge (3500 or 3520)	0.0282	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
n-Butyl Acetate	NIOSH 1450	150-mg Charcoal Tube	0.01 - 0.2	1 - 10	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0316	8 Hrs.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0132	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00087 (#546) 0.00651 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Butyraldehyde	OHA 1007 (Modified)	Assay N571 Passive Badge	0.00683	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Cadmium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	13 - 2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Calcium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 960 / 5 - 2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Carbon Black	NIOSH 5000	37-mm pre-weighed PVC Filter, 5-um pore size	1 - 2	30 - 570	Indefinite	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
Carbon Dioxide	EPA 3C/ASTM D1946	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	EPA 3C/ASTM D1946	Flex Foil Bag	1 L	Grab	5 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
Carbon Monoxide	EPA 3C/ASTM D1946	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	EPA 3C/ASTM D1946	Flex Foil Bag	1 L	Grab	5 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
Carbon Tetrachloride	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	3 - 150	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0302	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0145	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00109 (#546) 0.00605 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Chlorobenzene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1.5 - 40	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0293	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0142	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology (Modified)	Assay N546 or N566 Badge	0.00102 (#546) 0.00708 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Chloroform	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1 - 50	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0335	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0130	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology (Modified)	Assay N546 or N566 Badge	0.00146 (#546) 0.00688 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Chromium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 1000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Cobalt	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	25 - 2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Copper	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 1000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Cresols	NIOSH 2546	150-mg XAD-7 Tube	0.01 - 0.1	1 - 24	Undetermined	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Crotonaldehyde	Assay	AT N571 Passive	0.00716 L/min	8 Hrs	28 Days	Should be shipped on ice or	IH Refrigerator in

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
	Technology(Mod)	Monitor				equivalent; refrigerate upon receipt.	IH/SVOA Lab
Cumene	NIOSH 1501	150-mg Charcoal Tube	< 0.2	1 - 30	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0245	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0128	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology (Modified)	Assay N546 or N566 Badge	0.00083 (#546) 0.00685 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Cyclohexane	NIOSH 1500	150-mg Charcoal Tube	0.01 - 0.2	2.5 - 5	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Cyclohexanone	NIOSH 1300	150-mg Charcoal Tube	0.01 - 0.2	1 - 10	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0289	8 Hrs.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Diborane	NIOSH 6006	PTFE filter + oxidizer impregnated charcoal tube	0.5 - 1.0	60 - 260	7 Days	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
1,2-Dichlorobenzene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1 - 10	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0278	8 Hrs.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
1,3-Dichlorobenzene	3M (Modified)	3M Badge (3500 or 3520)	0.0267	8 Hrs.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
1,4-Dichlorobenzene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1 - 8	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0278	8 Hrs.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
1,1-Dichloroethane	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	0.5 - 15	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
1,2-Dichloroethane	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1 - 50	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0332	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
cis-1,2-Dichloroethylene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	0.2 - 5	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
trans-1,2-Dichloroethylene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	0.2 - 5	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Diesel Range Hydrocarbons C10 -	NIOSH 1550	150-mg Charcoal Tube	0.01 - 0.2	1.3 - 20	14 Days	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
C22							
Diethyl Ether (Ethyl ether, Ethyl oxide)	3M (Modified)	3M 3520 Passive Monitor	0.0368	4 Hr	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
2,5-Dimethylbenzaldehyde	Assay Technology(Mod)	AT N571 Passive Monitor	0.00479 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
1,4-Dioxane	NIOSH 1602	150-mg Charcoal Tube	0.01 - 0.2	0.5 - 15	6 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
n-Dodecane (C12)	3M (Modified)	3M Badge (3500 or 3520)	0.0215	Undetermined	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Epichlorohydrin	NIOSH 1010	150-mg Charcoal Tube	0.01 - 0.2	2 - 30	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Ethane	ASTM D1945-03	Entech Canister	0.01 - 1	1	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	ASTM D1945-03	Tedlar Bag	0.01 - 1	1	72 Hrs	Should be stored at room temperature.	Back Counter IH/SVOA Lab
Ethanol	NIOSH 1400	150-mg Charcoal Tube	0.05	0.1 - 10	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M 3520 Passive Monitor	0.0437	1 Hr Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0209	4 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00154 (#546) 0.0111 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Ethyl Acetate	NIOSH 1457	150-mg Charcoal Tube	0.01 - 0.2	0.1 - 10	6 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0144	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Ethylbenzene	NIOSH 1501	150-mg Charcoal Tube	< 0.2	1 - 24	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0273	8 Hrs. Max	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N545 or N546 Badge	0.00091 (#546) 0.0073 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Fixed Gas Screen (H2, C2H2, CO_2, CO, CH_4, N_2, O_2)	EPA 3C/ASTM D1946	Entech Canister	400 mL or 1L	Grab or Time Integrated	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	EPA 3C/ASTM D1946	Flex Foil Bag	1	Grab	5 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
Formaldehyde	NIOSH 2016 (Modified)	DNPH-coated Silica Gel	0.03 - 1.5	1 - 15	34 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	OSHA 1007 (Modified)	AT N571 Passive Monitor	0.01305 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	OSHA 1007 (Modified)	SKC UMEx-100 Passive Badge	28.6	15 min. or 8 Hrs	21 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	EPA IP-6C (Modified)	SKC UMEx-100 Passive Badge	28.6	15 min. or 8 Hrs	21 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Gasoline Range Hydrocarbons C6 - C10	EPA TO-15 (Modified)	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.	VOA Lab
Gasoline Range Hydrocarbons C6 - C10	NIOSH 1550	150-mg Charcoal Tube	0.01 - 0.2	1.3 - 20	14 Days	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Glutaraldehyde	OSHA 64 (Modified)	DNPH-coated Glass Fiber Filters	1 - 2	15 - 480	17 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	NIOSH 2532 (Modified)	DNPH-coated Silica Gel	0.05 - 0.5	1 - 30	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology (Modified)	AT N571 Passive Monitor	0.00603 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Heptane (n-Heptane)	NIOSH 1500	150-mg Charcoal Tube	0.01 - 0.2	Undetermined	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Hexaldehyde	OSHA 1007 (Modified)	AT N571 Passive Monitor	0.00540 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
1,6-Hexamethylene Diisocyanate (1,6-HDI)	OSHA 42	37-mm Glass Fiber Filter coated with 1,2PP	1	15	18 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Hexane (n-Hexane)	NIOSH 1500	150-mg Charcoal Tube	0.01 - 0.2	Undetermined	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.032	8 Hrs Max.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0143	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	ASTM D1945-03	Entech Canister	0.01 - 1	1	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	ASTM D1945-03	Tedlar Bag	1	Grab	72 Hrs	Should be stored at room temperature.	Back Counter IH/SVOA Lab
2-Hexanone	NIOSH 1300	150-mg Charcoal Tube	0.01 - 0.2	1 - 10	7 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
Hexavalent Chromium (Soluble)	NIOSH 7600	37-mm PVC Filter, 5-um	1 - 4	100 - 400	14 Days	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Hexavalent Chromium	OSHA ID-215	37-mm PVC Filter, 5-um	2	30 - 960	Ship overnight, within 24 hours of sampling.	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Hydrobromic Acid	NIOSH 7903	600-mg Cleaned Silica Gel Tube	0.2 - 0.5	3 - 100	21 Days	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Hydrochloric Acid	NIOSH 7903	600-mg Cleaned Silica Gel	0.2 - 0.5	3 - 100	21 Days	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Hydrofluoric Acid	NIOSH 7903	600-mg Cleaned Silica Gel	0.2 - 0.3	3 - 100	21 Days	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Hydrogen	EPA 3C/ASTM D1946	Entech Canister	400 mL or 1L	Grab or Time Integrated	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	EPA 3C/ASTM D1946	Flex Foil Bag	1	Grab	5 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
Hydrogen Cyanide	NIOSH 6010	800-mg Soda Lime Tube	0.05 - 0.2	2 - 90	14 Days	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Hydrogen Sulfide	NIOSH 6013	600 mg - LOW SO4 Charcoal tube, Orbo 34	0.1 - 1.5	20 - 40	30 Days	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Iron	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 960 / 5 - 100	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Isopropanol (2-Propanol)	NIOSH 1400	150-mg Charcoal Tube	0.01 - 0.2	0.3 - 3	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M 3520 Passive Monitor	0.0994	8 Hrs	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0178	4 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Isobutyl Acetate	3M (Modified)	3M Badge (3500 or 3520)	0.0310	8 Hrs	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Isopropyl Acetate	3M (Modified)	3M Badge (3500 or 3520)	0.0317	7 Hrs	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Isovaleraldehyde	OSHA 1007 (Modified)	AT N571 Passive Monitor	0.00601 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Lead	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	50 - 2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
Lithium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	100 - 2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Magnesium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 960 / 5 - 67	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Manganese	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 960 / 5 - 200	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Mercury	NIOSH 6009	200-mg Anasorb C300 Tube	0.15 - 0.25	2 - 100	30 Days	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Mercury, Inorganic	OSHA ID-140	800-mg Anasorb C300 Cartridge	0.02	9.6	30 Days	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Methane	EPA 3C/ASTM D1946	Entech Canister	Grab or Time integrated	400 mL or 1L	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	EPA 3C/ASTM D1946	Flex Foil Bag	Grab	1 L	5 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	ASTM D1945-03	Entech Canister	Grab or Time Integrated	400 mL or 1 L	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	ASTM D1945-03	Tedlar Bag	Grab	1	72 Hrs	Should be stored at room temperature.	Back Counter IH/SVOA Lab
Methanol	NIOSH 2000	150-mg Silica Gel Tube	0.02 - 0.2	1 - 5	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
4-4'-Methylene Bisphenyl Isocyanate (4,4'-MDI)	OSHA 47	37-mm Glass Fiber Filter coated with 1,2PP	1 L/min	15	15 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Methylal	NIOSH 1611	150-mg Charcoal Tube	0.1-0.2	1-3	Unknown	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Methylene Chloride	NIOSH 1005	2 Charcoal Tubes in series, 150-mg each	0.01 - 0.2	0.5 - 2.5	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M 3520 Passive Monitor	0.03$79*	6 Hrs Max.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Methyl Ethyl Ketone	OSHA 1004	225-mg Anasorb CMS Tube	0.05	≤ 12	15 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0363	8 Hrs Max.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC + OSHA 1004	SKC 575-002 Passive Badge	0.01688	8 Hrs Max.	25 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Methyl Isobutyl Ketone	OSHA 1004	225-mg Anasorb CMS Tube	0.05	≤ 12	15 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC + OSHA 1004	SKC 575-002 Passive Badge	0.01362	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	NIOSH 1300	150-mg Charcoal Tube	1 - 10	0.01 - 0.2	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or	0.0300	8 Hrs	3 Weeks	May be shipped on ice or equivalent;	IH Refrigerator in

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
		3520)				refrigerate upon receipt.	IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00092 (#546) 0.00751 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Methyl Methacrylate	3M (Modified)	3M Badge (3500 or 3520)	0.0318	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0131	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00100 (#546) 0.00751 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Methyl tert-Butyl Ether (MTBE)	NIOSH 1615	150-mg Charcoal Tube	0.1 - 0.2	2 - 96	5 Days / 3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0308	8 Hrs.	28 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Molybdenum	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 960 / 5 - 67	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Naphthas (client must submit bulk liquid sample to be used as reference standard)	NIOSH 1550	150-mg Charcoal Tube	0.01 - 0.2	1.3 - 20	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Natural Gas Screen (CH_4, C_2H_6, C_3H_8, C_4H_{10}, C_5H_{12}, C_6H_{14})	ASTM D1945-03	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.	IH Counter in SVOA Lab
	ASTM D1945-03	Tedlar Bag	Grab	1	72 Hrs.	Should be stored at room temperature.	IH Counter in SVOA Lab
Nickel	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 1000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Nicotine	NIOSH 2551	120-mg XAD-4 Tube	0.1 - 1	0.5 - 600	14 Days -Dark	Should be shipped on ice or equivalent; refrigerate upon receipt. Avoid Light exposure.	IH Refrigerator in IH/SVOA Lab
Nitric Acid	NIOSH 7903	600-mg Cleaned Silica Gel Tube	0.2 - 0.5	3 - 100	21 Days	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Nitrogen	EPA 3C/ASTM D1946	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	EPA 3C/ASTM D1946	Flex Foil Bag	1 L	Grab	5 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
Octane (n-Octane)	NIOSH 1500	150-mg Charcoal Tube	0.01 - 0.2	4	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	Back Counter IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0266	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	Back Counter IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0127	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	Back Counter IH/SVOA Lab

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00078 (#546) 0.00703 (#546)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	Back Counter IH/SVOA Lab
Oxygen	EPA 3C/ASTM D1946	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
	EPA 3C/ASTM D1946	Flex Foil Bag	1 L	Grab	5 Days	Should be stored at room temperature.	Back Counter IH/SVOA Lab
Particulates, Respirable Dusts	NIOSH 0600	37-mm pre-weighed PVC Filter, 5-um pore size, w/al cyclone	2.5	20 - 400	Indefinite	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Particulates, Total Dusts	NIOSH 0500	37-mm pre-weighed PVC Filter, 5-um pore size	1 - 2	7 - 133	Indefinite	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Pentane (n-Pentane)	NIOSH 1500	150-mg Charcoal Tube	0.01 - 0.4	4	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M 3520 Passive Monitor	0.0353	3 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Monitor	0.0149	8 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology (Modified)	Assay N546 or N566 Badge	0.00105 (#546) 0.00886 (#566)	8 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	ASTM D1945-03	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.	Back Counter in IH/SVOA Lab
	ASTM D1945-03	Tedlar Bag	1 L	Grab	72 Hrs	Should be stored at room temperature.	Back Counter in IH/SVOA Lab
Pesticides, Organochlorine	TO-10A	PUF Tube, 76 mm	1 - 5	240 - 7200	10 Days	Must be shipped on wet ice; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Pesticides, Organophosphorus	NIOSH 5600	OVS-2 Tube; 13-mm Quartz Filter with 450-mg XAD-2	0.2 - 1	12 - 240	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Pesticides, Organophosphorus	TO-10A	PUF Tube, 76 mm	1 - 5	240 - 7200	10 days	Must be shipped on wet ice; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Phenol	NIOSH 2546	150-mg XAD-7 Tube	0.01 - 0.1	1 - 24	Undetermined	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
4-Phenylcyclohexene	OSHA In-House Method (Modified)	150 or 600 mg Charcoal Tube	0.2	10 - 360	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Phosphine	OSHA 1003	37-mm glass fiber filter with a mercuric chloride treated polyester filter	TWA: 1.0 STEL: 2.0	TWA: 240 L max STEL: 30 L max	17 Days (filter extremely short holdtime)	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
Phosphoric Acid	NIOSH 7903	600-mg Cleaned Silica Gel	0.2 - 0.5	3 - 100	21 Days	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Polychlorinated Biphenyls (PCBs) - Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260.	NIOSH 5503	13-mm, Glass fiber filter in series with a 150-mg Florisil	0.05 - 0.2	1 - 50	2 Months for Tubes	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Polychlorinated Biphenyls (PCBs) - Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260.	TO-10A	PUF Tube, 76 mm	1 - 5	240 - 7200	10 Days	Must be shipped on wet ice; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Polynuclear Aromatic Hydrocarbons (PAH/PNA)	NIOSH 5506	37-mm, 2-um PTFE filter in series with a 120-mg XAD-2	2	200 - 1000	Unknown-Protect from light/heat	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Potassium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 960 / 5 - 1000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Propane	ASTM D1945-03	Entech Canister	400ml or 1 L	Grab or Time integrated	28 Days	Should be stored at room temperature.	Back Counter in IH/SVOA Lab
	ASTM D1945-03	Tedlar Bag	1 L	Grab	72 Hrs.	Should be stored at room temperature.	Back Counter in IH/SVOA Lab
1-Propanol	NIOSH 1401/1405	150-mg Charcoal Tube	0.01-0.2	1-10	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Propionaldehyde	OSHA 1007 (Modified)	AT N571 Passive Badge	0.00798 L/min	8 Hours	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
n-Propyl Acetate	NIOSH 1450	150-mg Charcoal Tube	0.01-0.2	18-150	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Pyridine	NIOSH 1613	150-mg Charcoal Tube	0.01-1.0	1 - 10	Undetermined	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Selenium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	60 - 2000 / 13 - 2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Silicon Tetrahydride (Silane)	OSHA CSI	15 mL of 0.01 N KOH in a MGFB	1.0 L/min Max	480 L Max	7 days	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Silver	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	60 - 2000 / 250-2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
Sodium	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	30 - 2000 / 30 - 960	Indefinite	Should be stored at room temperature.	IH Bin in Metal Lab
Strontium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	25 - 2000 / 10 - 1000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Styrene	NIOSH 1501	150-mg Charcoal Tube	< 1.0	1 - 14	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0289	8 Hrs. Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0137	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00094 (#546) 0.00755 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Sulfuric Acid	NIOSH 7903	600-mg Cleaned Silica Gel	0.2 - 0.5	3 - 100	21 Days	Should be stored at room temperature.	IH Drawer in IH/SVOA Lab
Tetrachloroethylene	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	1.0 - 40	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0283	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0131	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00101 (#546) 0.00583 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Tetrahydrofuran	NIOSH 1609	150-mg Charcoal Tube	0.01 - 0.2	1 - 9	Undetermined	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0372	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0174	4 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00121 (#545) 0.00886 (#546)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Thallium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	50 - 2000 / 25 - 2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Tolualdehyde	OSHA 1007 (Modified)	AT N571 Passive Badge	0.00524 L/min	8 Hours	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
Toluene	NIOSH 1501	150-mg Charcoal Tube	< 0.2	1 - 8	30 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0314	8 Hrs Max.	3 Weeks	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0149	8 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00095 (#546) 0.00735 (#566)	8 Hrs Max.	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Toluene-2,4-Diisocyanate (2,4-TDI)	OSHA 42	37-mm Glass Fiber Filter coated with 1,2PP	1 L/min	15	18 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Toluene-2,6-Diisocyanate (2,6-TDI)	OSHA 42	37-mm Glass Fiber Filter coated with 1,2PP	1 L/min	15	18 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Toxaphene	NIOSH 5039	37-mm, 0.8-um, MCE Filter	0.2 - 1	2 - 30	14 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
1,1,1-Trichloroethane	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	0.1 - 8	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0309	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Monitor	0.0145	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00108 (#546) 0.0065 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
1,1,2-Trichloroethane	NIOSH 1003	150-mg Charcoal Tube	0.01 - 0.2	2 - 60	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0297	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Monitor	0.0125	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00109 (#546) 0.0065 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Trichloroethylene	NIOSH 1022	150-mg Charcoal Tube	0.01 - 0.2	1 - 30	17 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0311	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0143	4 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00109 (#546) 0.00705 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab

Analyte	Method Reference	Sample Media	Sampling Rate	Air Volume	Sample Stability	Preservation	Sample Storage
Valeraldehyde	OSHA 1007 (Modified)	AT N571 Passive Badge	0.00601 L/min	8 Hrs	28 Days	Should be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Vanadium	NIOSH 7300	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 2000	Indefinite	Should be stored at room temperature.	Counter in Metal Lab Digestion Room
Vinyl Acetate	3M (Modified)	3M Badge (3500 or 3520)	0.0358	8 Hrs Max.	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0163	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N545 or N546 Badge	0.00112 (#546) 0.00811 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Vinyl Chloride	NIOSH 1007	(2) 150-mg Charcoal Tube	0.05	3 - 5	10 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Vinylidene Chloride	NIOSH 1015	150-mg Charcoal Tube	0.01 - 0.2	2.5 - 7	21 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0351	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Badge	0.0123	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00130 (#546) 0.00764 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Volatile Organic Compounds	OSHA PV2120	Entech Canister	400ml or 1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.	VOA Lab
Volatile Organic Compounds	EPA TO-15	Entech Canister	1 L	Grab or Time integrated	30 Days	Should be stored at room temperature.	VOA Lab
Xylene isomers	NIOSH 1501	150-mg Charcoal Tube	< 0.2	2 - 23	30 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	3M (Modified)	3M Badge (3500 or 3520)	0.0273	8 Hrs Max.	3 Weeks	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	SKC (Modified)	SKC 575-002 Passive Monitor	Isomer specific	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
	Assay Technology(Mod)	Assay N546 or N566 Badge	0.00093(#546) 0.00668 (#566)	8 Hrs Max.	14 Days	May be shipped on ice or equivalent; refrigerate upon receipt.	IH Refrigerator in IH/SVOA Lab
Zinc	N7300/OSHA ID-121	37-mm, 0.8-um, MCE Filter	1 - 4	5 - 960 / 5 - 200	Indefinite	Should be stored at room temperature.	Counter in Metals Lab Digestion Room

SECTION 23

HANDLING OF SAMPLES *(NELAC 5.5.8)*

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal. This section applies to all samples (environmental, air, industrial hygiene, etc.) received at the laboratory except as noted in individual method SOPs.

23.1 CHAIN OF CUSTODY (COC)

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name

The samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory. The sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the sample control personnel at the laboratory or to a TestAmerica courier. Samples are only considered to be received by lab when personnel at the laboratory have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The receipt from the courier is stored in the project folder.

23.1.2 Legal / Evidentiary Chain-of-Custody

If samples are identified for legal/evidentiary purposes, the Project Manager or Sample Control will enter "Legal ICOC" or "LCOC" into the comments section of Element. Sample control signs the samples into the secure walk-in refrigerator or freezer. Each time the sample is removed or returned to secure storage it is recorded in Element LIMS for that sample. Refer to SOP PE-QAD-026 Internal Chain of Custody Procedures for more detailed information.

23.2 SAMPLE RECEIPT

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections.

23.2.1 Laboratory Receipt

When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance, irregularity, or compromised sample receipt must be documented on a Notification of Discrepancy form and brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record.

23.2.1.1 Unique Sample Identification

All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at anytime. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory. This Primary ID is made up of the following information (consisting of 6 components):

Example: PTJ - 0001 - 1 - A

X -Location ID
X – Year
X - Month

Login ID

Sample Number

Container

The above example states that TestAmerica Phoenix Laboratory (Location) received samples in 2010 (Year) in October (Month). Login ID is 0001 (start at 0001 each month). The container code indicates it is the first sample ("1") of the work order and the first container ("A") of Sample #1.

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.2.1.2 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Figure 23-2) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- A COC filled out completely;
- Samples must be properly labeled;
- Proper sample containers with adequate volume for the analysis of both environmental and IH samples and necessary QC;
- Samples must be preserved according to the requirements of the requested analytical method or IH Sampling Guide;
- Sample holding times must be adhered to;
- All samples submitted for water Volatile Organic analyses must have a Trip Blank submitted at the same time;
- The Project Manager will be notified if any sample is received in damaged condition.

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined. A copy of the sample acceptance policy is provided to each client prior to shipment of samples.

23.2.2 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.2.3 Sample condition at the time of receipt is documented on the Sample Receipt Form

23.2.4 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation

with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or
- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the LIMS according SOP PE-SMP-001 Sample Control.

23.3 SAMPLE STORAGE

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators suitable for the sample matrix. Aqueous Metal samples and some IH samples are stored unrefrigerated. In addition, samples to be analyzed for volatile organic analytes are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every two weeks.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator and place them on carts, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came. All samples are kept in the refrigerators for two to four weeks after analysis, which meets or exceeds most sample holding times. After two to four weeks the samples are moved to the room temperature sample archive area where they are stored for an additional four weeks before they are disposed of. This eight week holding period allows samples to be checked if a discrepancy or question arises. Special arrangements may be made to store samples for longer periods of time. This extended holding period allows additional metal analyses to be performed on the archived sample and assists clients in dealing with legal matters or regulatory issues.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

23.4 HAZARDOUS SAMPLES AND FOREIGN SOILS

To minimize exposure to personnel and to avoid potential accidents, hazardous and foreign soil samples are stored in Hazardous Sample bins in an isolated area designated for storage of hazardous samples and foreign soils only. For any sample that is known to be hazardous at the time of receipt or, if after completion of analysis the result exceeds the acceptable regulatory levels, a Hazardous Sample Notification Form must be completed by the analyst.

This form may be completed by Sample Control, Project Managers, or analysts and must be attached to the report. The sample itself is clearly marked with a red tag reading "HAZARDOUS" or "FOREIGN SOIL" and is placed in the Hazardous Samples Bins. A copy of the form must be included with the original COC and Work Order and the original must be given to the Sample Control Custodian. Analysts will present any sample determined to be hazardous after completion of analysis for storage in the assigned area to the Sample Control Custodian.

All hazardous samples are either returned to the client or disposed of appropriately through a hazardous waste disposal firm or via a laboratory waste stream. Depending on the circumstances, clients may be asked to bear the disposal cost if the laboratory is asked to dispose of the hazardous sample. Additional information about handling Hazardous Samples is contained in SOP PE-SMP-001 Sample Control and SOP PE-SFT-001 Sample Disposal and Waste Management. Foreign soil samples are handled according to the procedures in SOP PE-SMP-006 Receiving and Waste Management of Foreign Soils.

23.5 SAMPLE SHIPPING

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses (see Note). The chain-of-custody form is signed by the sample control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

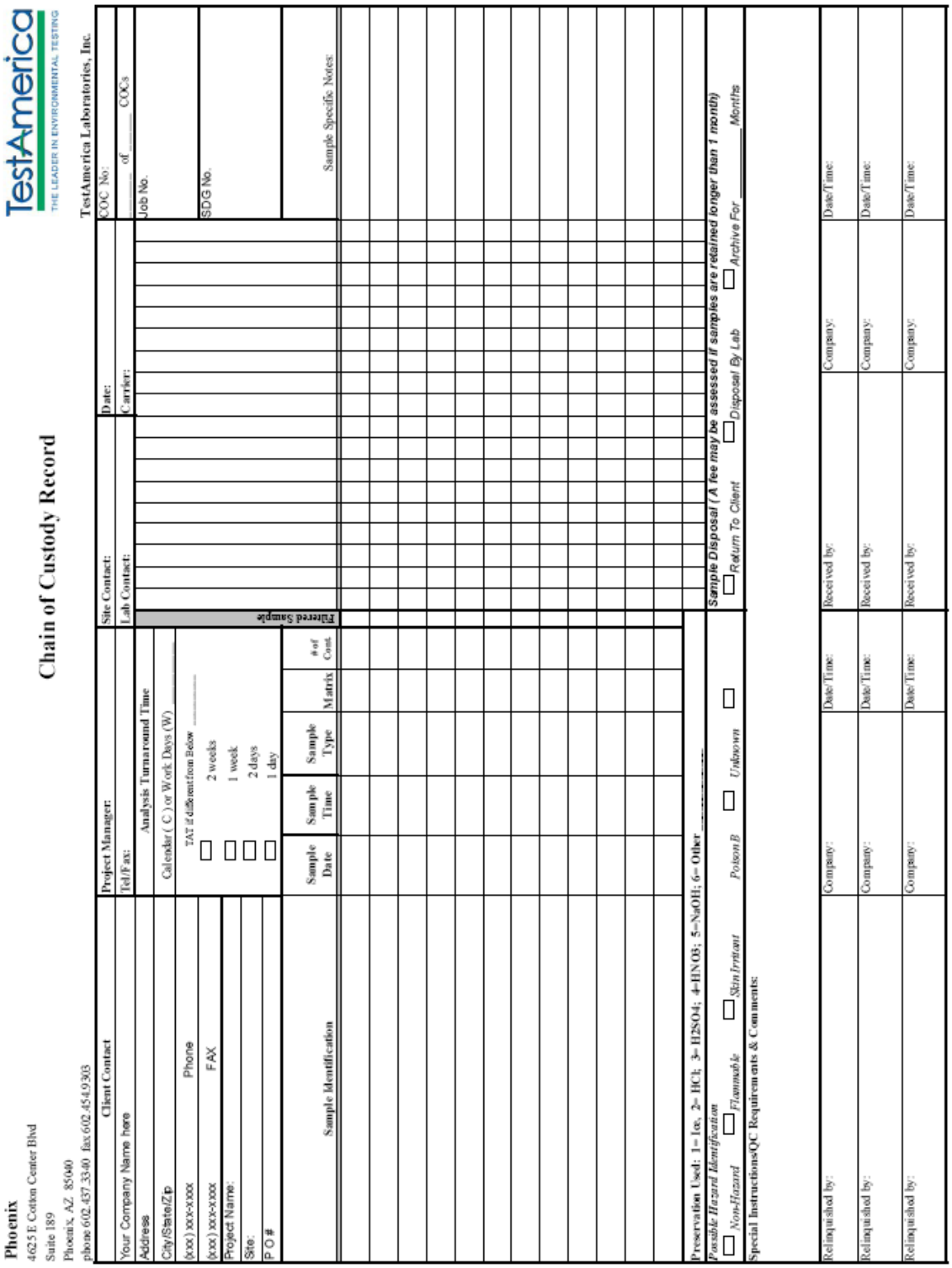
Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will analyze the trip blank but note as a discrepancy that the analysis was not requested.

23.6 SAMPLE DISPOSAL

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP PE-SFT-001 Sample Disposal and Waste Management). All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

If a sample is part of a known litigation, the affected legal authority, sample data user, and/or submitter of the sample must participate in the decision about the sample's disposal. All documentation and correspondence concerning the disposal decision process must be kept on file.

Figure 23-1.
Example: Chain of Custody (COC)



Phoenix
4625 E Cotton Center Blvd
Suite 189
Phoenix, AZ 85040
phone 602.437.3340 fax 602.454.9303

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Chain of Custody Record

TestAmerica Laboratories, Inc.

Client Contact	Project Manager:	Site Contact:	Date:	COC No:
Your Company Name here	Tel/Fax:	Lab Contact:	Carrier:	____ of ____ COCs
Address	Analysis Turnaround Time			Job No.
City/State/Zip	Calendar (C) or Work Days (W)			
(xxx) xxx-xxxx Phone	TAT if different from Below _____			
(xxx) xxx-xxxx FAX	☐ 2 weeks			SDG No.
Project Name:	☐ ☐ 1 week			
Site:	☐ ☐ 2 days			
P.O #	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type	Matrix	# of Cont.	Filtered Sample	Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other _____

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* *Poison B* ☐ *Unknown* ☐

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* _____ *Months*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:

Figure 23-2

Sample Acceptance Policy

Sample Acceptance Policy
Phoenix Sample Acceptance Policy

All incoming work will be evaluated against the criteria listed below. Where applicable, data from any samples that do not meet the criteria listed below will be noted on the laboratory report defining the nature and substance of the variation. In addition, the client will be notified either by telephone, fax or e-mail ASAP after the receipt of the samples.

1) Samples must arrive with labels intact with a Chain of Custody filled out completely. The following information must be recorded.
- *Client name, address, phone number and fax number (if available)*
- *Project name and/or number*
- *The sample identification*
- *Date, time and location of sampling*
- *The collectors name*
- *The matrix description*
- *The container description*
- *The total number of each type of container*
- *Preservatives used*
- *Analysis requested*
- *Requested turnaround time (TAT)*
- *Any special instructions*
- *Purchase Order number or billing information (e.g., quote number) if available*
- *The date and time that each person received or relinquished the sample(s), including their signed name.*
- ***The date and time of receipt must be recorded between the last person to relinquish the samples and the person who receives the samples in the lab. The date and time relinquished/received must be exactly the same.***
  - **Information must be legible**

2) Samples must be properly labeled.
  - Use durable labels (labels provided by the Phoenix laboratory are preferred)
  - Include a unique identification number
  - Include sampling date and time & sampler ID
  - Include preservative used
  - Use indelible ink
  - **Information must be legible**

3) Proper sample containers with adequate volume for the analysis and necessary QC are required for each analysis requested.

4) Samples must be preserved according to the requirements of the requested analytical method. This includes samples (other than water samples for metals analysis) being chilled to below 6° C and above freezing (0°C). **Note:** Samples that are hand delivered to the laboratory immediately after

collection may not have had time to cool sufficiently. In this case the samples will be considered acceptable as long as there is evidence that the chilling process has begun (arrival on ice).

- Chemical preservation (pH) will be verified prior to analysis and the project manager will be notified immediately if there is a discrepancy. If analyses will still be performed, all affected results will be flagged to indicate improper preservation.

- For Volatile Organic analyses in drinking water (Method 524.2). Residual chlorine must be neutralized prior to preservation. If there is prior knowledge that the samples are not chlorinated, state it on the COC and use the VOA vials pre-preserved with HCl. The following are other options for a sampler and laboratory where the presence of chlorine is not known:
  - 1. Test for residual chlorine in the field prior to sampling.
    - If no chlorine is present, the samples are to be preserved using HCl as usual.
    - If chlorine is present, add ascorbic acid prior to adding HCl.
  - 2. Use VOA vials pre-preserved with ascorbic acid and add HCl after filling the VOA vial with the sample.

5) Sample Holding Times
   - The Phoenix laboratory will make every effort to analyze samples within the regulatory holding time. Samples must be received in the laboratory with enough time to perform the sample analysis. Except for short holding time samples (< 48 hr HT) samples must be received with at least 48 hrs (working days) remaining on the holding time for us to ensure analysis.

   - Analyses that are "field" analyses (e.g., pH, Dissolved Oxygen, Residual Chlorine) will be analyzed within 24 hours from receipt of the samples in the laboratory. Field analysis received after 4:00 PM on Friday or on the weekend will be analyzed no later then the next business day after receipt (Monday, unless a holiday).

6) Samples submitted for Volatile Organic analyses must also have a Trip Blank submitted at the same time. TestAmerica's Phoenix laboratory will supply a blank with the bottle order.

7) The project manager will be notified if any sample is received in damaged condition. The Phoenix laboratory will request that a sample be resubmitted for analysis.

8) Recommendations for packing samples for shipment.

   - Pack samples in Ice rather than "Blue" ice packs.

   - Soil samples should be placed in plastic zip-lock bags. The containers often have dirt around the top and do not seal very well and are prone to intrusion from the water from melted ice.

   - Water samples are best if wrapped with bubble-wrap or paper (newspaper or paper towels work) and then placed in plastic zip-lock bags.

   - Fill extra cooler space with bubble wrap.

Figure 23-3

Sample Receipt Form

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

SAMPLE RECEIPT FORM

Date/Time: 10/27/2010 2:35:18P

Client Code: 550

TAL Project Number: PTJ1680

Received By: Lisa Maycock Logged By: Andrea Ristau

Sample Temperature: 14.8°C

Samples Received: [X] On Ice [ ] On Blue Ice [ ] Unchilled

Check All that Apply:

Analysis	N/A	pH Verified	Additional Preservative Added?	Sample Numbers Needing Adjustment
500ml Amber w/HCL	[ ]	[ ]	[ ] HCL	
1L Amber w/HCL	[ ]	[ ]	[ ] HCL	
Poly w/HNO3	[ ]	[ ]	[ ] HNO3	
Poly w/H2SO4	[ ]	[ ]	[ ] H2SO4	
500ml Amber w/H2SO4	[ ]	[ ]	[ ] H2SO4	
1L Amber w/H2SO4	[ ]	[ ]	[ ] H2SO4	
Poly w/NaOH	[ ]	[ ]	[ ] NaOH	
Poly w/ NaOH + Zinc Acetate	[ ]	[ ]	[ ] NaOH + Zinc Acetate	

Volatile Soil Samples Received in: ____ N/A ____ Brass Sleeves ____ Glass Jars ____ Encore ____ Field Methanol

X Other: ____

Date	Initials	Sample Number	Comments
10/27/2010		PTJ1680-01	
10/27/2010		PTJ1680-02	
10/27/2010		PTJ1680-03	

Reviewed By: Lom Date: 10.28.10 Time: 0931

10/27/2010 2:35:19PM
Page 1 of 1

SECTION 24

ASSURING THE QUALITY OF TEST RESULTS *(NELAC 5.5.9)*

24.1 OVERVIEW

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control (QC) measurements (e.g. Blanks, Laboratory Control Samples (LCS) (also known as a Blank Spike (BS)), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

Required QC is method/program dependant (EPA methods, NELAC, AIHA) and may vary depending on analytes requested. For more definitive information, reference the individual laboratory method SOPs. The following is a generalized discussion of common quality control measures in use in the laboratory.

24.2 CONTROLS

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, and drying. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 NEGATIVE CONTROLS

Table 24-1. Example – Negative Controls

Control Type	Details
Method Blank (MB)	Are used to assess preparation and analysis for possible contamination during the preparation and processing steps.
	The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples (including IH samples); not to exceed 20 environmental samples.
	The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, sample media (IH Samples), etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).

Table 24-1. Example – Negative Controls

Control Type	Details
Calibration Blanks	Are prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.
Instrument Blanks	Are blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.
Trip Blank [1]	Are required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses. Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples. For IH methods, this may include a media blank submitted with the IH samples.
Field Blanks [1]	Are sometimes used for specific projects by the field samplers. A field blank is prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER and AIHA IH Program)
Equipment Blanks [1]	Are also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (NELAC)
Holding Blanks	Also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory.

[1] When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.3.1 Negative Controls for Microbiological Methods

Microbiological Methods utilize a variety of negative controls throughout the process to ensure that false positive results are not obtained. These controls are critical to the validity of the microbiological analyses. Some of these negative controls are:

Table 24-2. Negative Controls for Microbiology

Control Type	Details
Sterility Checks (Media)	Are analyzed for each lot of pre-prepared media, ready-to-use media and for each batch of medium prepared by the laboratory.

Table 24-2. Negative Controls for Microbiology

Control Type	Details
Filtration Blanks	Blanks are run at the beginning and/or end of each batch depending on the type of water sample. For pre-sterilized single use funnels a sterility check is performed on at least one funnel per lot.
Sterility checks (Sample Containers)	Are performed on at least one container per lot of purchased, pre-sterilized containers. If containers are prepared and sterilized by the laboratory, one container per sterilization batch is checked. Container sterility checks are performed using non-selective growth media.
Sterility Checks (Dilution Water)	Are performed on each batch of dilution water prepared by the laboratory and on each batch of pre-prepared dilution water. All checks are performed using non-selective growth media.
Sterility Checks (Filters)	Are also performed on at least one filter from each new lot of membrane filters using non-selective growth media.

Negative culture controls demonstrate that a media does not support the growth of non-target organisms and ensures that there is not an atypical positive reaction from the target organisms. Prior to the first use of the media, each lot of pre-prepared selective media or batch of laboratory prepared selective media is analyzed with at least one known negative culture control as appropriate to the method.

24.4 POSITIVE CONTROLS

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) (Matrix spikes are not applicable to air samples) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory/accreditation program (SDW, NELAC, AIHA, etc.) and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch.

Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

24.4.1.1 The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

24.4.1.2 The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCSs may be

processed for solid matrices; final results may be calculated as mg/kg or µg/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

24.4.1.3 Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

24.4.1.4 The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally 1 for each batch of samples; not to exceed 20 environmental samples. For IH Samples it is generally 1 for each analysis day.

24.4.1.5 If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking Chlordane, Toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

24.4.1.5.1 For methods that have 1-10 target analytes, spike all components.

24.4.1.5.2 For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.

24.4.1.5.3 For methods with more than 20 target analytes, spike at least 16 components.

24.4.1.5.4 Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.

24.4.1.5.5 Exception: Due to analyte incompatibility between the various PCB Aroclors, Aroclors 1016 and 1260 are used for spiking for methods 8082 and 608 as they cover the range of all of the Aroclors. Aroclor 1242 is spiked for TO-10. Specific Aroclors may be used by request on a project specific basis.

24.4.2 <u>Positive Controls for Microbiological Methods</u>

- Each lot of pre-prepared media (including chromofluorogenic reagent) and each batch of laboratory prepared media is tested with a pure culture of known positive reaction.

- In addition, every analytical batch also contains a pure culture of known positive reaction.

- A pure culture of known negative reaction is also tested with each analytical batch to ensure specificity of the procedure.

24.5 SAMPLE MATRIX CONTROLS

Table 24-3. Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	Used to assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used.
	Typical Frequency [1]	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects. If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	Essentially a sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Are similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.
Duplicates[2]	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency [1]	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Are spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] See the specific analytical SOP for type and frequency of sample matrix control samples.

[2] LCSDs may not be required except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed, both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as “Relative Percent Difference” (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 ACCEPTANCE CRITERIA (CONTROL LIMITS)

24.6.1 As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

24.6.2 Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method requires more frequent updating (e.g. EPA SW846 8000 series methods are reviewed and updated if necessary approximately every six months). Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

24.6.3 Laboratory generated Percent (%) Recovery acceptance (control) limits are generally established by taking ± 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20 – 30 data points (more points are preferred). (Element LIMS: The system defaults to collecting the previous 3 months data. This time frame should be shortened if there are more than 200 points since the system slows down tremendously. The time frame should be extended if there are not 20-30 points).

24.6.3.1 Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV) unless the analytical method specifies a tighter limit.

24.6.3.2 In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) can be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

24.6.3.3 The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5% and the analyte must be detectable and identifiable.

24.6.3.4 The maximum acceptable recovery limit will be 150%.

24.6.3.5 Unless method specified, the maximum acceptable RPD limit will be 35% for waters and 40% for soils. The minimum RPD limit is 20%.

24.6.3.6 If either the high or low end of the control limit changes by ≤ 5% from the previous control limits, the control chart is visually inspected and, using professional judgment, they may be left unchanged if there is no affect on laboratory ability to meet the existing limits.

24.6.4 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical

control limits. Refer to SOP PE-QAD-001 Control Limits and Statistical Process Control for additional information.

24.6.5 A LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

24.6.5.1 The analyte results are below the reporting limit and the LCS is above the upper control limit.

24.6.5.2 If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

24.6.5.3 For NELAC work, there is an allowable number of Marginal Exceedances (ME):

- <11 analytes – 0 marginal exceedances are allowed.
- 11 – 30 Analytes – 1 marginal exceedance is allowed.
- 31-50 Analytes – 2 marginal exceedances are allowed.
- 51-70 Analytes – 3 marginal exceedances are allowed.
- 71-90 Analytes – 4 marginal exceedances are allowed.
- > 90 Analytes – 5 marginal exceedances are allowed.

24.6.5.3.1 Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit (NELAC).

24.6.5.3.2 Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

24.6.5.3.3 Though marginal exceedances may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

24.6.6 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.6.7 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client).

Under certain circumstances, where all of the samples are from the same location and share similar chromatography, the reanalysis may be performed on a single sample rather than all of the samples and if the surrogate meets the recovery criteria in the reanalysis, all of the affected samples would require reanalysis.

24.7 ADDITIONAL PROCEDURES TO ASSURE QUALITY CONTROL

24.7.1 The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21) and use of PT samples (see Section 15).

24.7.2 A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

24.7.3 Use of formulae to reduce data is discussed in the method SOPs and in Section 20.

24.7.4 Selection of appropriate reagents and standards is included in Section 9 and 21.

24.7.5 A discussion on selectivity of the test is included in Section 5.

24.7.6 Constant and consistent test conditions are discussed in Section 18.

24.7.7 The laboratories sample acceptance policy is included in Section 23.

SECTION 25

REPORTING RESULTS *(NELAC 5.5.10)*

25.1 OVERVIEW

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client.

Review of reported data is included in Section 19.

25.2 TEST REPORTS

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed on laboratory letterhead, reviewed, and signed by the appropriate Project Manager. At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title (e.g. Laboratory Report) with a "Sample Result" column header.

25.2.2 Each report page printed on company letterhead, which includes the laboratory name, address and telephone number.

25.2.3 A unique identification of the report (e.g. report number) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

Note: Page numbers of report are represented as page # of ##. Where the first number is the page number and the second is the total number of pages.

25.2.4 A copy of the chain of custody (COC).

- Any COCs involved with Subcontracting are included.

- In most cases, the applicable COC is not paginated but is an integral part of the report. If the COC is not a paginated portion of the report then there will be a statement on the front of the report to effect of "The Chain of Custody, X page(s), is included and is an integral part of this report.". The number of pages of the CoC (X) is entered into Element so that it is correct for each report

- COC Exception: For IH laboratory reports, the COC is considered a separate document.

- Any additional addenda to the report must be treated in a similar fashion so it is a recognizable part of the report and cannot accidentally get separated from the report (e.g. Sampling information).

25.2.5 The name and address of client and a project name/number, if applicable.

25.2.6 Client project manager or other contact.

25.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

25.2.8 Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.

25.2.9 Date reported or date of revision, if applicable.

25.2.10 Method of analysis including method code (EPA, Standard Methods, etc); and in the case of IH methods, any modifications to the methods. For Industrial Hygiene reports, test results not covered under AIHA-LAP accreditation must be clearly identified on the final test report.

25.2.11 Reporting limits.

25.2.12 Method detection limits (if requested).

25.2.13 Definition of Data qualifiers and reporting acronyms (e.g. ND).

25.2.14 Sample results. Measurement below the reporting limit are reported as < the reporting limit or ND. Results are not reported as"0".

25.2.15 For AIHA projects, the final report includes the measured quantitative result of the analysis of any blank samples submitted to the laboratory. Additionally, a statement is included that discloses whether on not the sample results have been corrected for contamination based on the field blank or method blank.

25.2.16 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

25.2.17 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (Refer to Sec. 25.2.4 – Item 4 regarding additional addenda).

25.2.18 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

25.2.19 A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory.

25.2.20 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Signatories are appointed by the Lab Director.

25.2.21 When NELAC accreditation is required, the lab shall certify that the test results meet all requirements of NELAC or provide reasons and/or justification if they do not.

25.2.22 Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.

25.2.23 When soil samples are analyzed, a specific identification as to whether soils are reported on a “wet weight” or “dry weight” basis.

25.2.24 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.25 If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report (e.g., partial report or draft report). A complete report must be sent once all of the work has been completed.

25.2.26 Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy (No. CA-I-P-002) for details on internally applying electronic signatures of approval.

25.2.27 <u>REPORTING LEVEL OR REPORT TYPE</u>

The laboratory offers four levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Level I/II is a report with all the features described in Section 26.2 plus summary information; including results for the method blank; percent recovery for laboratory control samples and matrix spike samples; and the RPD values for all MSD and sample duplicate analyses.
- Level III contains all the information supplied in Level I/II; chromatograms, including QC, calibration standards and samples; quantitation reports; initial and continuing calibration information; and copies of bench sheets/instrument printouts where required.

- Level IV is the same as Level III with the addition of multiple sample dilutions; extraction/preparation logs; analysis logs and standard preparation logs.

In addition to the various levels of QC packaging, the laboratory also provides reports in diskette deliverable form. Initial reports may be provided to clients by facsimile. All faxed reports are followed by hardcopy. Procedures used to ensure client confidentiality are outlined in Section 25.5.

25.2.28 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica's services. TestAmerica Phoenix offers a variety of EDD formats including Excel, ASCII, Dbase, and Access.

EDD specifications are submitted to the IT department by the PM for review and undergo the contract review process. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff coding the EDD.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.3 SUPPLEMENTAL INFORMATION FOR TEST

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

25.3.1 Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

25.3.2 Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet NELAC sample acceptance requirements such as improper container, holding time, or temperature.

25.3.3 Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

25.3.4 Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and

reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This necessitates a limited scope of interpretation, and this work is performed by the QA Department. This is the only form of "interpretation" of data that is routinely performed by the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.4 ENVIRONMENTAL TESTING OBTAINED FROM SUBCONTRACTORS

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP CA-L-S-002).

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of TestAmerica are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.5 CLIENT CONFIDENTIALITY

In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

TestAmerica will not intentionally divulge to any person (other than the Client or any other person designated by the Client in writing) any information regarding the services provided by TestAmerica or any information disclosed to TestAmerica by the Client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.5.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are faxed with a cover sheet or e-mailed with the following note that includes a confidentiality statement similar to the following:

This material is intended only for the use of the individual(s) or entity to whom it is addressed and may contain information that is privileged and confidential. It is our policy that facsimiles are intended for and should be used for business purposes only. If you are not the intended recipient, or the employee or

agent responsible for delivering this material to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this facsimile is strictly prohibited. If you have received this communication in error, please notify the sender. Thank you for your professional consideration and cooperation.

25.6 FORMAT OF REPORTS

The format of reports is designed to accommodate each type of environmental or industrial hygiene test carried out and to minimize the possibility of misunderstanding or misuse.

25.7 AMENDMENTS TO TEST REPORTS

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

The revised report is retained on the Archive data server, as is the original report. The revised report is stored in the Archive data server under the sample number followed by "REVISION". The revised report will have the word "revised" or "amended" next to the date rather than the word "Issued" or "Reported".

When the report is re-issued, a notation of "report reissued" is placed on the case narrative/signature page of the report in the Comments or Additional Information section of the Case Narrative with a brief explanation of reason for the re-issue and a reference back to the last final report generated. *For Example*: *Report was revised on 11/3/08 to include toluene in sample NQA1504 per client's request. This final report replaces the final report generated on 10/27/08 at 10:47am.*

Note: Re-issued or revised Industrial Hygiene reports are generated with the current date the report is issued. Information concerning the revision is clearly stated in the Case Narrative and references the original report date.

25.8 POLICIES ON CLIENT REQUESTS FOR AMENDMENTS

25.8.1 Policy on Data Omissions or Reporting Limit Increases

Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely *no possible* impact on the interpretation of the analytical results and there is *no possibility* of the change being interpreted as misrepresentation by anyone inside or outside of our company.

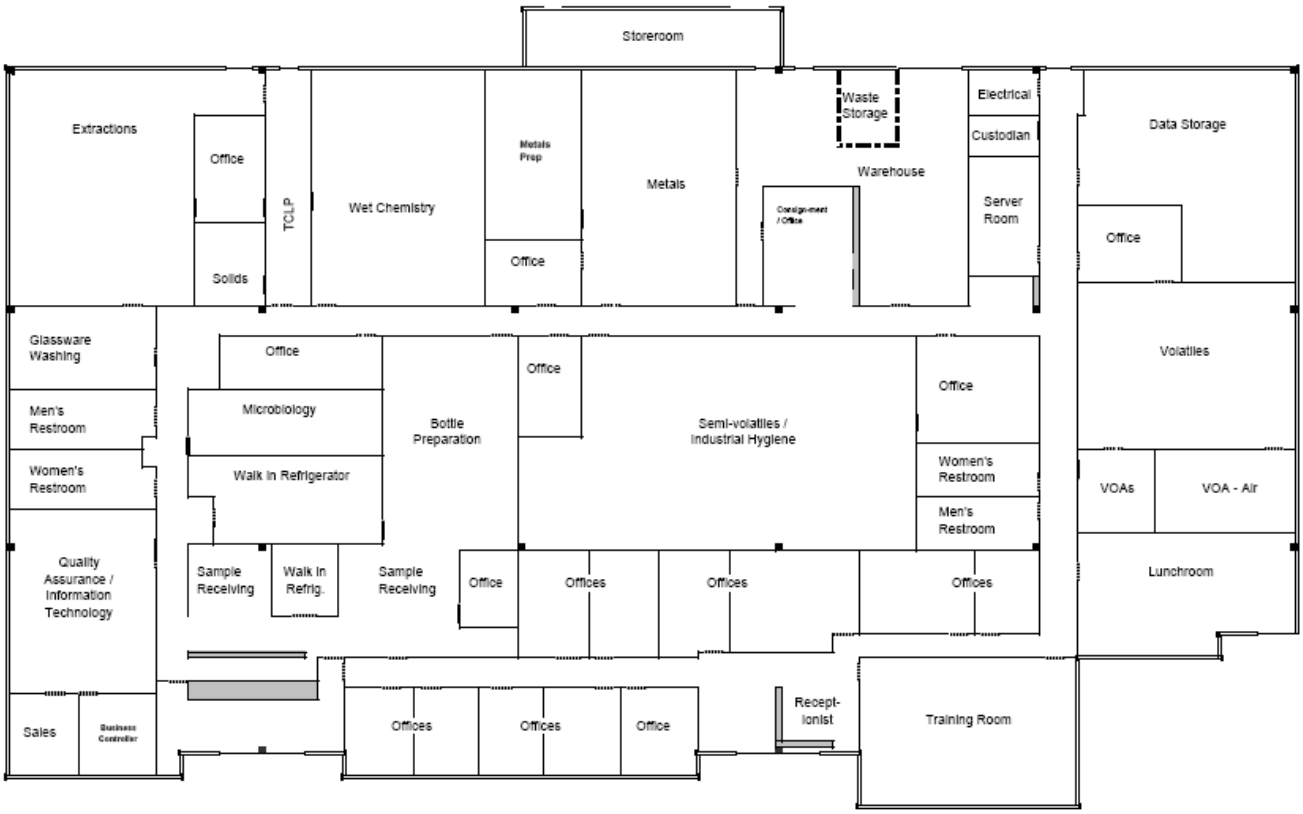
25.8.2 Multiple Reports

TestAmerica does not issue multiple reports for the same workorder where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1.

Laboratory Floor Plan

TestAmerica Phoenix Laboratory Floor Plan



Appendix 2. Glossary/Acronyms

Glossary:

Acceptance Criteria:
Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation:
The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one. (NELAC)

Accrediting Authority:
The Territorial, State, or Federal Agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation (NELAC) [1.5.2.3]

Accuracy:
The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analyst:
The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality. (NELAC)

Assessment:
The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of NELAC). (NELAC)

Assessment Criteria:
The measures established by NELAC and applied in establishing the extent to which an applicant is in conformance with NELAC requirements. (NELAC)

Assessment Team:
The group of people authorized to perform the on-site inspection and proficiency testing data evaluation required to establish whether an applicant meets the criteria for NELAP accreditation. (NELAC)

Assessor:
One who performs on-site assessments of accrediting authorities and laboratories' capability and capacity for meeting NELAC requirements by examining the records and other physical evidence for each one of the tests for which accreditation has been requested. (NELAC)

Audit:
A systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity. (EPA-QAD)

Batch:
Environmental samples which are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of the same matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) and /or those samples not requiring preparation, which are analyzed together as a group using the same calibration curve or factor. An analytical batch can include samples originating from various environmental matrices and can exceed 20 samples. (NELAC Quality Systems Committee)

Blank:
A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Blind Sample:
A sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.

Calibration:
To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. (NELAC)

Calibration Blank (CB)
A volume of reagent water. The results must fall below the reporting level, the MDL, or a multiplier of the MDL.

Calibration Curve:
The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (NELAC)

Calibration Method:
A defined technical procedure for performing a calibration. (NELAC)

Calibration Standard (CAL):
A substance or reference material used to calibrate an instrument (QAMS), usually prepared from the primary dilution standard solution(s) or stock standard solutions.

Certified Reference Material (CRM):
A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30–2.2)

Chain of Custody:
An unbroken trail of accountability that ensures the physical security of samples and includes the signatures of all who handle the samples. (NELAC) [5.12.4]

Clean Air Act:
The enabling legislation in 42 U>S>C> 7401 et seq., Public Law 91-604, 84 Stat. 1676 Pub. L. 95-95, 91 Stat., 685 and Pub. L. 95-190, 91 Stat., 1399, as amended, empowering EPA to promulgate air quality standards, monitor and enforce them. (NELAC)

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/SUPERFUND):
The enabling legislation in 42 U.S.C. 9601-9675 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. 9601 et seq., to eliminate the health and environmental threats posed by hazardous waste sites. (NELAC)

Compromised Samples:
Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified. (NELAC)

Confidential Business Information (CBI):
Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. NELAC and its representatives agree to safeguarding identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation:
Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: (NELAC)

Second column confirmation
Alternate wavelength
Derivatization
Mass spectral interpretation
Alternative detectors or
Additional Cleanup procedures

Conformance:
An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Continuing Calibration Verification Standard (CCV):
A CAL solution which is analyzed after every tenth field sample analysis, not including QC samples, which verifies the previously established calibration curve and confirms accurate analyte quantitation for the previous field samples analyzed.

Correction: Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis. No significant action is taken to change behavior, process or procedure.

Corrective Action:
The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit:
A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria). (NELAC)

Data Reduction:
The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form. (EPA-QAD)

Deficiency:
An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Department Manager (however named):
The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties, and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses. (NELAC)

Detection Limit:
The lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value. See Method Detection Limit. (NELAC)

Document Control:
The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQC)

Duplicate Analyses:
The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Environmental Detection Limit (EDL):
The smallest level at which a radionuclide in an environmental medium can be unambiguously distinguished for a given confidence interval using a particular combination of sampling and measurement procedures, sample size, analytical detection limit, and processing procedure. The EDL shall be specified for the 0.95 or greater confidence interval. The EDL shall be established initially and verified annually for each test method and sample matrix. (NELAC Radioanalysis Subcommittee)

Equipment Blank:
Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (NELAC)

External Standard Calibration:
Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA):
The enabling legislation under 7 U.S.C. 135 et seq., as amended, that empowers the EPA to register insecticides, fungicides, and rodenticides. (NELAC)

Federal Water Pollution Control Act (Clean Water Act, CWA):
The enabling legislation under 33 U.S.C. 1251 et seq., Public Law 92-50086 Stat 816, that empowers EPA to set discharge limitations, write discharge permits, monitor, and bring enforcement action for non-compliance. (NELAC)

Field Blank:
Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Testing:
NELAC's approach to accrediting laboratories by program, method and analyte. Laboratories requesting accreditation for a program-method-analyte combination or for an up-dated/improved method are required to submit to only that portion of the accreditation process not previously addressed (see NELAC, section 1.9ff). (NELAC)

Finding:
An assessment conclusion that identifies a condition having a significant effect on an item or activity. As assessment finding is normally a deficiency and is normally accompanied by specific examples of the observed condition. (NELAC)

Holding Times (Maximum Allowable Holding Times):
The maximum times that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Initial Calibration Standards (ICAL):
A series of CAL solutions used to initially establish instrument calibration and develop calibration curves.

Initial Calibration Verification Standard (ICV):
A CAL solution, which is analyzed initially prior to any field sample analysis, which verifies the previously established calibration curve.

Initial Demonstration of Capability (IDC):
A procedure to establish the ability of the analyst to generate acceptable accuracy and precision.

Inspection:
An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic. (ANSI/ASQC E4-1994)

Internal Standard:
A known amount of standard added to a test portion of a sample and carried through the entire measurement process as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (NELAC)

Internal Standard Calibration:
Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank:
A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Response:
Instrument response is normally expressed as either peak area or peak height however it may also reflect a numerical representation of some type of count on a detector (e.g. Photomultiplier tube, or Diode array detector) and is used in this document to represent all types.

Laboratory:
A defined facility performing environmental analyses in a controlled and scientific manner. (NELAC)

Laboratory Control Sample (LCS) (however named, such as laboratory fortified blank, spiked blank (BS/BSD), or QC check sample):
A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), there is no LCS. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Note: NELAC standards allow a matrix spike to be used in place of this control as long as the acceptance criteria are as stringent as for the LCS. (NELAC)

Laboratory Control Sample Duplicate (LSCD):
A second sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps.

An LCSD shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Laboratory Duplicate:
Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently. (NELAC)

Least Squares Regression (1st Order Curve):
The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit 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 and may be laboratory dependent. (Analytical Chemistry, 55, p.2217, December 1983, modified) See also Method Detection Limit.

Manager (however named):
The individual designed as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A Department Manager may report to the manager. In some cases, the Department Manager and the manager may be the same individual. (NELAC)

Matrix:
The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.

Drinking Water: any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Non-aqueous Liquid: any organic liquid with <15% settleable solids.

Biological Tissue: any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Solids: includes soils, sediments, sludges, and other matrices with >15% settleable solids.

Chemical Waste: a product or by-product of an industrial process that results in a matrix not previously defined.

Air: whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device. (NELAC)

Matrix Spike (spiked sample or fortified sample):

Prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix spikes shall be performed at a frequency of one in 20 samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as, total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in a matrix spike may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the spike. (QAMS)

Matrix Spike Duplicate (spiked sample or fortified sample duplicate):
A second replicate matrix spike is prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Matrix spike duplicates shall be analyzed at a minimum of 1 in 20 samples per matrix type per sample extraction or preparation method. The laboratory shall document their procedure to select the use of an appropriate type of duplicate. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in the duplicates may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the duplicate. (QAMS)

Method Blank (also known as Laboratory Reagent Blank):
A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. (NELAC)

Method Detection Limit:
The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B)

National Environmental Laboratory Accreditation Conference (NELAC):
A voluntary organization of State and Federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories. A subset of NELAP. (NELAC)

National Environmental Laboratory Accreditation Program (NELAP):
The overall National Environmental Laboratory Accreditation Program of which NELAC is a part. (NELAC)

Negative Control:
Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results. (NELAC)

NELAC Standards:
The plan of procedures for consistently evaluating and documenting the ability of laboratories performing environmental measurements to meet nationally defined standards established by the National Environmental Laboratory Accreditation Conference. (NELAC)

Performance Audit:
The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory. (NELAC)

Performance Based Measurement System (PBMS):
A set of processes wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner. (NELAC)

Positive Control:
Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. (NELAC)

Precision:
The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (NELAC)

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. (NELAC)

Proficiency Testing:
A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (NELAC) [2.1]

Proficiency Testing Program:
The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (NELAC)

Proficiency Test Sample (PT):
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. (QAMS)

Quality Assurance:
An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. (QAMS)

Quality Assurance [Project] Plan (QAPP):
A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control:
The overall system of technical activities which purpose is to measure and control the quality of a product or service so that it meets the needs of users. (QAMS)

Quality Control Sample:
An uncontaminated sample matrix spiked with known amounts of analytes from a source independent from the calibration standards. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. (EPA-QAD)

Quality Manual:
A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (NELAC)

Quality System:
A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC (ANSI/ASQC-E-41994)

Quantitation Limits:
The maximum or minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be quantified with the confidence level required by the data user. (NELAC)

Range:
The difference between the minimum and the maximum of a set of values. (EPA-QAD)

Reagent Blank (method reagent blank):
A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (QAMS)

Reference Material:
A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30-2.1)

Reference Method:
A method of known and documented accuracy and precision issued by an organization recognized as competent to do so. (NELAC)

Reference Standard:
A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM-6.0-8)

Relative Percent Difference (RPD):
The difference between two values divided by the average of the values as expressed as a percent, used to determine the closeness of two related values.

Replicate Analyses:
The measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval. (NELAC)

Report Limit (RL):
The laboratory nominal Quantitation Limit (QL) or the level of sensitivity required by the client but not lower than the LOD.

Requirement:
Denotes a mandatory specification; often designated by the term “shall”. (NELAC)

Resource Conservation and Recovery Act (RCRA):
The enabling legislation under 42 USC 321 et seq. (1976), that gives EPA the authority to control hazardous waste from the “cradle-to-grave”, including its generation, transportation, treatment, storage, and disposal. (NELAC)

Safe Drinking Water Act (SDWA):
The enabling legislation, 42 USC 300f et seq. (1974), (Public Law 93-523), that requires the EPA to protect the quality of drinking water in the U.S. by setting maximum allowable contaminant levels, monitoring, and enforcing violations. (NELAC)

Sample Duplicate:
Two samples taken from and representative of the same population and carried through all steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variance of the total method including sampling and analysis. (EPA-QAD)

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity:
(Analytical chemistry) the capability of a test method or instrument to respond to a target substance of constituent in the presence of non-target substances. (EPA-QAD)

Sensitivity:
The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (NELAC)

Spike:
A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, a representative number (at a minimum 10%) of the listed components may be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.. (NELAC)

Standard:
The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies. (ASQC)

Standard Operating Procedures (SOPs):
A written document which details the method of an operation, analysis, or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks. (QAMS)

Standardized Reference Material (SRM):
A certified reference material produced by the U.S. National Institute of Standards and Technology or other equivalent organization and characterized for absolute content, independent of analytical method. (EPA-QAD)

Surrogate:
A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit):
A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Director:
Individuals(s) who has overall responsibility for the technical operation of the environmental testing laboratory. (NELAC)

Test:
A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process, or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate. (ISO/IEC Guide 2-12.1, amended)

Test Method:
An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP. (NELAC)

Toxic Substances Control Act (TSCA):
The enabling legislation in 15 USC 2601 et seq., (1976) that provides for testing, regulating, and screening all chemicals produced or imported into the United States for possible toxic effects prior to commercial manufacture. (NELAC)

Traceability:
The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM-6.12)

Uncertainty:
A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

United States Environmental Protection Agency (EPA):
The Federal governmental agency with responsibility for protecting public health and safeguarding and improving the natural environment (i.e., the air, water, and land) upon which human life depends. (US-EPA)

Validation:
The process of substantiating specified performance criteria. (EPA-QAD)

Verification:
Confirmation by examination and provision of evidence that specified requirements have been met. (NELAC)

Acronyms:

BS – Blank Spike
BSD – Blank Spike Duplicate
CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
CRS – Change Request Form
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DU – Duplicate
DUP - Duplicate
EHS – Environment, Health and Safety
EPA – Environmental Protection Agency
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
HPLC - High Performance Liquid Chromatography
ICP - Inductively Coupled Plasma Atomic Emission Spectroscopy
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
MDL – Method Detection Limit
MS – Matrix Spike
MSD – Matrix Spike Duplicate
MSDS - Material Safety Data Sheet
NELAC - National Environmental Laboratory Accreditation Conference
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Standard Deviation
SOP: Standard Operating Procedure
TAT – Turn-Around-Time
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3.

Laboratory Certifications, Accreditations, Validations

TestAmerica Phoenix maintains certifications, accreditations, certifications, and validations with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

Organization	Certificate Number
American Industrial Hygiene Association	154268
Arizona Department of Health Services	AZ0728
California ELAP	2704
California NELAP	01109CA
Nevada	AZ010302009
New York	11898
Oregon (ORELAP)	AZ100001
US Department of Agriculture	P330-10-00310

The certificates and parameter lists (which may differ) for each organization may be found on the corporate web site, the laboratory's public server, the final report review table, and in the following offices: QA, marketing, and project management.

Claims of Accreditation Status

TestAmerica Phoenix has agreed to make only valid claims as to its accreditation/certification status by any authority by ensuring that the expiration dates are not exceeded and the method-specific scope or parameter lists are supportable, as required by each. Any false claims would be reported to that authority. The agreement covers the use of the authority's name, such as "Authority-Accredited," logo, or certificate number. The only valid proof of accreditation/certification is the current certificate and scope of the authority. It is the responsibility of the laboratory to make these documents available to all staff, and it is the staff's duty to reference only the current documents.

A report with scope and non-scope analytes may only be presented on the same report if the non-accredited results are clearly and unambiguously identified. No report with non-scope analytes may be associated with the logo, "Authority accredited" phrase, or the certificate number. Only the analytes specified by a unique method are valid within the scope. There shall be no intentional misleading of the users of the laboratory's services in this regard.

No opinions and/or interpretations based on results outside the laboratory's scope may be presented on a document referenced by "Authority-accredited", the logo, or the certificate number. If these are made, they must be written in a separate letter which is not endorsed by the authority.

The "Authority-accredited" logo may only be affixed to equipment calibrated by a laboratory that is accredited by the authority. If calibration labels contain the logo, they must also show the calibration laboratory's name or its certificate number, the instrument's unique identification, the date of the last calibration, and a cross-reference to the last calibration certificate.

Should the company decide to use the "Authority-accredited" logo in marketing activities, no misrepresentation may occur. Only reference to the accredited scope at a specific laboratory site is allowed. If any "Authority-accredited" language is used in proposals or quotations, any non-scope analytes must be clearly denoted as not accredited by that authority. The same is true for any use of laboratory letterhead with the "Authority-accredited" wording or logo. The logo may not be affixed to any material, item, product, part, or packaging, thereby implying accreditation status to that piece. In literature, any use of the logo must be positioned adjacent to the accredited laboratory's name and clearly state that the presence of the logo does not imply certification/approval of the products tested. At no time may the logo appear to suggest that a person is accredited. Misrepresentation of accreditation status is never allowed and must be reported if it occurs. If in doubt, the idea of the logo's use may be presented to the authority for approval.

If accreditation is terminated or suspended, the laboratory will immediately cease to use the "Authority-accredited" wording, the logo, or the certificate number reference in any way and inform clients impacted by the change.

Appendix 4.

Methods Performed

Preparation Only Methods

Method	Aqueous	Solid	Waste	Air
Organics				
EPA 1311	X	X	X	
EPA 3500B	X		X	
EPA 3510C	X		X	
EPA 3520C	X		X	
EPA 3600C	X	X	X	
EPA 3610B Alumina	X	X	X	
EPA 3630C Silica Gel	X	X	X	
EPA 3660B Sulfur	X	X	X	
EPA 3665A H2SO4/Permanganate	X	X	X	
EPA 3545 PFE		X		
EPA 3580A	X	X	X	
EPA 5000	X	X	X	
EPA 5030 B & C	X	X	X	
EPA 5035 & 5035A		X	X	
Inorganics				
EPA 1311	X	X	X	
EPA 1312	X	X	X	
EPA 3005A	X			
EPA 3010A	X		X	
EPA 3020A	X		X	
EPA 3050B		X	X	

Organics Methods Performed

Parameter	Method	Aqueous	Solid	Waste	Air
Volatile Organics (VOC)	EPA 8260B	X	X	X	
	EPA 524.2	X			
	EPA 624	X		X	
	EPA TO-15				X
VOC Aromatic & MTBE	EPA 8021B	X	X	X	X
Base Neutrals and Acids (BNAs)	EPA 8270C	X	X	X	
	EPA 625	X			
Organochlorine Pesticides	EPA 8081A	X	X	X	
	EPA 608	X		X	
	EPA TO-10A				X
Chlorinated Herbicides	EPA 8151A	X	X	X	
Organophosphorus Pesticides	EPA 8141A	X	X	X	
	EPA 1657	X		X	
	EPA TO-10A				X
PCBs	EPA 8082	X	X	X	
	EPA TO-10A				X
Petroleum Hydrocarbons	ADHS 8015AZ R1		X		
Diesel Range Organics	EPA 8015B/8015D	X	X	X	
Gasoline Range Organics	EPA 8015B/8015D	X	X	X	X
PAHs	EPA 8310	X	X	X	
Formaldehyde	EPA TO-11A				X

Metals Methods Performed

Parameter	Methods	Aqueous	Solid	Waste	Air
Trace Metals	EPA 200.7	X			
	EPA 200.8	X			
	EPA 6010B	X	X	X	
	EPA 6020	X	X	X	
	NIOSH 7300				X
Hardness	SM 2340B	X			
	EPA 200.7	X			
	EPA 200.8	X			
Mercury	EPA 245.1	X			
	EPA 7470A	X		X	
	EPA 7471A		X	X	
	NIOSH 6009				X

Microbiology Methods Performed

Parameter	Method	Aqueous	Solid	Waste	Air
Fecal Coliform by Mtf	SM 9221E	X	X	X	
Fecal Coliform by Membrane Filtration	SM 9222D	X			
Heterotrophic Bacteria	SIMPLATE	X			
Total Coliforms & E. Coli by Colilert	SM 9223B	X			
Total Coliform by Mf	SM 9221B & C	X			
E. Coli (not for NPDES)	SM9221F	X			

Inorganics Methods Performed

Parameter	Method	Aqueous	Solid	Waste	Air
Acidity	SM 2310B	X			
(NV Only)	EPA 305.1	X			
Alkalinity (Carbonate, Bicarbonate, Total)	SM 2320B	X			
Ammonia	SM 4500 NH3 D + NV	X			
Bromide	EPA 300.0	X			
	EPA 9056	X	X		
Carbon, Total Organic	SM 5310B	X			
	EPA 9060A	X	X		
Carbon, Dissolved Organic	SM 5310B	X			
Chloride	EPA 300.0	X			
	EPA 9056	X	X		
Chlorine, Total Residual	HACH 8167	X			
Chromium, Hexavalent	SM 3500 CR D	X	X		
Corrosivity	SM 2330B	X			
Conductivity	SM 2510B	X			
	EPA 9050A	X	X	X	
Cyanide, Total	SM 4500 CN E	X	X	X	
	SM 4500CN B C	X	X	X	
	EPA 9010C		X	X	
	EPA 9013	X	X	X	
	EPA 9014	X	X	X	
Cyanide, Amenable	SM 4500 CN G	X			
Demand, Biological Oxygen	SM 5210B	X		X	
Demand, Carbonaceous (CBOD)	SM 5210B	X		X	
Demand, Chemical Oxygen	SM 5220D	X		X	
Fluoride	EPA 300.0	X	X		
	EPA 9056	X	X		
	SM 4500 F C	X			
Flashpoint	EPA 1010A	X		X	
	EPA 1030		X		
n-Hexane Extractable Materials	EPA 1664A	X			
Silica Gel Treated n-Hexane Extractable Materials	EPA 1664A	X			

Inorganics Methods Performed

Nitrate	EPA 300.0	X			
	EPA 9056	X	X		
Nitrate & Nitrite	EPA 300.0	X			
	EPA 9056	X	X		
Nitrite	EPA 300.0	X			
	EPA 9056	X	X		
	SM 4500 NO2 B	X			
Total Kjeldahl Nitrogen	SM 4500 NH3 D	X			
Total Kjeldahl Nitrogen (NV Only)	SM 4500 Norg C	X			
Orthophosphate	EPA 300.0	X			
	EPA 9056	X	X		
	SM 4500 P E	X			
Paint Filter Liquids Test	EPA 9095B	X		X	X
Perchlorate	EPA 314.0	X			
pH	SM 4500 H+ B	X			
	EPA 9040B	X			
	EPA 9041A	X			
	EPA 9045D		X	X	
Phosphorus, Total	SM 4500 P B E	X	X	X	
Solids, Total	SM 2540B	X		X	
Solids, Total Dissolved	SM 2540C	X		X	
Solids, Total Suspended	SM 2540D	X		X	
Solids, Total Volatile	EPA 160.4	X		X	
Settleable Solids	SM 2540F	X			
Solids, Total, Fixed and Volatile	SM 2540G	X	X		
Sulfate	EPA 300.0	X			
	EPA 9056	X	X		
Sulfide	SM 4500 S D	X			
Temperature	SM 2550	X			
Turbidity	EPA 180.1	X			

Industrial Hygiene Testing Performed		
Instrumentation	**Technology/Detector**	**Method**
Gas Chromatography	GC / FID	NIOSH 1003 (mod) NIOSH 1005 (mod) NIOSH 1010 (mod) NIOSH 1015 (mod) NIOSH 1022 (mod) NIOSH 1300 (mod) NIOSH 1400 (mod) NIOSH 1401 (mod) NIOSH 1405 (mod) NIOSH 1450 (mod) NIOSH 1457 (mod) NIOSH 1500 (mod) NIOSH 1501 (mod) NIOSH 1602 (mod) NIOSH 1604 (mod) NIOSH 1609 (mod) NIOSH 1605 (mod) NIOSH 1615 (mod) NIOSH 1610 (mod) In-house method for 4-PCH OSHA 7 (mod) NIOSH 2000 (mod) NIOSH 1403 (mod) NIOSH 2551 (mod) NIOSH 1550 (mod) OSHA 48 (mod) NIOSH 2546 (mod) NIOSH 1611 (mod) NIOSH 1613 (mod) NIOSH 1606 (mod) NIOSH 1007 (mod)
	GC/ECD	NIOSH 5039 (mod) NIOSH 5503
	GC/FPD	NIOSH 5600
	GC/MS	OSHA PV 2120 (mod)
Gas Chromatography (Diffusive Samplers)	GC / FID	3M 3500 3M 3520 OSHA 111 (mod) OSHA 1005 (mod) OSHA 1004 (mod) OSHA 7 (mod) SKC Assay Technologies

Industrial Hygiene Testing Performed		
Instrumentation	**Technology/Detector**	**Method**
		OSHA 69 (mod) OSHA 1001 (mod) OSHA 1002 (mod)
Ion Chromatography (IC)		NIOSH 6013 OSHA ID-215 NIOSH 7903 (mod)
Liquid Chromatography	HPLC/ UV	NIOSH 2016 (mod) OSHA 1007 OSHA42 OSHA 47 OSHA 64 (mod) NIOSH 2532 (mod) Using Assay Technologies 571 Passive monitor Formaldehyde, Carbonyls by HPLC EPA TO-11A EPA IP6A & EPA IP6C NIOSH 5506 (mod)
	HPLC/ FL	NIOSH 5506 (mod)
Atomic Absorption	CVAA	NIOSH 6009 OSHA ID-140
Inductively-Couple Plasma	ICP/MS	NIOSH 7300 (mod) OSHA ID-121 (mod) OSHA ID-125G (mod) NIOSH 7303 (mod)
	ICP/AES	NIOSH 7300 (mod) OSHA ID-121 (mod) OSHA ID-125G (mod) NIOSH 7303 (mod) NIOSH 9100 (mod) NIOSH 9102 (mod) OSHA 121 (mod) OSHA 125G (mod) OSHA CSI Method for Silane OSHA 1003 (mod) NIOSH 6006 (mod)
Spectrometry	UV/Vis (Colorimetric)	NIOSH 7600 (mod) H2S Radiello NIOSH 6010 (mod)
Miscellaneous	Gravimetric	NIOSH 0500 (mod) NIOSH 0600 (mod) NIOSH 5000 (mod)

APPENDIX B

HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN
OLD FORT LOWELL RESTORATION PROJECT

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1 Hospital Emergency Map and Directions
2 Accident/Incident Report Form
3 Job Task Safety Analysis and PPE Assessment (JTSA) Forms
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5 SAFE Observation Checklist
6 Relevant Standard Operating Procedures

HEALTH AND SAFETY PLAN FOR LEVEL D TASKS

1 GENERAL PROJECT SITE INFORMATION

Date:	October 14, 2011
Job #:	10204058.26
Job Name:	Old Fort Lowell Restoration Project
Site Address:	5460 East Fort Lowell Road, Tucson, Arizona
Client Contact Information (Name and #):	**City of Tucson:** Lynne Birkinbine – Primary Contact – (520) 837-3708
Scope of Work (List Job Tasks):	1) Observe excavation of contaminated soil. 2) Collect verification samples after excavations are completed to identify the levels of any remaining contaminants and to determine whether additional soil must be removed. 3) Observe stockpiling and removal of soil for transportation off site. 4) Observe abandonment of 3 groundwater wells. 5) Observe removal of approximately 6 septic tanks.

ONSITE ORGANIZATION AND COORDINATION

SCS Project Manager/Field Staff/ H&S Representative:	Pat Hartshorne	520-471-0647 cell 520-696-1617 office
SCS Project Director:	Brad Johnston	602-910-0547 cell 602-840-2596 office
SCS QA Manager:	Dave Laney	602-670-7009 cell 602-840-2596 office
Desert Archaeology	Trish Castalia	520-881-2244
Innovative Excavating	Dan Arnett	520-881-8648
Laboratory: TestAmerica	Carlene McCutcheon	602-437-3340

2 EMERGENCY CONTACT AND NOTIFICATION INFORMATION

Nearest Hospital Address (attach directions and map):	**Tucson Medical Center** **5301 East Grant Road** **Tucson, Arizona** **(520) 327-5461**
Police:	**Call 911**
Fire :	**Call 911**
Ambulance:	**Call 911**
Describe Client Emergency Notification System (if available)	**Not applicable**
Describe Emergency Procedures and medical care	**Call 911**

The map and directions to the hospital are included in ATTACHMENT 1.

Keep a cell phone with you at all times and carry a first aid kit in your vehicle for minor injuries. Report ALL work-related injuries and illnesses – THIS IS REQUIRED – even if you think it is minor. In addition, report all non-work related injuries that may affect your ability to safely perform your job. For non-emergency accidents/incidents/illnesses, the following procedures must be followed as soon as practicably possible:

1. Complete the Accident-Incident Report form (included in **ATTACHMENT 2**) for all accidents and injuries, regardless of mildness or severity.

2. Notify your supervisor and the following other people:

   - Office Director (Brad Johnston) or Office Services Manager (Eva Hoffman) at 602-840-2596

   - Corporate Health and Safety Director (Gary Pons) or the Corporate Human Resources Manager (Wilma Ross) at 800-326-9544

3. For non-emergency accidents/incidents/illnesses, you and your supervisor (or the Office Director or Office Services Manager) must contact our workers compensation provider, **WorkCare (800-455-6155)**, to report the incident ***before seeking any medical attention***. After assessing the incident, WorkCare may determine that seeking additional medical attention is unnecessary. If that determination has been made, WorkCare will then proceed to provide instructions on appropriate first-aid treatment over the telephone.

3 JOB TASK SAFETY ANALYSIS AND PPE ASSESSMENT (JTSA)

The JTSA for all major work tasks described in Section 1 are included in **ATTACHMENT 3**.

STANDARD RULES OF CONDUCT

The following general rules should be followed while performing work at each site:

- SCS employees must review the Health and Safety Plan and sign the acknowledgement form included in Section 8 before work begins.
- All personnel attending daily tailgate meetings are required to sign the "Acknowledgment of Site Specific Tailgate Health and Safety Meeting Form" included in **ATTACHMENT 4**.
- Individual health conditions of workers that may affect emergency treatment (e.g., allergies) should be identified to the Project Manager, other SCS Field Personnel that you are working with, and/or Health and Safety Coordinator for the project.
- Working while under the influence of intoxicants, narcotics, or controlled substances is prohibited.
- Smoking and eating within the work areas are prohibited.
- Checking in (for safety reasons) with your supervisor, Project Manager, or other person is recommended at the end of the day.
- A first aid kit and cellular telephone are required for each job site.

4 SAFE OBSERVATIONS

SCS employees must fill out SAFE observation checklists during the project or site work. At least one checklist will be completed per week by each SCS Field Personnel, or more frequently during continuous days of fieldwork. Copies of the checklists for this project are included in **ATTACHMENT 5**.

5 HAZARD ASSESSMENT

Potential hazards that may be encountered on the site during the project activities include the following and brief discussions of the site-specific hazards follows.

X	Natural Hazards
X	Heat/Cold Stress Hazards
X	Construction Activity Hazards
X	Noise Hazards
X	Electrical Hazards

	Fire and Explosion Hazards
	Biological Hazards
	Confined Space/Oxygen Deficiency
X	Chemical Hazards
	Other

NATURAL HAZARDS

Field workers should be familiar with the basic natural hazards that may be encountered on the site. Natural hazards most likely to be encountered on the site include bees, spiders, or rattlesnakes. People with known allergic reactions, show evidence of an allergic reaction, or receive a large number of bites or stings must seek medical attention immediately.

The telephone number for **Poison Control** in the Tucson area is (520) 626-6016

The telephone number for **Pima County Animal Control** is (520) 743-7550

HEAT/COLD STRESS HAZARDS

Field activities are scheduled to occur in the late winter or spring, creating a potential for both hot and cold weather. Field workers must dress appropriately for the weather, drink plenty of liquids, get plenty of sleep, avoid alcoholic beverages or smoking, and acclimatize themselves to weather conditions. Workers wearing personal protective clothing are particularly susceptible to heat stress. Site personnel should be familiar with identification of heat stress victims, appropriate first-aid treatment, and the prevention of heat stress casualties.

CONSTRUCTION ACTIVITY/NOISE/ELECTRICAL HAZARDS

Construction activities for this project include excavation and well abandonment activities. Construction activity hazards include movement of heavy equipment and vehicle traffic associated with construction activities. Hard hats, steel toe boots, safety glasses, and safety vests are required in designated work areas at the site whenever heavy equipment is operating. Hearing protection may be necessary during operation of some heavy equipment. Stay aware of surroundings, locations of equipment, and planned activities in the area. Public utility surveys must be performed prior to performing subsurface investigations. Work areas must be evaluated for proximity to both underground and overhead utilities.

Call **Arizona Blue Stake** at 1-800-782-5348 (1-800-STAKE-IT)

CHEMICAL AND PHYSICAL AGENT HAZARDS

Potential chemical hazards identified for the site are primarily associated with petroleum hydrocarbons, PAHs, arsenic, and lead in soil (see Table 1). It is not anticipated that vapors or fumes will be of concern during the excavation activities; therefore, air monitoring will not be performed. Dust must be controlled during site activities.

Level D (no respiratory protection; minimal skin protection) personal protection equipment (PPE) is considered to be adequate for this project. If dust becomes an issue, a half-face respirator with HEPA filter will be required.

During remediation, it may be necessary to perform air monitoring at and/or near the site. The purpose of monitoring would be to evaluate whether contingency measures are necessary to keep potential impacts to the community within acceptable parameters. If necessary, several locations may be selected around the perimeter of the site for ambient air monitoring stations. If this type of monitored is needed, high volume air samplers would be operated at these stations to monitor particulate matter less than 10 microns in size (PM_{10}) and PAHs to evaluate whether it is possible that chemicals of concern from excavation operations could be carried to offsite areas. If monitoring data indicate that the potential for exposure to airborne contaminants is likely, contingency measures could be implemented. These might include increased dust suppression via application of water or foam, or reduction in the size of the working face of the excavation. The excavation contractor might also be required to cease onsite activities any time wind speed exceeds a predetermined value.

Table 1. Chemical Hazards and Air Monitoring Plan

Chemical	PEL	TLV	IDLH	Monitoring equipment	Action Levels for monitoring equip.	Sample Location ID and Frequency	Procedures when Action Levels Exceeded
Hydrocarbons				NA			
PAHs				NA			
Arsenic				NA			
Lead				NA			

6 SITE SECURITY AND CONTROL, DECONTAMINATION AND DISPOSAL MEASURES

SITE SECURITY AND CONTROL MEASURES

The site is currently fenced and has locked gates. The gates must remain closed at all times except while entering and leaving the site. Observers at the site must remain outside the work area, unless otherwise notified. Decontamination areas will be set up within the work zones, as necessary. Sanitation facilities will consist of portable toilets.

Tailgate meetings will be held at the beginning of each work day and will be attended by all site workers. Tailgate meeting forms are included in **ATTACHMENT 4.**

DECONTAMINATION PROCEDURES

Decontaminate sampling equipment as follows:

- Pre-rinse equipment if there is an excessive amount of soil attached
- Wash using tap water, Liquinox soap, and a scrub brush in a plastic container
- Rinse with distilled/deionized water in a plastic container
- Final rinse with distilled/deionized water using a water sprayer

Personnel will use protective gloves while sampling. Remove gloves and other disposable PPE and place in a plastic trash bag. Thoroughly wash hands, arms, and face using water and Liquinox soap in a plastic bucket or using a sprayer. Dry with paper towels.

If necessary based on field observations, the backhoe bucket will be decontaminated between excavations and before leaving the site using non phosphate detergent and tap water wash, or a steam cleaner. It is not anticipated that the decontamination water from this procedure will need to be containerized.

7 APPLICABLE STANDARD OPERATING PROCEDURES (SOP) AND PROGRAMS

The following relevant SOPs from the SCS SCS Injury and Illness Prevention Plan are provided in **ATTACHMENT 6**:

- Appendix J – Excavation and Construction Earthwork Program
- Appendix J – Attachment A – Excavation and Earthwork Construction Safety

Other relevant SOPs posted on the SCS Intranet include:

- SOP 24 – Avoidance of Slips, Trips, and Falls

8 ACKNOWLEDGEMENT PAGE

"I have read the attached Health and Safety Plan for Old Fort Lowell Restoration Project, dated November 11, 2010. I have discussed any questions that I have regarding the materials with the person in charge of site safety for SCS activities on the project, and I understand the requirements."

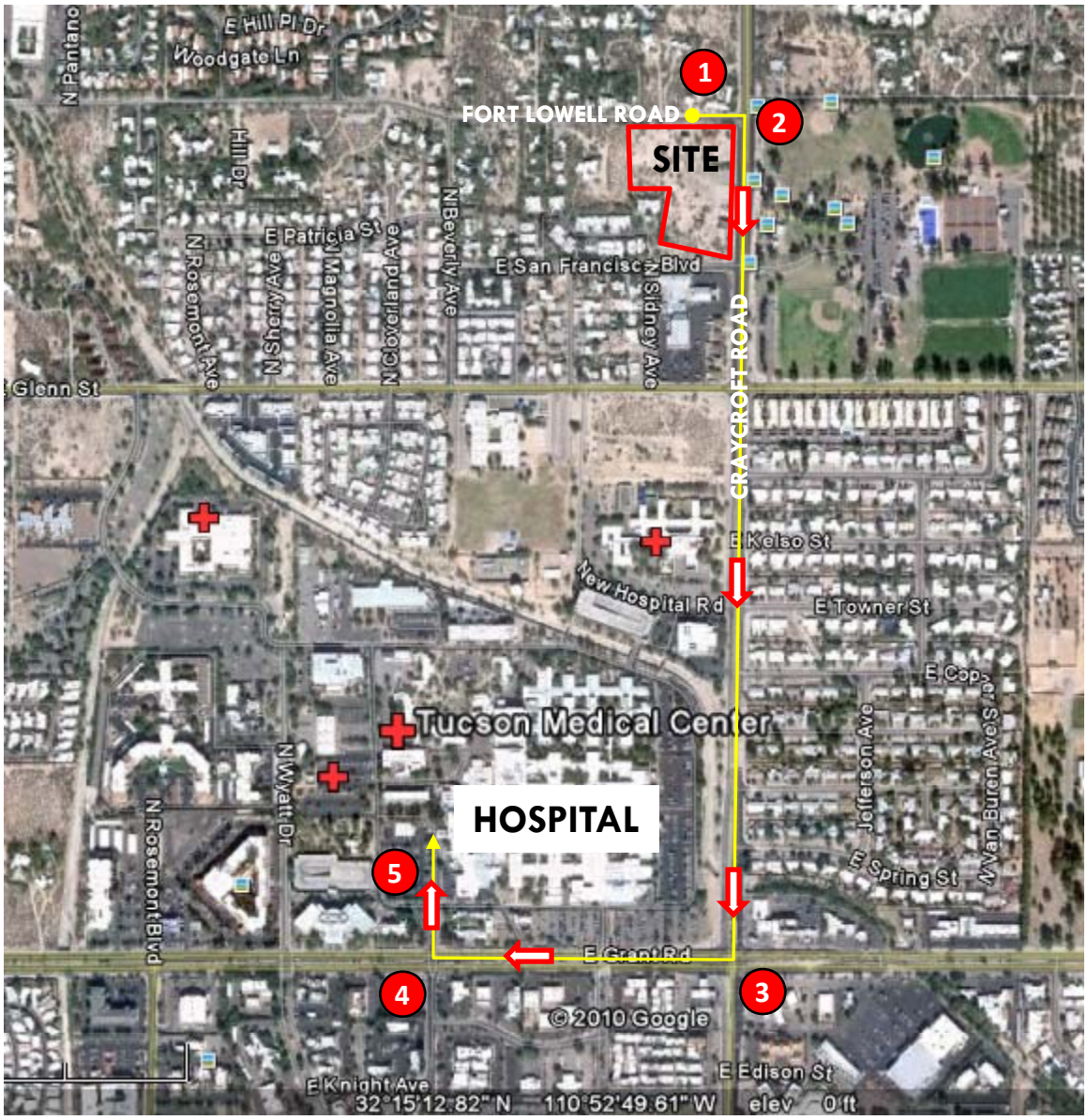
Name	Signature	Date

Approved by:_____

Date:_____

ATTACHMENT 1

HOSPITAL EMERGENCY MAP AND DIRECTIONS



DIRECTIONS TO TUCSON MEDICAL CENTER, 5301 EAST GRANT ROAD, (520) 327-5461

1. The site is at the southwest corner of Fort Lowell and Craycroft Roads. Turn right from the north side of the site onto Fort Lowell Road.
2. Go less than one block east on Fort Lowell Road and turn right onto Craycroft Road.
3. Go south 0.75 mile on Craycroft Road and turn right onto Grant Road.
4. Go west 0.25 mile on Grant Road and turn right onto Beverly Avenue.
5. Tucson Medical Center is at the northwest corner of Craycroft and Grant Roads.

N

0 0.25 0.5

APPROXIMATE SCALE IN MILES

Disclaimer: This figure is based on available data. Actual conditions may differ. All locations and dimensions are approximate.

ATTACHMENT 2

ACCIDENT/INCIDENT REPORT FORM

INCIDENT

Case # _____ Date _____ Time _____ Facility _____
Describe Incident _____ Recordable _____

Who

Employee ID# _____ Privacy Case ☐
Employee Name _____
Job Title _____
Department _____
Shift _____

Job Performing at time of Accident

☐ Not Performing usual Occupation

Job Title _____
Department _____
Shift _____

What

Incident Type _____ ☐ Sharps Injury?
General Activity _____ ☐ Doing before incident
Specific Activity

Where

General Location _____
Specific Location _____
☐ Off Premises

INJURY/ILLNESS

Injury/Illness Description _____

Body Part Side of Injury Nature of Injury

Employee Description _____
of Bodily Injury/Illness:

Injury Source _____ Doctor _____
Case of Injury _____ Hospital _____

Treatment

☐ Medical Treatment Required
☐ Treatment Was Administered on Scene
☐ Further Medical Aid is Required
☐ Fatal Date of Death _____

Transportation to Medical Facility

Type _____
Date _____ Time Left _____ Returned _____
☐ Employee Was Hospitalized ☐ Employee Rec'd First Aid
☐ Treated at Clinic ☐ Treated in Emergency Room
☐ Received Outpatient Care

DAYS AWAY/RESTRICTED

Last Day Work	First Day Away	Last Day Away	First Day Back	Off W.C.	Days Away
_____	_____	_____	_____	_____	_____

Total Days Away _____
Date Last Worked _____
First Day Away _____
Last Day Away _____
Returned to Work _____
☐ Estimate (Return to Work)

Days Away

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Year Total _____

Restricted Days History

First Day Restricted	Last Day Restricted	Restricted Days
_____	_____	_____

Total Restricted Days _____
Last Restricted Date _____
☐ Estimate (Last Restricted Date)

Restricted Days

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Year Total _____

Date Disability Began → _____

ADDITIONAL INFO

Additional Info

Crew Size _____
Working With _____
Work Phase _____
Supervision _____
Supervisor _____

Years in Occupation _____
Working Overtime when Injured? ☐
How long has employee worked on this job prior to day of injury? _____
Number of consecutive days worked prior to injury _____
☐ Vehicle Involved ☐ Property Damage

Reporting Information

Reported to _____
Date Reported _____ Time Reported _____
Employee's Statement of injury or Illness ☐

Safety Equipment Used

☐ Guards ☐ Safe Guards Provided ☐ Safe Guards Used
☐ Glasses ☐ Gloves ☐ Hearing Protection
☐ Respirators ☐ Seat Belt ☐ Shoes
☐ Hardhat ☐ Other _____

Secondary Hazard Information

Secondary Source of Injury _____ Secondary Hazard _____

CLAIMS

Claim Number _____ ☐ Open ☐ Final ☐ Reopened Date Closed _____

Cost

Medical _____
Legal _____
Admin _____
Co. Prop. _____
Other Prop. _____
Comp. Paid _____
Total Cost _____

Insurance _____
Law Firm _____

Property Damage

Company _____
Other _____

Type

☐ Medical ☐ Litigated
☐ Indemnity ☐ Rehabilitation
☐ Possible Fraud

Workers Compensation

☐ Worker Comp Claim?
Classification _____
Workers Comp Code

Allocated/Reserved

Allocated _____
Reserved _____

Witness Information

Name 1 _____ Phone _____
Address _____ Date _____
City/State/ZIP _____ Statement ☐
Name 2 _____ Phone _____
Address _____ Date _____
City/State/ZIP _____ Statement ☐
Name 3 _____ Phone _____
Address _____ Date _____
City/State/Zip _____ Statement ☐

Additional Information

_____

ATTACHMENT 3

JOB TASK SAFETY ANALYSIS AND PPE ASSESSMENT (JTSA)

JOB TASK SAFETY ANALYSIS AND PPE ASSESSMENT FORM

Job Task Safety Analysis Form				
Task Type (Check all that Apply)	**Engineering Services**	**Task Description (include an estimate of task duration in hrs/day):** Observe excavation of contaminated soil, removal of septic tanks, and abandonment of wells; GPS locations; perform verification soil sampling (up to 10 hours/day)	**Location or Project:** COT Old Fort Lowell Restoration Project Remediation **Date Revised:** 8/2/10 **Project #/Revision #:** 10204058.26	
Analysis Team Member	**Position Title**		**Reviewed by**	**Position Title**
Brad Johnston	Vice President			
Pat Hartshorne	Project Manager			
Special Training Required		OSHA 40 hour training, 8-hour refresher training		
Applicable SAFE Checklist(s): Specify type and category number		Lean SAFE Checklist ES-Excavations Lean SAFE Checklist ES-Hand Soil Sampling		

This form is the certification that the hazard assessment has been performed for the workplace as required under 29 CFR 1910.132.

Job Task Step	Potential Environmental and Personnel Hazards[1]	Critical Actions	PPE Required
1. Mobilize equipment to site	Driving vehicles, lifting of gear during loading and unloading	• Drive in a safe manner • Pull over to rest if sleepy • Use proper lifting techniques when loading and unloading gear	Head: None Eye/Face: None Hand: None or leather gloves Body: None Foot: None or steel-toe ANSI boots Hearing: None Respiratory: None
2. Excavation of soil, stockpiling, backfilling, and transportation and disposal of soil; removal of septic tanks; abandonment of wells	Heavy equipment; dust; PAHs, arsenic, and lead in soil; heat and cold; natural hazards	• Be aware of machinery • Stay in operator's view • Stay back from sides of wells and excavations • Watch for uneven surfaces/ trip hazards • Stay upwind of excavations • Make sure appropriate dust suppression is performed • Wear appropriate safety PPE • Wear hand protection if handling soil • Drink plenty of water • Dress appropriate for weather • Watch for snakes, insects, scorpions, or spiders	Head: Hardhat Eye/Face: Safety glasses Hand: None unless handling soil, then use appropriate vinyl, latex, or nitrile gloves Body: Safety vest, sunscreen Foot: Steel-toe ANSI boots Hearing: None /Ear plugs or muffs Respiratory: None or HEPA
3. GPS excavated areas, sample locations, and other areas of interest	Slip, trip, and falls; excavations; natural hazards; heavy equipment; heat	• Be aware of machinery • Stay in operator's view • Watch for uneven surfaces/ trip hazards • Watch for snakes, insects, scorpions, or spiders	Head: Hardhat Eye/Face: None Hand: None Body: Safety vest, sunscreen Foot: Steel-toe ANSI boots Hearing: None Respiratory: None

Job Task Step	Potential Environmental and Personnel Hazards[1]	Critical Actions	PPE Required
4. Collect verification samples from base and perimeter of excavations	Potential contaminants (PAHs, metals), heavy equipment, heat	• Be aware of surroundings • Stay in operator's view • Watch for uneven surfaces/ trip hazards • Do not enter excavations deeper than 4 feet bgs, use backhoe bucket to collect soil • Wear appropriate safety PPE • Drink plenty of water • Dress appropriate for weather	Head: Hardhat Eye/Face: None Body: Safety vest, sunscreen Hand: Vinyl, latex, or nitrile gloves Foot: Steel-toe ANSI boots Hearing: None Respiratory: None

See Table 1 for examples of Environmental Hazards and Table 2 for Personal Hazards

Table 1: Potential Environmental/Safety Hazards with Possible Critical Actions	
Environmental conditions	1. Is there adequate lighting? Provide portable lighting, flashlights, hardhats with light attachments 2. Are there sources of heat or cold stress? Cold Stress: Use insulated coveralls or clothing, provide heaters or blankets. Heat stress: provide plenty of ice and fluids, monitor body temperature and pulse, provide cooling vests, provide cooling fans or mistifiers 3. Are there any radiation sources? Provide radiation protection, monitor for radiation, 4. Is there adequate ventilation to remove air contaminants? Provide ventilation fans or blowers 5. Is adequate air monitoring conducted? Conduct personal or real-time monitoring 6. Are there any biological hazards such as ticks, spiders, snakes, chiggers, etc potentially present in work area? Use DEET or other tick or insect sprays, cover exposed skin areas with clothing, tuck in pant leggings into boots
Injurious Contact	1. Can an employee or clothing come in contact with, struck by, caught between moving parts of machinery? Install guards or warning signs/barriers 2. Any there any pinch points between two moving parts or objects? Provide guards, barriers, or warning signs 3. Is there sufficient room to work and not be in the line of fire or in traffic area? Personnel provide traffic support, use traffic cones 4. Is there an object or machinery that can strike people? Provide barriers or use proper PPE 5. Is energy sources controlled and lockout/tagout? Provide lockout/tagout and check controls 6. Are machines guarded properly? Use proper guards
Overextension	See Exhibit 4.7-2 for evaluation of ergonomic hazards such as awkward postures, lifting, high hand force, repetitive motion, and repeated contact.
Slips, Trips, Falls	1. Is there a chance that ice, oil water or other slick material to accumulate on working surfaces? Use shoe overlays or slip-resistant boots, use absorbents. 2. Is the area clear of debris and litter? Provide proper housekeeping and inspect area before task 3. Are there any walking obstructions such as hidden ditches or hoses on ground? Identify obstructions with tape or other warning devices 4. Does the job require stairs, ladders or other elevated surfaces? Provide railings or fall protection 5. Is there a chance to fall from elevated level? Provide railings or fall protection
Other Safety Hazards	1. Correct tools for job available? Evaluate tools required 2. Is proper equipment lifting/moving equipment available? Provide manlifts, hoists, or cranes for lifting 3. Is critical equipment maintained? Check maintenance records 4. Is communications between groups adequate for safe performance? Provide radios or cell phones to employees
Drilling, excavation, confined space, operation of heavy machinery, operating power tools	See appropriate SAFE Checklist for Safe behaviors for each category type

Use Exhibit 4.7-2 to determine ergonomic hazards

Table 2: Personal Hazards and Guidance on PPE Selection		
Personal System	**Potential Hazards**	**Recommended PPE**
Head	1. Potential for falling overhead objects? 2. Potential for contact with electrical conductors coming in contact with head?	Hardhats, ANSI Z-89.1 approved Non-conductive Hardhats Class A or B, ANSI Z-89.1 approved
Eye/Face	1. Exposed to flying particles or objects that can impact eye or face? 2. Exposed to flying sparks or molten metal? 3. Exposed to corrosive vapors or liquids? 4. Exposed to optical radiation?	Faceshield , ANSI approved goggles, minimal protection is safety glasses with side shields Faceshields or goggles Faceshield or chemical splash resistant goggles Welder faceshield with adequate optical density shades
Hand/Body	1. Exposed to possible cuts or abrasions? 2. Exposed to hot surfaces or heat sources? 3. Exposed to hazardous chemicals through dermal route?	Leather gloves or abrasion resistant gloves Leather or other heat resistant gloves/ Heat reflective coveralls Chemical resistant gloves and coveralls appropriate for chemicals of concern
Foot	1. Potential for objects falling or rolling over foot? 2. Potential for objects piercing foot? 3. Feet exposed to dangerous or corrosive chemicals? 4. Feet exposed to electrical hazard 5. Exposed to tripping hazards and uneven surfaces?	Steel-toe boots, ANSI Z-41 approved, metatarsal guards should be considered Steel-toe and shank boots, ANSI Z-41 approved Chemical resistant boots with steel-toe and shank Non-conductive safety boots, ANSI Z-41 approved Boots with high ankle support
Hearing	Exposed above 80 dBA	Hearing plugs or muffs with NRR sufficient to reduce exposures below 80 dBA
Respiratory	1. Oxygen deficient or IDLH atmosphere, or unknown atmosphere 2. Below 50 times PEL, but above 10 times PEL, or corrosive to eye/face 3. Above 10 times PEL, but below 50 times PEL, non-corrosive to eyes/face	SCBA or supplied air with escape bottle Full face cartridge or filter respirators, PAPR Half-face respirator

ATTACHMENT 4

TAILGATE MEETING FORM

ACKNOWLEDGMENT OF SITE-SPECIFIC TAILGATE HEALTH AND SAFETY MEETING FORM

DIRECTIONS: Please complete this form to show that you have attended the Site-Specific Tailgate Health and Safety Meeting and have received site-specific health and safety training (SCS and other workers attending meeting).

Name (print)	Signature	Company	Date

ACKNOWLEDGMENT OF SITE-SPECIFIC TAILGATE HEALTH AND SAFETY MEETING FORM

DIRECTIONS: Please complete this form to show that you have attended the Site-Specific Tailgate Health and Safety Meeting and have received site-specific health and safety training (SCS and other workers attending meeting).

Name (print)	Signature	Company	Date

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DIRECTIONS: Please complete this form to show that you have attended the Site-Specific Tailgate Health and Safety Meeting and have received site-specific health and safety training (SCS and other workers attending meeting).

Name (print)	Signature	Company	Date

ATTACHMENT 5

SAFE OBSERVATION CHECKLIST

SAFE OBSERVATION LOG FOR ES - EXCAVATIONS

Date: _____ Project No. _____ Office/Profit Center: _____

Location: _____ Observed By: _____

Working Around Excavations	Safe	At-Risk	Feedback/Corrective Action
1. Reviews site-specific H&S plan and attends daily tailgate meetings with site personnel.			
2. Stays out of the swing radius of excavator and other heavy machinery.			
3. Stays out of trenches more than 4 feet deep. Uses backhoe bucket to collect samples from deeper trenches.			
4. Keeps away from potentially unstable trench walls.			
5. Works uphill or cross-grade, never downhill from heavy equipment.			
6. If applicable, uses air monitoring devices to check levels of suspected contaminants.			
7. Wears hardhat, safety vest, safety boots and safety glasses.			

General SAFE Observation	
Unsafe Act(s) or Condition (s) Identified:	**Corrective Action:**
Estimated Hazard Level	Low _____ Moderate_____ High_____
General Comments	

Revised 12/08/2009

SAFE OBSERVATION LOG FOR ES – HAND SOIL SAMPLING

Date: _____ Project No. _____ Office/Profit Center: _____

Location: _____ Observed By: _____

Hand Soil Sampling	Safe	At-Risk	Feedback/Corrective Action
1. Reviews site-specific H&S plan.			
2. Uses sampling equipment appropriate for the project (trowels, hand auger, shovel, pick, etc.).			
3. Takes frequent breaks and perform stretches to relieve stress on muscles and tendons from repetitive motion.			
4. If applicable, uses ergonomic tools such as shock absorbing handles to relieve the stress on ligaments and muscles from forceful pounding. Stops repetitive or physical activities if pain is experienced pain to prevent injury.			
5. Evaluates capabilities before going into the field to determine if they can safely complete a task. Obtain assistance if necessary.			
6. If applicable, uses air monitoring devices to check levels of suspected contaminants.			
7. Wears safety vest if in traffic areas, long pants, and safety boots.			

General SAFE Observation	
Unsafe Act(s) or Condition (s) Identified:	**Corrective Action:**
Estimated Hazard Level	Low _____ Moderate_____ High_____
General Comments	

Revised 12/08/2009

ATTACHMENT 6

RELEVANT STANDARD OPERATING PROCEDURES

Appendix J

Excavation and Construction Earthwork Program

Appendix J - Excavation and Construction Earthwork Program

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Vehicles Traffic J-3
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Barricades or Stop Logs J-3
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Safe Work Practices J-4
Soil Classification J-4
Protective Systems J-5

Attachment

Attachment A: Excerpt from the OSHA Technical Manual Regarding Excavation Safety J-6

Appendix J

Excavation and Construction Earthwork Program

PURPOSE AND SCOPE

This section provides guidance on the prevention of injury from trench cave-in or collapse. Because construction projects include excavation or similar earthwork, understanding dangers posed by the collapse of deep trenches or excavations, including death by suffocation or by being crushed, is very important. This section outlines measures required for construction projects with trenches greater than 4 feet deep (from shoring, laying back of slopes at stable angles, etc.). Hazards associated with earthwork and protective systems related to these hazards are discussed.

GENERAL

A permit may be required for excavations deeper than 4 feet (check local regulations). A competent person will be assigned the responsibility of applying regulations. When completing construction projects, all persons working in or around trenches deeper than 4 feet must be trained and must perform work in accordance with specifications contained ***Appendix K (Confined Space Entry Program)***.

Landfills

The following instructions apply to excavations located at or near landfills containing trash or organic wastes that may produce methane or other gases:

- **No Smoking.**
- A competent person must evaluate atmosphere in any trench entered by employees. This includes testing for methane, oxygen, hydrogen sulfide, and volatile organic compounds. Appropriate respiratory protection believed necessary will be specified and worn.
- Periodically during construction, work areas must be monitored for concentrations of methane, oxygen, and other chemicals of concern. If necessary, forced ventilation to reduce gas concentrations will be provided.
- Workers may not handle excavated solid waste, unless they are wearing appropriate protective gloves and clothing.
- Electric motors and controls used in the excavation area should be intrinsically safe or explosion-proof.
- No open flame or electric arc welding is allowed in, on, or close to the excavation area, unless the area is continuously monitored for combustible gases, and a Hot Work Permit has been completed (see ***SOP 5***).

- When assembled, pipe valves for landfill gas should be immediately closed and kept closed as construction progresses, to prevent migration of landfill gas through the pipe. Piping should be capped at the end of each work day.

Other Hazardous Atmospheres

The following requirements apply to excavations before employees can be allowed to enter for any reason:

- A competent person will conduct atmospheric testing and document results.

- For potentially hazardous atmospheres, continuous monitoring should be practiced while workers are in the excavation. Readings must be documented at least every 2 hours, or more often as changes in atmosphere occur.

- Appropriate emergency rescue equipment must be provided at the excavation. This equipment will be identified on the Site-Specific Health and Safety Plan (SSHSP; see ***SOP 2***), excavation permit, or attached equipment checklist. All persons expected to perform rescues must be trained in rescue procedures and must have practiced at least one rescue within the last 12 months.

Underground Installations

The Superintendent or foreman will coordinate excavations as follows:

- Excavations at a client's or third party's host facility:

  - Contact facility representative at least 24 hours in advance of digging.
  - Arrange to locate lines and buried obstacles before digging.
  - Arrange to locate and isolate energy sources before digging.

- Excavations in right of way or areas outside a host facility:

  - Contact Digger's Hot Line or local equivalent at least 48 hours in advance to locate underground systems.

- Excavations proceeding without a representative from a utility:

  - Use electronic detection equipment to locate buried systems.
  - Use manual excavation to locate positions of buried obstacles.

- Open excavations:

  - Protect, support, or remove underground systems or lines to protect employees entering excavations.

  - Protect energized lines or systems against physical damage from the excavation, the work process, and backfill operations.

Access and Egress

Ramps must be designed and constructed in accordance with design specifications of the Professional Registered Engineer. Trench excavations greater than 4 feet in depth require:

- Stairway.
- Ladder.
- Ramp.

The method of access and egress must be located no more than 25 feet horizontally in any direction. Egress devices will be secured to prevent slippage or movement.

Vehicle Traffic

Employees exposed to public vehicular traffic must be provided with, and must wear, warning vests suitable for high visibility.

Falling Materials

Employees are not permitted underneath loads handled by lifting or digging equipment. They must stand away from any vehicle being loaded or unloaded to avoid being struck by spillage or falling materials.

Barricades or Stop Logs

Barricades or stop logs must be placed at least 2 feet from the edge of an excavation, and 4 feet from the edge is recommended to:

- Control vehicular approach.
- Protect against sloughing or falling materials.
- Control the proximity of spoil piles to the excavation edge.

Water Accumulation Hazards

Where water accumulates, excavations will be considered to have Type C soils. The following precautions apply:

- Water accumulation must be controlled by pumps. Employees are not to enter excavations unless:

  - Shield systems are utilized.
  - Body harness and lifelines are used.
  - Reliable footing is provided to elevate workers above the water line.

- Where excavations interrupt the natural drainage of surface water, diversion ditches or other effective means must be used.

Adjacent Structures

Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees must not be permitted, except when:

- A support system, such as an underpinning, is provided to ensure the safety of employees and the stability of the structure.
- The excavation is in stable rock.
- A Registered Professional Engineer has determined that the structure is far enough away from excavation activities.
- A Registered Professional Engineer has determined that the excavation will not present hazards to employees.

Sidewalks, pavement, and other structures are not to be undermined. A support system or other method must be provided to protect employees from possible collapse into the excavation. Inspections must be conducted and documented by a competent person. Documentation of findings during periodic inspections should be entered on the excavation permit form.

SAFE WORK PRACTICES

The competent person must review safe work practices with workers entering the excavation. Orientation will be held before workers are permitted into or around the excavation. The following regulations apply:

- Workers must use the buddy system when entering an excavation.
- Workers in excavations deeper than 4 feet must be attended.
- The competent person or designee must remain at the excavation until employees exit and are accounted for.
- The competent person or designee must remain at the site until the excavation is barricaded and workers leave the area.

Soil Classification

Unless designated and specified by a Registered Professional Engineer, the following regulations apply:

- When greater than 4 feet deep, the soil classification shall be determined by the site competent person. The slope of the excavation walls must be sloped properly based on the soil classification determined by the competent person in accordance with OSHA 29 CFR 1926 Subpart P, Appendix A or state OSHA regulations (i.e California Code of Regulations, Title 8 Section 1541.1 Appendix B).

- Stable rock excavations may be determined by the competent person when using a:
  - Visual test, and either a:
  - Pocket penetrometer or a hand-operated shear-vane.
- Sloping or benching excavations greater than 20 feet deep must be designed by a Registered Professional Engineer.

Protective Systems

When not provided by the client or rented from a manufacturer's representative, excavation plans will be reviewed by a Registered Professional Engineer. Recommendations for specific protective system(s) are to be documented and obtained prior to excavating and before employees are permitted to enter the excavation. This review and recommendation need not be performed when:

- Excavations are made entirely of stable rock.
- Excavations are less than 5 feet deep, and examination of the ground by a competent person provides no indication of potential cave-in.

The Registered Professional Engineer's recommended protective system(s) is to be documented in sufficient detail to establish compliance with OSHA's 29 CFR 1926.650. These recommendations are to be signed by the Registered Professional Engineer. The report must remain at the site. **When manufactured support systems are to be utilized, the manufacturer's written specifications, recommendations, and limitations must also remain at the site.**

A competent person must monitor the construction and maintenance of the recommended protective system and its use in excavations. ***Attachment A (found on the company intranet site)*** contains valuable information regarding excavation and trench safety. This information should be used as guidance during monitoring activities at the site.

ATTACHMENTS

Attachment A: Excerpt from the OSHA Technical Manual Regarding Excavation Safety

Attachment A. Excerpt from the OSHA Technical Manual Regarding Excavation Safety

Information from the OSHA Technical Manual regarding excavation safety is found on the company intranet site at:
http://eye.scsengineers.com/TechnicalAdvisor/Health&Safety/index.htm

Appendix J - Attachment A

EXCAVATION AND EARTHWORK CONSTRUCTION SAFETY

Taken from OSHA Technical Manual, Section V, Chapter 2

OSHA Technical Manual

SECTION V: CHAPTER 2

EXCAVATIONS: HAZARD RECOGNITION IN TRENCHING AND SHORING

Contents:

I. Introduction
II. Definitions
III. Overview
IV. Determination of Soil Type
V. Test Equipment
VI. Shoring Types
VII. Shielding Types
VIII. Sloping and Benching
IX. Spoil
X. Special Health and Safety Considerations
XI. Bibliography

Appendix V:2-1. Site Assessment Questions

I. INTRODUCTION.

Excavating is recognized as one of the most hazardous construction operations. OSHA recently revised Subpart P, *Excavations,* of 29 CFR 1926.650, .651, and .652 to make the standard easier to understand, permit the use of performance criteria where possible, and provide construction employers with options when classifying soil and selecting employee protection methods.

This chapter is intended to assist *OSHA Technical Manual* users, safety and health consultants, OSHA field staff, and others in the recognition of trenching and shoring hazards and their prevention.

II. DEFINITIONS.

A. **ACCEPTED ENGINEERING PRACTICES** are procedures compatible with the standards of practice required of a registered professional engineer.

B. **ADJACENT STRUCTURE STABILITY** refers to the stability of the foundation(s) of adjacent structures whose location may create surcharges, changes in soil conditions, or other disruptions that have the potential to extend into the failure zone of the excavation or trench.

C. **COMPETENT PERSON** is an individual who is capable of identifying existing and predictable hazards or working conditions that are hazardous, unsanitary, or dangerous to employees, and who *has authorization to take prompt corrective measures to eliminate or control these hazards and conditions.*

D. **CONFINED SPACE** is a space that, by design and/or configuration, has limited openings for entry and exit, unfavorable natural ventilation, may contain or produce hazardous substances, and is not intended for continuous employee occupancy.

E. **EXCAVATION**. An **Excavation** is any man-made cut, cavity, trench, or depression in an earth surface that is formed by earth removal. A **Trench** is a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth of a trench is greater than its width, and the width (measured at the bottom) is not greater than 15 ft (4.6 m). If a form or other structure installed or constructed in an excavation reduces the distance between the form and the side of the excavation to 15 ft (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

F. **HAZARDOUS ATMOSPHERE** is an atmosphere that by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen-deficient, toxic, or otherwise harmful may cause death, illness, or injury to persons exposed to it.

G. **INGRESS AND EGRESS** mean "entry" and "exit," respectively. In trenching and excavation operations, they refer to the provision of safe means for employees to enter or exit an excavation or trench.

H. **PROTECTIVE SYSTEM** refers to a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, and from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

I. **REGISTERED PROFESSIONAL ENGINEER** is a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer who is registered in any state is deemed to be a "registered professional engineer" within the meaning of Subpart P when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

J. **SUPPORT SYSTEM** refers to structures such as underpinning, bracing, and shoring that provide support to an adjacent structure or underground installation or to the sides of an excavation or trench.

K. **SUBSURFACE ENCUMBRANCES** include underground utilities, foundations, streams, water tables, transformer vaults, and geological anomalies.

L. **SURCHARGE** means an excessive vertical load or weight caused by spoil, overburden, vehicles, equipment, or activities that may affect trench stability.

M. **TABULATED DATA** are tables and charts approved by a registered professional engineer and used to design and construct a protective system.

N. **UNDERGROUND INSTALLATIONS** include, but are not limited to, utilities (sewer, telephone, fuel, electric, water, and other product lines), tunnels, shafts, vaults, foundations, and other

underground fixtures or equipment that may be encountered during excavation or trenching work.

O. **UNCONFINED COMPRESSIVE STRENGTH** is the load per unit area at which soil will fail in compression. This measure can be determined by laboratory testing, or it can be estimated in the field using a pocket penetrometer, by thumb penetration tests, or by other methods.

P. **DEFINITIONS THAT ARE NO LONGER APPLICABLE**. For a variety of reasons, several terms commonly used in the past are no longer used in revised Subpart P. These include the following:

1. **Angle of Repose** Conflicting and inconsistent definitions have led to confusion as to the meaning of this phrase. This term has been replaced by **Maximum Allowable Slope.**

2. **Bank, Sheet Pile, and Walls** Previous definitions were unclear or were used inconsistently in the former standard.

3. **Hard Compact Soil** and **Unstable Soil** The new soil classification system in revised Subpart P uses different terms for these soil types.

4.

III. OVERVIEW: SOIL MECHANICS.

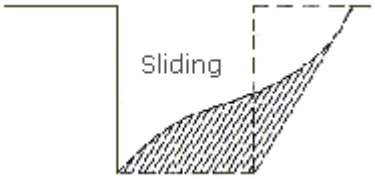
A number of stresses and deformations can occur in an open cut or trench. For example, increases or decreases in moisture content can adversely affect the stability of a trench or excavation. The following diagrams show some of the more frequently identified causes of trench failure.

A. **TENSION CRACKS**. Tension cracks usually form at a horizontal distance of 0.5 to 0.75 times the depth of the trench, measured from the top of the vertical face of the trench. See the accompanying drawing for additional details.

FIGURE 5:2-1. TENSION CRACK.

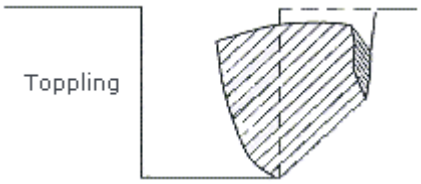
B. **SLIDING** or sluffing may occur as a result of tension cracks, as illustrated below.

FIGURE 5:2-2. SLIDING.



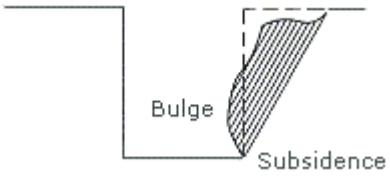
C. **TOPPLING**. In addition to sliding, tension cracks can cause toppling. Toppling occurs when the trench's vertical face shears along the tension crack line and topples into the excavation.

FIGURE 5:2-3. TOPPLING.



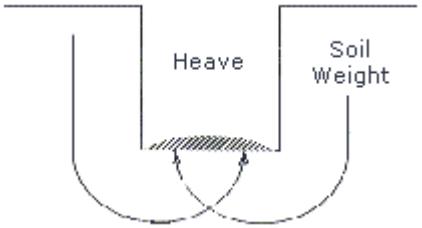
D. **SUBSIDENCE AND BULGING**. An unsupported excavation can create an unbalanced stress in the soil, which, in turn, causes subsidence at the surface and bulging of the vertical face of the trench. If uncorrected, this condition can cause face failure and entrapment of workers in the trench.

FIGURE 5:2-4. SUBSIDENCE AND BULGING.



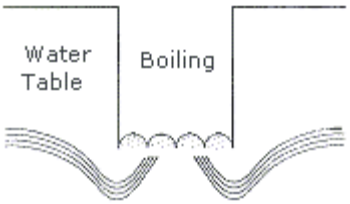
E. **HEAVING OR SQUEEZING**. Bottom heaving or squeezing is caused by the downward pressure created by the weight of adjoining soil. This pressure causes a bulge in the bottom of the cut, as illustrated in the drawing above. Heaving and squeezing can occur even when shoring or shielding has been properly installed.

FIGURE 5:2-5. HEAVING OR SQUEEZING.



F. **BOILING** is evidenced by an upward water flow into the bottom of the cut. A high water table is one of the causes of boiling. Boiling produces a "quick" condition in the bottom of the cut, and can occur even when shoring or trench boxes are used.

FIGURE 5:2-6. BOILING.



G. **UNIT WEIGHT OF SOILS** refers to the weight of one unit of a particular soil. The weight of soil varies with type and moisture content. One cubic foot of soil can weigh from 110 pounds to 140 pounds or more, and one cubic meter (35.3 cubic feet) of soil can weigh more than 3,000 pounds.

IV. DETERMINATION OF SOIL TYPE.

OSHA categorizes soil and rock deposits into four types, A through D, as follows:

A. **STABLE ROCK** is natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. It is usually identified by a rock name such as granite or

sandstone. Determining whether a deposit is of this type may be difficult unless it is known whether cracks exist and whether or not the cracks run into or away from the excavation.

B. **TYPE A SOILS** are cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater. Examples of Type A cohesive soils are often: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. (No soil is Type A if it is fissured, is subject to vibration of any type, has previously been disturbed, is part of a sloped, layered system where the layers dip into the excavation on a slope of 4 horizontal to 1 vertical (4H:1V) or greater, or has seeping water.

C. **TYPE B SOILS** are cohesive soils with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa). Examples of other Type B soils are: angular gravel; silt; silt loam; previously disturbed soils unless otherwise classified as Type C; soils that meet the unconfined compressive strength or cementation requirements of Type A soils but are fissured or subject to vibration; dry unstable rock; and layered systems sloping into the trench at a slope less than 4H:1V (only if the material would be classified as a Type B soil).

D. **TYPE C SOILS** are cohesive soils with an unconfined compressive strength of 0.5 tsf (48 kPa) or less. Other Type C soils include granular soils such as gravel, sand and loamy sand, submerged soil, soil from which water is freely seeping, and submerged rock that is not stable. Also included in this classification is material in a sloped, layered system where the layers dip into the excavation or have a slope of four horizontal to one vertical (4H:1V) or greater.

E. **LAYERED GEOLOGICAL STRATA**. Where soils are configured in layers, i.e., where a layered geologic structure exists, the soil must be classified on the basis of the soil classification of the weakest soil layer. Each layer may be classified individually if a more stable layer lies below a less stable layer, i.e., where a Type C soil rests on top of stable rock.

V. TEST EQUIPMENT AND METHODS FOR EVALUATING SOIL TYPE.

Many kinds of equipment and methods are used to determine the type of soil prevailing in an area, as described below.

A. **POCKET PENETROMETER**. Penetrometers are direct-reading, spring-operated instruments used to determine the unconfined compressive strength of saturated cohesive soils. Once pushed into the soil, an indicator sleeve displays the reading. The instrument is calibrated in either tons per square foot (tsf) or kilograms per square centimeter (kPa). However, Penetrometers have error rates in the range of ± 20-40%.

1. **Shearvane (Torvane)**. To determine the unconfined compressive strength of the soil with a shearvane, the blades of the vane are pressed into a level section of undisturbed soil, and the torsional knob is slowly turned until soil failure occurs. The direct instrument reading must be multiplied by 2 to provide results in tons per square foot (tsf) or kilograms per square centimeter (kPa).

2. **Thumb Penetration Test**. The thumb penetration procedure involves an attempt to press the thumb firmly into the soil in question. If the thumb makes an indentation in the soil only with great difficulty, the soil is probably Type A. If the thumb penetrates no further than the length of the thumb nail, it is probably Type B soil, and if the thumb penetrates the full length of the thumb, it is Type C soil. The thumb test is subjective and is therefore the least accurate of the three methods.

3. **Dry Strength Test**. Dry soil that crumbles freely or with moderate pressure into

individual grains is granular. Dry soil that falls into clumps that subsequently break into smaller clumps (and the smaller clumps can be broken only with difficulty) is probably clay in combination with gravel, sand, or silt. If the soil breaks into clumps that do not break into smaller clumps (and the soil can be broken only with difficulty), the soil is considered unfissured unless there is visual indication of fissuring.

B. **PLASTICITY OR WET THREAD TEST**. This test is conducted by molding a moist sample of the soil into a ball and attempting to roll it into a thin thread approximately 1/8 inch (3 mm) in diameter (thick) by 2 inches (50 mm) in length. The soil sample is held by one end. If the sample does not break or tear, the soil is considered cohesive.

C. **VISUAL TEST**. A visual test is a qualitative evaluation of conditions around the site. In a visual test, the entire excavation site is observed, including the soil adjacent to the site and the soil being excavated. If the soil remains in clumps, it is cohesive; if it appears to be coarse-grained sand or gravel, it is considered granular. The evaluator also checks for any signs of vibration.

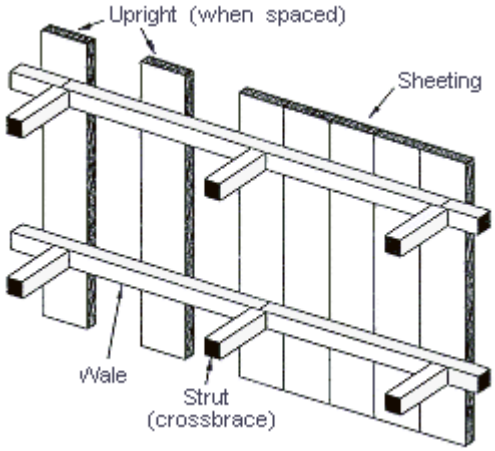
During a visual test, the evaluator should check for crack-line openings along the failure zone that would indicate tension cracks, look for existing utilities that indicate that the soil has previously been disturbed, and observe the open side of the excavation for indications of layered geologic structuring.

The evaluator should also look for signs of bulging, boiling, or sluffing, as well as for signs of surface water seeping from the sides of the excavation or from the water table. If there is standing water in the cut, the evaluator should check for "quick" conditions (see Paragraph III. F. in this chapter). In addition, the area adjacent to the excavation should be checked for signs of foundations or other intrusions into the failure zone, and the evaluator should check for surcharging and the spoil distance from the edge of the excavation.

VI. SHORING TYPES.

Shoring is the provision of a support system for trench faces used to prevent movement of soil, underground utilities, roadways, and foundations. Shoring or shielding is used when the location or depth of the cut makes sloping back to the maximum allowable slope impractical. Shoring systems consist of posts, wales, struts, and sheeting. There are two basic types of shoring, timber and aluminum hydraulic.

FIGURE V:2-7. TIMBER SHORING.



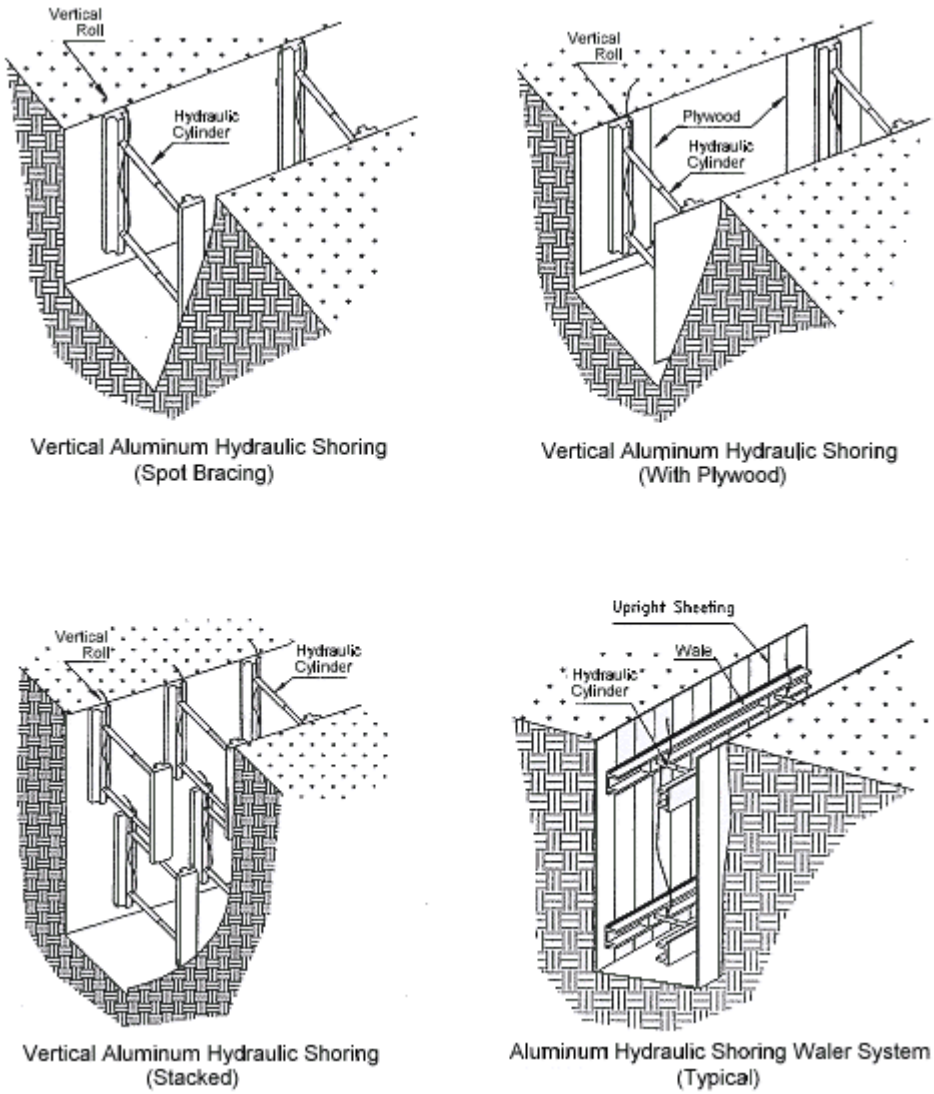
A. **HYDRAULIC SHORING**. The trend today is toward the use of hydraulic shoring, a prefabricated

strut and/or wale system manufactured of aluminum or steel. Hydraulic shoring provides a critical safety advantage over timber shoring because workers do not have to enter the trench to install or remove hydraulic shoring. Other advantages of most hydraulic systems are that they:

- Are light enough to be installed by one worker;
- Are gauge-regulated to ensure even distribution of pressure along the trench line;
- Can have their trench faces "preloaded" to use the soil's natural cohesion to prevent movement; and
- Can be adapted easily to various trench depths and widths.

All shoring should be installed from the top down and removed from the bottom up. Hydraulic shoring should be checked at least once per shift for leaking hoses and/or cylinders, broken connections, cracked nipples, bent bases, and any other damaged or defective parts.

FIGURE V:2-8. SHORING VARIATIONS: TYPICAL ALUMINUM HYDRAULIC SHORING INSTALLATIONS.



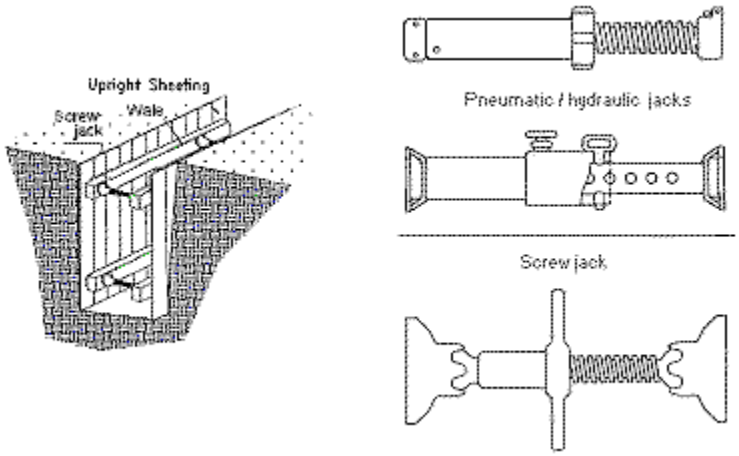
B. **PNEUMATIC SHORING** works in a manner similar to hydraulic shoring. The primary difference is that pneumatic shoring uses air pressure in place of hydraulic pressure. A disadvantage to the use of pneumatic shoring is that an air compressor must be on site.

1. **Screw Jacks**. **Screw** jack systems differ from hydraulic and pneumatic systems in that the struts of a screw jack system must be adjusted manually. This creates a hazard because the worker is required to be in the trench in order to adjust the strut. In addition, uniform "preloading" cannot be achieved with screw jacks, and their weight creates handling difficulties.

2. Single-Cylinder Hydraulic Shores. Shores of this type are generally used in a water system, as an assist to timber shoring systems, and in shallow trenches where face stability is required.

3. Underpinning. This process involves stabilizing adjacent structures, foundations, and other intrusions that may have an impact on the excavation. As the term indicates, underpinning is a procedure in which the foundation is physically reinforced. Underpinning should be conducted only under the direction and with the approval of a registered professional engineer.

FIGURE V:2-9. SHORING VARIATIONS.



IV. **SHIELDING TYPES**.

B. **TRENCH BOXES** are different from shoring because, instead of shoring up or otherwise supporting the trench face, they are intended primarily to protect workers from cave-ins and similar incidents. The excavated area between the outside of the trench box and the face of the trench should be as small as possible. The space between the trench boxes and the excavation side are backfilled to prevent lateral movement of the box. Shields may not be subjected to loads exceeding those which the system was designed to withstand.

FIGURE V:2-10. TRENCH SHIELD.

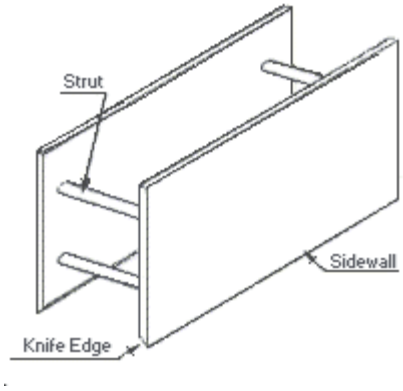
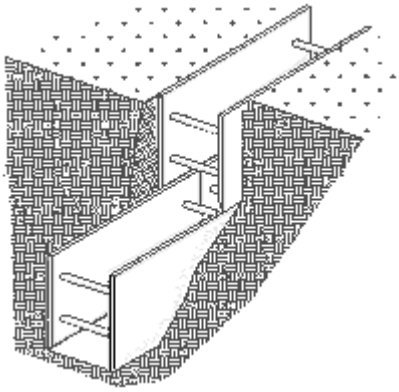


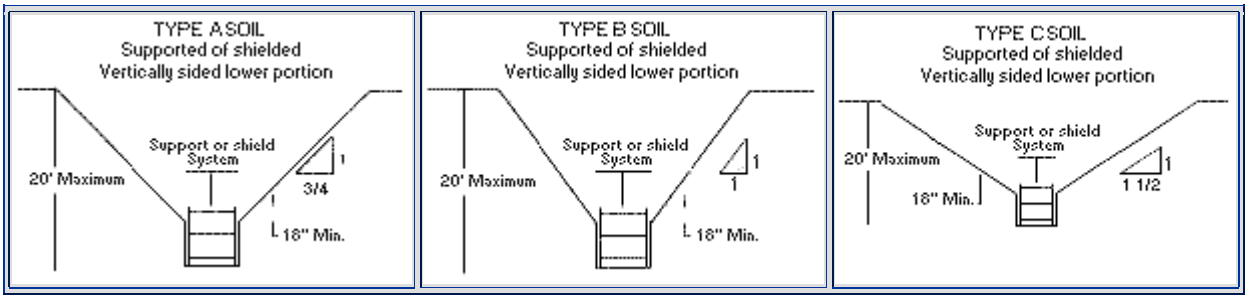
FIGURE V:2-11. TRENCH SHIELD, STACKED.



B. **COMBINED USE**. Trench boxes are generally used in open areas, but they also may be used in combination with sloping and benching. The box should extend at least 18 in (0.45 m) above the surrounding area if there is sloping toward excavation. This can be accomplished by providing a benched area adjacent to the box.

Earth excavation to a depth of 2 ft (0.61 m) below the shield is permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench and there are no indications while the trench is open of possible loss of soil from behind or below the bottom of the support system. Conditions of this type require observation on the effects of bulging, heaving, and boiling as well as surcharging, vibration, adjacent structures, etc., on excavating below the bottom of a shield. Careful visual inspection of the conditions mentioned above is the primary and most prudent approach to hazard identification and control.

FIGURE V:2-12. SLOPE AND SHIELD CONFIGURATIONS.



VIII. SLOPING AND BENCHING.

A. **SLOPING**. Maximum allowable slopes for excavations less than 20 ft (6.09 m) based on soil type and angle to the horizontal are as follows:

TABLE V:2-1. ALLOWABLE SLOPES.

Soil type	Height/Depth ratio	Slope angle
Stable Rock	Vertical	90°
Type A	¾:1	53°
Type B	1:1	45°
Type C	1½:1	34°
Type A (short-term)	½:1	63°
(For a maximum excavation depth of 12 ft)		

FIGURE V:2-13. SLOPE CONFIGURATIONS: EXCAVATIONS IN LAYERED SOILS.

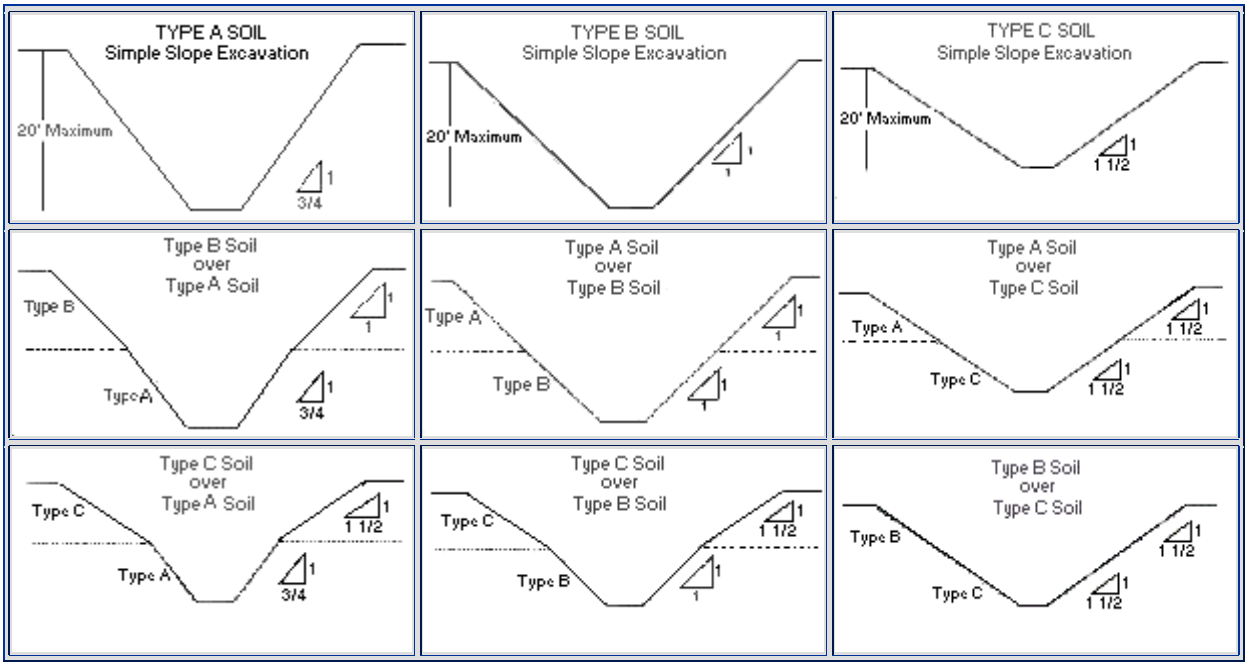
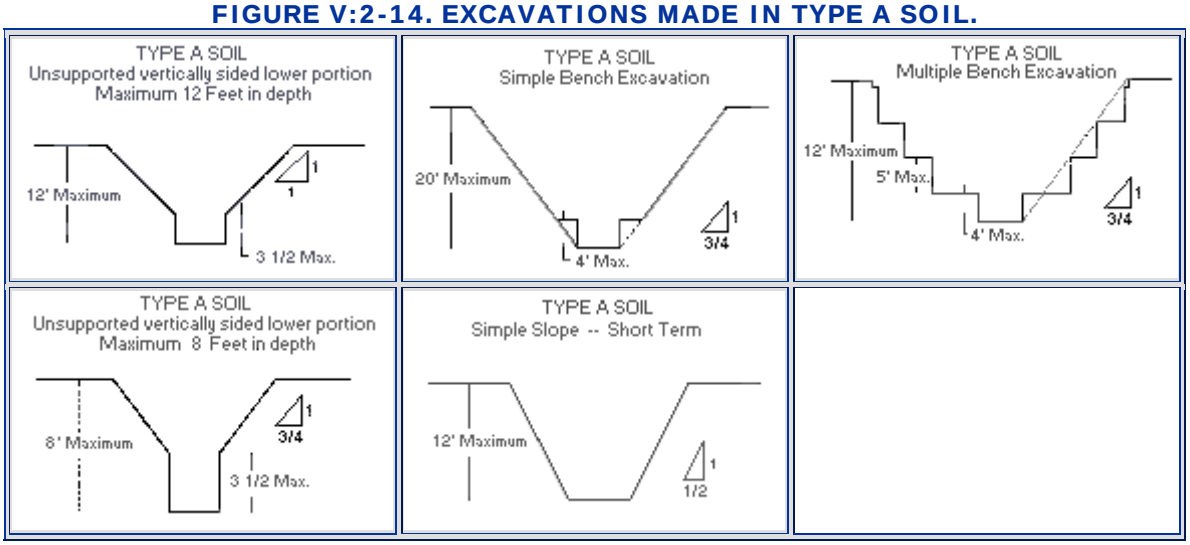


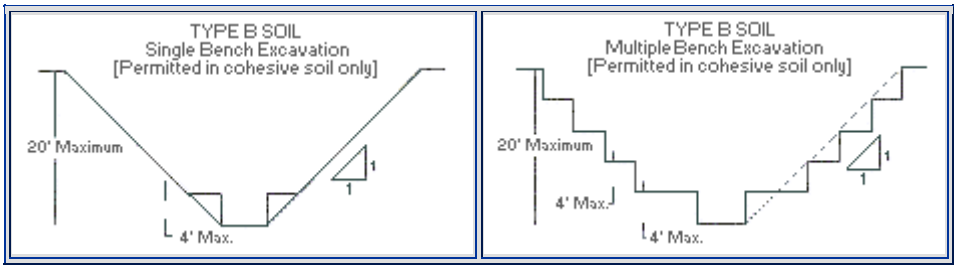
FIGURE V:2-14. EXCAVATIONS MADE IN TYPE A SOIL.



B. **BENCHING.** There are two basic types of benching, simple and multiple. The type of soil determines the horizontal to vertical ratio of the benched side.

As a general rule, the bottom vertical height of the trench must not exceed 4 ft (1.2 m) for the first bench. Subsequent benches may be up to a maximum of 5 ft (1.5 m) vertical in Type A soil and 4 ft (1.2 m) in Type B soil to a total trench depth of 20 ft (6.0 m). All subsequent benches must be below the maximum allowable slope for that soil type. For Type B soil the trench excavation is permitted in cohesive soil only.

FIGURE V:2-15. EXCAVATIONS MADE IN TYPE B SOIL.



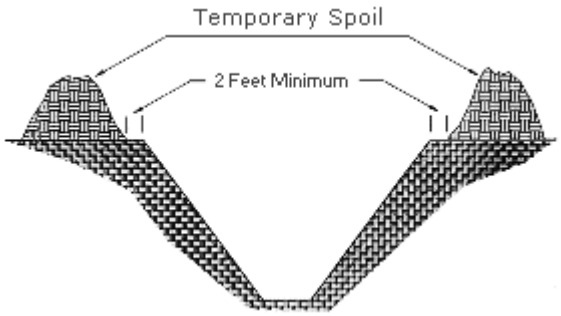
IX. **SPOIL**.

A. **TEMPORARY SPOIL**. Temporary spoil must be placed no closer than 2 ft (0.61 m) from the surface edge of the excavation, measured from the nearest base of the spoil to the cut. This distance should not be measured from the crown of the spoil deposit. This distance requirement ensures that loose rock or soil from the temporary spoil will not fall on employees in the trench.

Spoil should be placed so that it channels rainwater and other run-off water away from the excavation. Spoil should be placed so that it cannot accidentally run, slide, or fall back into the

excavation.

FIGURE V:2-16. TEMPORARY SPOIL.



B. **PERMANENT SPOIL**. Permanent spoil should be placed at some distance from the excavation. Permanent spoil is often created where underpasses are built or utilities are buried. The improper placement of permanent spoil, i.e. insufficient distance from the working excavation, can cause an excavation to be out of compliance with the horizontal-to-vertical ratio requirement for a particular excavation. This can usually be determined through visual observation. Permanent spoil can change undisturbed soil to disturbed soil and dramatically alter slope requirements.

X. SPECIAL HEALTH AND SAFETY CONSIDERATIONS.

A. **COMPETENT PERSON**. The designated competent person should have and be able to demonstrate the following:

- Training, experience, and knowledge of:
  - soil analysis;
  - use of protective systems; and
  - requirements of 29 CFR Part 1926 Subpart P.
- Ability to detect:
  - conditions that could result in cave-ins;
  - failures in protective systems;
  - hazardous atmospheres; and
  - other hazards including those associated with confined spaces.
- Authority to take prompt corrective measures to eliminate existing and predictable hazards and to stop work when required.

B. **SURFACE CROSSING OF TRENCHES**. Surface crossing of trenches should be discouraged; however, if trenches must be crossed, such crossings are permitted only under the following conditions:

- Vehicle crossings must be designed by and installed under the supervision of a registered professional engineer.
- Walkways or bridges must be provided for foot traffic. These structures shall:
  - have a safety factor of 4;
  - have a minimum clear width of 20 in (0.51 m);

- be fitted with standard rails; and
- extend a minimum of 24 in (.61 m) past the surface edge of the trench.

C. **INGRESS AND EGRESS**. Access to and exit from the trench require the following conditions:

- Trenches 4 ft or more in depth should be provided with a fixed means of egress.
- Spacing between ladders or other means of egress must be such that a worker will not have to travel more than 25 ft laterally to the nearest means of egress.
- Ladders must be secured and extend a minimum of 36 in (0.9 m) above the landing.
- Metal ladders should be used with caution, particularly when electric utilities are present.

D. **EXPOSURE TO VEHICLES**. Procedures to protect employees from being injured or killed by vehicle traffic include:

- Providing employees with and requiring them to wear warning vests or other suitable garments marked with or made of reflectorized or high-visibility materials.
- Requiring a designated, trained flagperson along with signs, signals, and barricades when necessary.

E. **EXPOSURE TO FALLING LOADS**. Employees must be protected from loads or objects falling from lifting or digging equipment. Procedures designed to ensure their protection include:

- Employees are not permitted to work under raised loads.
- Employees are required to stand away from equipment that is being loaded or unloaded.
- Equipment operators or truck drivers may stay in their equipment during loading and unloading if the equipment is properly equipped with a cab shield or adequate canopy.

F. **WARNING SYSTEMS FOR MOBILE EQUIPMENT**. The following steps should be taken to prevent vehicles from accidentally falling into the trench:

- Barricades must be installed where necessary.
- Hand or mechanical signals must be used as required.
- Stop logs must be installed if there is a danger of vehicles falling into the trench.
- Soil should be graded away from the excavation; this will assist in vehicle control and channeling of run-off water.

G. **HAZARDOUS ATMOSPHERES AND CONFINED SPACES**. Employees shall not be permitted to work in hazardous and/or toxic atmospheres. Such atmospheres include those with:

- Less than 19.5% or more than 23.5% oxygen;
- A combustible gas concentration greater than 20% of the lower flammable limit; and
- Concentrations of hazardous substances that exceed those specified in the *Threshold Limit Values for Airborne Contaminants* established by the ACGIH (American Conference of Governmental Industrial Hygienists).

All operations involving such atmospheres must be conducted in accordance with OSHA requirements for occupational health and environmental controls (see Subpart D of 29 CPR 1926) for personal protective equipment and for lifesaving equipment (see Subpart E, 29 CFR 1926). Engineering controls (e.g., ventilation) and respiratory protection may be required.

When testing for atmospheric contaminants, the following should be considered:

- Testing should be conducted before employees enter the trench and should be done regularly to ensure that the trench remains safe.
- The frequency of testing should be increased if equipment is operating in the trench.
- Testing frequency should also be increased if welding, cutting, or burning is done in the trench.

Employees required to wear respiratory protection must be trained, fit-tested, and enrolled in a respiratory protection program. Some trenches qualify as confined spaces. When this occurs, compliance with the Confined Space Standard is also required.

H. **EMERGENCY RESCUE EQUIPMENT**. Emergency rescue equipment is required when a hazardous atmosphere exists or can reasonably be expected to exist. Requirements are as follows:

- Respirators must be of the type suitable for the exposure. Employees must be trained in their use and a respirator program must be instituted.
- Attended (at all times) lifelines must be provided when employees enter bell-bottom pier holes, deep confined spaces, or other similar hazards.
- Employees who enter confined spaces must be trained.

I. **STANDING WATER AND WATER ACCUMULATION**. Methods for controlling standing water and water accumulation must be provided and should consist of the following if employees are permitted to work in the excavation:

- Use of special support or shield systems approved by a registered professional engineer.
- Water removal equipment, i.e. well pointing, used and monitored by a competent person.
- Safety harnesses and lifelines used in conformance with 29 CFR 1926.104.
- Surface water diverted away from the trench.
- Employees removed from the trench during rainstorms.
- Trenches carefully inspected by a competent person after each rain and before employees are permitted to re-enter the trench.

J. **INSPECTIONS**. Inspections shall be made by a competent person and should be documented. The following guide specifies the frequency and conditions requiring inspections:

- Daily and before the start of each shift;
- As dictated by the work being done in the trench;
- After every rainstorm;
- After other events that could increase hazards, e.g. snowstorm, windstorm, thaw, earthquake, etc.;
- When fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom, or other similar conditions occur;
- When there is a change in the size, location, or placement of the spoil pile; and
- When there is any indication of change or movement in adjacent structures.

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APPENDIX V: 2-1. SITE ASSESSMENT QUESTIONS

During first and subsequent visits to a construction or facility maintenance location, the compliance officer (or the site's safety officer or other competent person) may find the following questions useful.

1. Is the cut, cavity, or depression a *trench* or an *excavation*?
2. Is the cut, cavity, or depression more than 4 ft (1.2 m) in *depth*?
3. Is there *water* in the cut, cavity, or depression?
4. Are there adequate means of *access* and *egress*?
5. Are there any *surface encumbrances*?
6. Is there exposure to *vehicular traffic*?
7. Are *adjacent structures stabilized*?

8. Does *mobile equipment* have a *warning system*?

9. Is a *competent person in charge* of the operation?

10. Is *equipment operating* in or around the cut, cavity, or depression?

11. Are procedures required to monitor, test, and *control hazardous atmospheres*?

12. Does a competent person *determine soil type*?

13. Was a *soil testing device* used to determine soil type?

14. Is the *spoil* placed 2 ft (0.6 m) or *more from the edge* of the cut, cavity, or depression?

15. Is the *depth* 20 ft (6.1 m) *or more* for the cut, cavity, or depression?

16. Has a *registered professional engineer* approved the procedure if the depth is more than 20 ft (6.1 m)?

17. Does the procedure require *benching* or *multiple benching*? *Shoring*? *Shielding*?

18. If provided, *do shields extend at least 18 in (0.5 m) above* the surrounding area if it is sloped toward the excavation?

19. If shields are used, is the depth of the cut *more than 2 ft (0.6 m) below the bottom of the shield*?

20. Are any required *surface crossings* of the cut, cavity, or depression the *proper width and fitted with hand rails*?

21. Are means of *egress* from the cut, cavity, or depression *no more than 25 ft (7.6m) from the work*?

22. Is *emergency rescue equipment* required?

23. Is there *documentation of the minimum daily excavation inspection*?

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APPENDIX C

ARCHAEOLOGICAL MONITORING PLAN

Plan for Monitoring the Removal of Contaminated Soils and Data Recovery for Selected Features at the Fort Lowell-Adkins Steel Property, Tucson, Pima County, Arizona

J. Homer Thiel

Reviewed by

Patricia Castalia
Desert Archaeology, Inc.
3975 N. Tucson Boulevard
Tucson, Arizona 85716

Submitted to

City of Tucson
P.O. Box 27210
Tucson, Arizona 85726-7210

Desert Archaeology, Inc.
3975 N. Tucson Blvd., Tucson, AZ 85716 ● 6 May 2011

COMPLIANCE SUMMARY

Date: 6 May 2011

Report Title: Plan for Monitoring the Removal of Contaminated Soils and Data Recovery for Selected Features at the Fort Lowell-Adkins Steel Property, Tucson, Pima County, Arizona

Client: City of Tucson

Client Project Name: Fort Lowell Contaminated Soil Removal and Archaeological Data Recovery

Compliance Agency: City of Tucson

Compliance Level: Local

Applicable Laws/Regulations:

State: Arizona Historic Preservation Act; State Burial Act(s), ARS 41-844 and ARS 41-865
Local: City of Tucson Resolution No. 12443 (1983); City of Tucson Administrative Directive "Protection of Archaeological and Historical Resources in City Projects" (1995, updated 2005)

Applicable Permits: Arizona Antiquities Act Project Specific Permit, Arizona State Museum

Tribal Consultation: Area tribes will be consulted for an Arizona State Museum Burial Agreement

Project Description: Monitoring the removal of contaminated soils within the Fort Lowell-Adkins Steel parcel at historic Fort Lowell. Data recovery will take place for selected features to recover data to address research questions

Final Disposition of project artifacts, field notes, data, and records: All project materials will be curated at the Arizona State Museum

Location:

Land Ownership: City of Tucson
County: Pima
Description: Sections 35 and 36, Township 13 South, Range 14 East on the USGS 7.5 minute topographic quad Tucson North, Arizona (AZ BB:9 [SW]).

Area of Potential Effect: The APE for the project includes the entire Adkins parcel and contains standing historic structures and buildings relating to historic Fort Lowell and archaeological deposits (prehistoric or historical)

Number of Surveyed Acres: N/A

Number of Sites: 2

List of Register-Eligible Properties: Historic Fort Lowell (AZ BB:9:40 [ASM]) and the Hardy Site (AZ BB:9:14 [ASM]). These were included in the Fort Lowell Multiple Resource Area, which was listed on the National Register on 10 April 1978.

List of Register-Ineligible Properties: 0

Summary of Results: Fort Lowell Park contains cultural resources dating to the Prehistoric and Historic eras.

Recommendations: It is recommended that the monitoring and discovery plan outlined in this report be carried out. Removal of contaminated soils will be monitored to ensure that any resources present are documented and preserved in place. A small number of features will be excavated and/or sampled to collect data to address research questions about the prehistoric and historic period use of the area.

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PLAN FOR MONITORING THE REMOVAL OF CONTAMINATED SOILS AND DATA RECOVERY FOR SELECTED FEATURES AT THE FORT LOWELL-ADKINS STEEL PROPERTY, TUCSON, PIMA COUNTY, ARIZONA

INTRODUCTION

The City of Tucson is planning to remove contaminated soils at the Fort Lowell-Adkins Steel property. This action followed the City of Tucson's (City) acquisition of the last remaining major portion of historic Fort Lowell. The Master Plan for the park as a whole was completed in 2009 (Poster-Frost 2009). Among its recommendations were that a number of post-fort buildings and structures be removed from the Fort Lowell-Adkins Steel property. The City's environmental consultant recommended removal of contaminated soils based upon site investigation. The City has received an Environmental Protection Agency Brownfields Cleanup Grant to remediate this site.

Desert Archaeology participated in the Master Planning process through the preparation of two reports that documented the historical and archaeological resources of the park, as well as archaeological surveys of all City-owned parcels (Thiel and Theriot 2008; Thiel 2009). Desert Archaeology was also contracted to monitor stabilization work for Officer's Quarters No. 2 and the adjoining kitchen, and to prepare a plan for demolition monitoring for non-contributing buildings and structures (Thiel 2010). The current project expands the monitoring work to include the removal of contaminated soils on the property. In addition, a select number of features will be sampled and/or excavated to recover materials to address three research questions. All of the previous work has been conducted for Pima County under Desert Archaeology's project specific Arizona Antiquities Act permit (No. 2007-139ps). A new permit will be requested for the soil remediation effort under contract to the City of Tucson.

This Monitoring and Data Recovery Plan includes a brief cultural history of the Tucson Basin, a brief history of the use of the Fort Lowell- Adkins Steel Property during the historic period, archaeological background, a research design, a work plan for the excavation and treatment of any subsurface remains located during the monitoring project, and a plan for the treatment of human burials and/or associated burial goods.

PROJECT LOCATION AND CULTURAL BACKGROUND

The Fort Lowell area has been occupied for over 1,000 years. Humans were drawn to the area due to the presence of water in the Rillito and the plantlife and animals present in the vicinity.

Project Area Location

The Fort Lowell-Adkins Steel property is located at the southwest corner of North Craycroft Road and East Fort Lowell Road. More specifically, it in is Sections 35 and 36, Township 13South, Range 14 East on the USGS 7.5 minute topographic quad Tucson North, Arizona (AZ BB:9 [SW]) (Figure 1). Pima County Assessor's Parcel numbers for the project area are 110-09-0350, 110-09-0340, 110-09-032A, 110-09-032B, and 110-09-0330.

The current project consists of the removal of soils contaminated by hydrocarbons, metals, and other substances as identified by an environmental site investigation performed by the City's environmental consultant, SCS Engineers. It is expected that between .5-2 ft (13-60 cm) of soil will be removed from contaminated areas.

The Area of Potential Effect (APE) for the project is the Fort Lowell-Adkins Steel Property, which include standing buildings and ruins dating to the Fort Lowell era (1873-1891), and the subsequent Territorial and Statehood periods use of the property as a sanatorium and steel tank fabrication facility (Figures 2 and 3). Prehistoric and historic era archaeological resources are likely to be present and probably extend into adjacent parcels.

Environmental Setting

The project area is located within the eastern portion of the Tucson Basin, a short distance south of the Rillito River and immediately west of Pantano Wash. Much of the surrounding area is now covered by residential housing, but it once supported vegetation typical of the Arizona Uplands subdivision of the Sonoran Desert Scrub series (Hansen 1996). Spicer (2004) recently prepared a lengthy list of plants and wildlife present in the Fort Lowell area during historic and modern times. In 1895 the area around the fort was described as: "On the south, the great plain of Tucson, bare or covered with brushy *Larrea* or mesquite, stretches away for scores of miles; on the north rise gravelly hills which slope up to the mountains. These hills are covered with giant cacti and other desert shrubs. Along the bed of the Rillito grow cottonwood, willow, mesquite, walnut and ash trees (Price 1895:197).

The elevation of the project area averages approximately 2,390 ft above sea level. The area slopes downward to the north and, during times of heavy precipitation, water runs across the Fort Lowell Park area in broad sheets towards the Rillito.

Portions of the project area, with Fort Lowell Park, have been heavily disturbed by the construction of roads and recreational facilities. Much of this work took place in the 1960s and 1970s, prior to the enactment of the cultural resource ordinance by the City of Tucson. The depth of ground disturbance is not known and there is a possibility that intact cultural resources may be present beneath existing roads, parking lots, and facilities. Other areas have seen less disturbance, including the Quartermaster and Commissary Storehouse Property and the Donaldson/Hardy parcels, and the likelihood of undisturbed subsurface cultural resources is much higher in these areas.

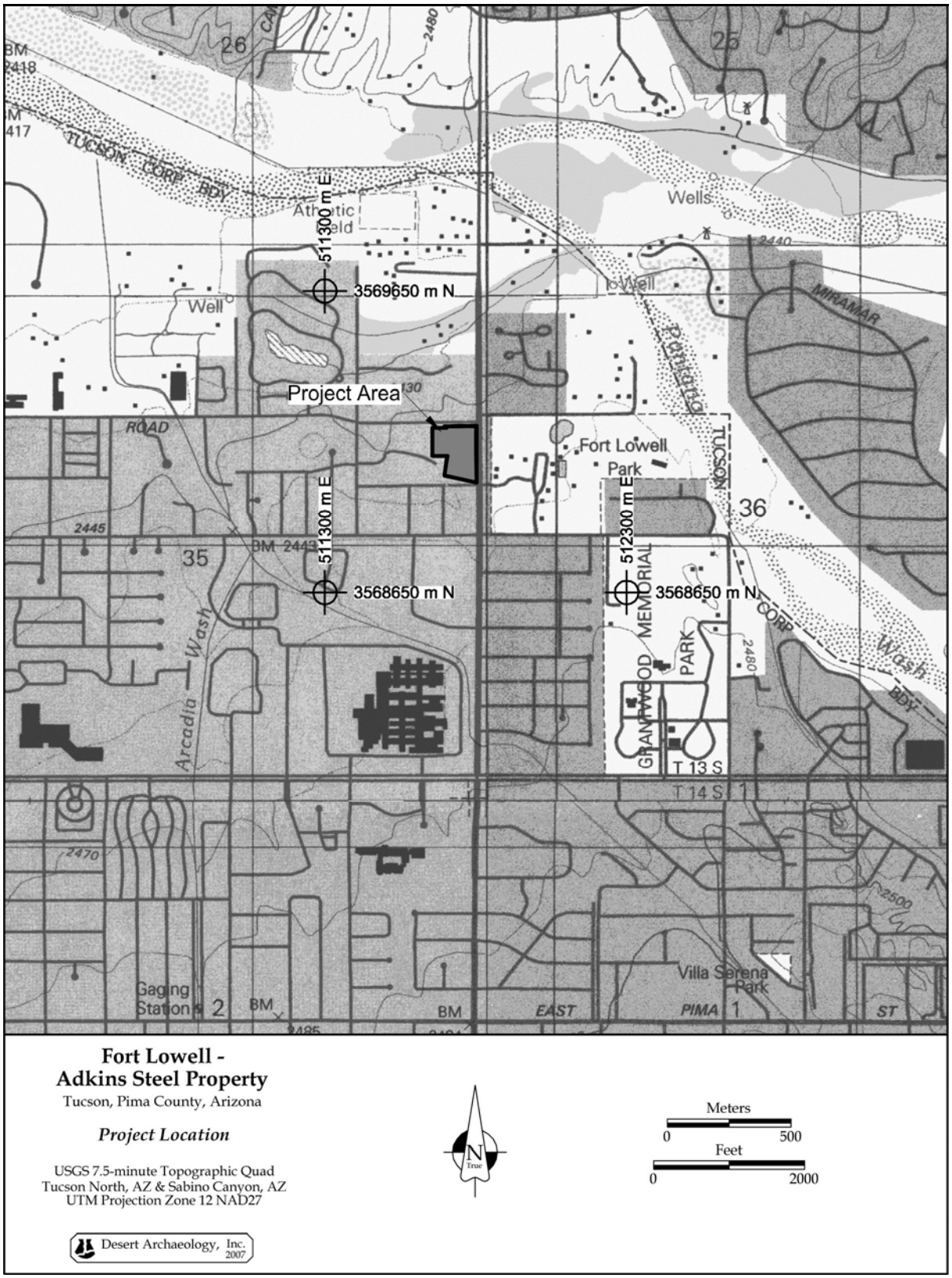

Figure 1. Reproduction of USGS 7.5-minute topographic quads Tucson North and Sabino Canyon, Ariz., showing location of project area.

Figure 2. The Area of Potential Effect at the Fort Lowell-Adkins Steel property.

Figure 3a. Fort Lowell-Adkins Steel property, looking south, on 22 March 2011.

Figure 3b. Fort Lowell-Adkins Steel property, looking west toward Officer Quarters 3 and 2, taken on 22 March 2011.

CULTURAL BACKGROUND OF THE PROJECT AREA

The history of the Southwest and of the Tucson Basin is marked by a close relationship between people and the natural environment. Environmental conditions have strongly influenced subsistence practices and social organization, and social and cultural changes have, in turn, made it possible to more efficiently exploit environmental resources. Through time, specialized adaptations to the arid region distinguished people living in the Southwest from those in other areas. Development of cultural and social conventions also became regionally specific, and by A.D. 650, groups living in the Tucson Basin can be readily differentiated from those living in other areas of the Southwest. Today, the harsh desert climate no longer isolates Tucson and its inhabitants, but life remains closely tied to the unique resources of the Southwest. The chronology of the Tucson Basin is summarized in Table 1.

Table 1. Periods, phases, and chronology of the Santa Cruz Valley-Tucson Basin.

Periods	Phases	Date Ranges
Historic		
American Statehood		A.D. 1912-present
American Territorial		A.D. 1856-1912
Spanish and Mexican		A.D. 1694-1856
Protohistoric		A.D. 1450-1694
Hohokam Classic	Tucson	A.D. 1300-1450
	Tanque Verde	A.D. 1150-1300
Hohokam Sedentary	Late Rincon	A.D. 1100-1150
	Middle Rincon	A.D. 1000-1100
	Early Rincon	A.D. 950-1000
Hohokam Colonial	Rillito	A.D. 850-950
	Cañada del Oro	A.D. 750-850
Hohokam Pioneer	Snaketown	A.D. 650/700-750
	Tortolita	A.D. 500-650/700
Early Ceramic	Late Agua Caliente	A.D. 350-475
	Early Agua Caliente	A.D. 50-350
Early Agricultural	Late Cienega	400 B.C.-A.D. 50
	Early Cienega	800-400 B.C.
	San Pedro	1200-800 B.C.
	(Unnamed)	2100-1200 B.C.
Archaic	Chiricahua	3500-2100 B.C.
	(Occupation gap?)	6500-3500 B.C.
	Sulphur Springs-Ventana	7500-6500 B.C.
Paleoindian		11,500?-7500 B.C.

Paleoindian Period (11,500?-7500 B.C.)

Archaeological investigations suggest the Tucson Basin was initially occupied some 13,000 years ago, a time much wetter and cooler than today. The Paleoindian period is characterized by small, mobile groups of hunter-gatherers who briefly occupied temporary campsites as they moved across the countryside in search of food and other resources (Cordell 1997:67). The hunting of large mammals, such as mammoth and bison, was a particular focus of the subsistence economy. A Clovis point characteristic of the Paleoindian

period (circa 9500 B.C.) was collected from the Valencia site, located along the Santa Cruz River in the southern Tucson Basin (Doelle 1985:183-184). Another Paleoindian point was found in Rattlesnake Pass, in the northern Tucson Basin (Huckell 1982). These rare finds suggest prehistoric use of the Tucson area probably began at this time. Paleoindian use of the Tucson Basin is supported by archaeological investigations in the nearby San Pedro Valley and elsewhere in southern Arizona, where Clovis points have been discovered in association with extinct mammoth and bison remains (Huckell 1993, 1995). However, because Paleoindian sites have yet to be found in the Tucson Basin, the extent and intensity of this occupation are unknown.

Archaic Period (7500-2100 B.C.)

The transition from the Paleoindian period to the Archaic period was accompanied by marked climatic changes. During this time, the environment came to look much like it does today. Archaic period groups pursued a mixed subsistence strategy, characterized by intensive wild plant gathering and the hunting of small animals. The only Early Archaic period (7500-6500 B.C.) site known from the Tucson Basin is found in Ruelas Canyon, south of the Tortolita Mountains (Swartz 1998:24). However, Middle Archaic period sites dating between 3500 and 2100 B.C. are known from the bajada zone surrounding Tucson, and, to a lesser extent, from floodplain and mountain areas. Investigations conducted at Middle Archaic period sites include excavations along the Santa Cruz River (Gregory, ed. 1999), in the northern Tucson Basin (Roth 1989), at the La Paloma development (Dart 1986), and along Ventana Canyon Wash and Sabino Creek (Dart 1984; Douglas and Craig 1986). Archaic period sites in the Santa Cruz floodplain were found to be deeply buried by alluvial sediments, suggesting more of these sites are present, but undiscovered, due to the lack of surface evidence.

Early Agricultural Period (2100 B.C.-A.D. 50)

The Early Agricultural period (previously identified as the Late Archaic period) was the period when domesticated plant species were first cultivated in the Greater Southwest. The precise timing of the introduction of cultigens from Mexico is not known, although direct radiocarbon dates on maize indicate it was being cultivated in the Tucson Basin and several other parts of the Southwest by 2100 B.C. (Mabry 2008). By at least 400 B.C., groups were living in substantial agricultural settlements in the floodplain of the Santa Cruz River. Recent archaeological investigations suggest canal irrigation also began sometime during this period.

Several Early Agricultural period sites are known from the Tucson Basin and its vicinity (Diehl 1997; Ezzo and Deaver 1998; Freeman 1998; Gregory, ed. 2001; Huckell and Huckell 1984; Huckell et al. 1995; Mabry 1998, 2008; Roth 1989). While there is variability among these sites–probably due to the 2,150 years included in the period–all excavated sites to date contain small, round, or oval semisubterranean pithouses, many with large internal storage pits. At some sites, a larger round structure is also present, which is thought to be for communal or ritual purposes.

Stylistically distinctive Cienega, Cortaro, and San Pedro type projectile points are common at Early Agricultural sites, as are a range of ground stone and flaked stone tools, ornaments, and shell jewelry (Diehl 1997; Mabry 1998). The fact that shell and some of the material used for stone tools and ornaments were not locally available in the Tucson area suggests trade networks were operating. Agriculture, particularly the cultivation of corn, was important in the diet and increased in importance through time. However, gathered wild plants–such as tansy mustard and amaranth seeds, mesquite seeds and pods, and agave hearts–were also frequently used resources. As in the preceding Archaic period, the hunting of animals such as deer, cottontail rabbits, and jackrabbits, continued to provide an important source of protein.

Early Ceramic Period (A.D. 50-500)

Although ceramic artifacts, including figurines and crude pottery, were first produced in the Tucson Basin during the Early Agricultural period (Heidke and Ferg 2001; Heidke et al. 1998), the widespread use of ceramic containers marks the transition to the Early Ceramic period (Huckell 1993). Undecorated plain ware pottery was widely used in the Tucson Basin by about A.D. 50, marking the start of the early Agua Caliente phase (A.D. 50-350).

Architectural features became more formalized and substantial during the Early Ceramic period, representing a greater investment of effort in construction, and perhaps more permanent settlement. A number of pithouse styles are present, including small, round, and basin-shaped houses, as well as slightly larger subrectangular structures. As during the Early Agricultural period, a class of significantly larger structures may have functioned in a communal or ritual manner.

Reliance on agricultural crops continued to increase, and a wide variety of cultigens–including maize, beans, squash, cotton, and agave–were an integral part of the subsistence economy. Populations grew as farmers expanded their crop production to floodplain land near permanently flowing streams, and it is assumed that canal irrigation systems also expanded. Evidence from archaeological excavations indicates trade in shell, turquoise, obsidian, and other materials intensified and that new trade networks developed.

Hohokam Sequence (A.D. 500-1450)

The Hohokam tradition developed in the deserts of central and southern Arizona sometime around A.D. 500 and is characterized by the introduction of red ware and decorated ceramics: red-on-buff wares in the Phoenix Basin and red-on-brown wares in the Tucson Basin (Doyel 1991; Wallace et al. 1995). Red ware pottery was introduced to the ceramic assemblage during the Tortolita phase (A.D. 500-650/700). The addition of a number of new vessel forms suggests that, by this time, ceramics were utilized for a multitude of purposes.

Through time, Hohokam artisans embellished this pottery with highly distinctive geometric figures and life forms such as birds, humans, and reptiles. The Hohokam diverged from the preceding periods in a number of other important ways: (1) pithouses were clustered into formalized courtyard groups, which, in turn, were organized into larger village segments,

each with their own roasting area and cemetery; (2) new burial practices appeared (cremation instead of inhumation) in conjunction with special artifacts associated with death rituals; (3) canal irrigation systems were expanded and, particularly in the Phoenix Basin, represented huge investments of organized labor and time; and (4) large communal or ritual features, such as ballcourts and platform mounds, were constructed at many village sites.

The Hohokam sequence is divided into the pre-Classic (A.D. 500-1150) and Classic (A.D. 1150-1450) periods. At the start of the pre-Classic, small pithouse hamlets and villages were clustered around the Santa Cruz River. However, beginning about A.D. 750, large, nucleated villages were established along the river or its major tributaries, with smaller settlements in outlying areas serving as seasonal camps for functionally specific tasks such as hunting, gathering, or limited agriculture (Doelle and Wallace 1991). At this time, large, basin-shaped features with earthen embankments, called ballcourts, were constructed at a number of the riverine villages. Although the exact function of these features is unknown, they probably served as arenas for playing a type of ball game, as well as places for holding religious ceremonies and for bringing different groups together for trade and other communal purposes (Wilcox 1991; Wilcox and Sternberg 1983).

Between A.D. 950 and 1150, Hohokam settlement in the Tucson area became even more dispersed, with people utilizing the extensive bajada zone as well as the valley floor (Doelle and Wallace 1986). An increase in population is apparent, and both functionally specific seasonal sites, as well as more permanent habitations, were now situated away from the river; however, the largest sites were still on the terraces just above the Santa Cruz. There is strong archaeological evidence for increasing specialization in ceramic manufacture at this time, with some village sites producing decorated red-on-brown ceramics for trade throughout the Tucson area (Harry 1995; Heidke 1988, 1996; Huntington 1986).

The Classic period is marked by dramatic changes in settlement patterns and possibly in social organization. Aboveground adobe compound architecture appeared for the first time, supplementing, but not replacing, the traditional semisubterranean pithouse architecture (Haury 1928; Wallace 1995). Although corn agriculture was still the primary subsistence focus, extremely large Classic period rock-pile field systems associated with the cultivation of agave have been found in both the northern and southern portions of the Tucson Basin (Doelle and Wallace 1991; Fish et al. 1992).

Platform mounds were also constructed at a number of Tucson Basin villages sometime around A.D. 1275-1300 (Gabel 1931). These features are found throughout southern and central Arizona and consist of a central structure that was deliberately filled to support an elevated room upon a platform. The function of the elevated room is unclear; some were undoubtedly used for habitation, whereas others may have been primarily ceremonial. Building a platform mound took organized and directed labor, and the mounds are believed to be symbols of a socially differentiated society (Doelle et al. 1995; Elson 1998; Fish et al. 1992; Gregory 1987).

By the time platform mounds were constructed, most smaller sites had been abandoned, and Tucson Basin settlement was largely concentrated at only a half-dozen large, aggregated communities. Recent research has suggested that aggregation and abandonment in the Tucson

area may be related to an increase in conflict and possibly warfare (Wallace and Doelle 1998). By A.D. 1450, the Hohokam tradition disappeared from the archaeological record.

Protohistoric Period (A.D. 1450-1694)

Little is known of the period from A.D. 1450, when the Hohokam disappeared from view, to A.D. 1697, when Father Kino first traveled to the Tucson Basin (Doelle and Wallace 1990). By that time, the Tohono O'odham people were living in the arid desert regions west of the Santa Cruz River, and groups that lived in the San Pedro and Santa Cruz valleys were known as the Sobaipuri (Doelle and Wallace 1990; Masse 1981). Both groups spoke the O'odham language and, according to historic accounts and archaeological investigations, lived in oval jacal surface dwellings rather than pithouses. One of the larger Sobaipuri communities was located at Bac, where the Spanish Jesuits, and later the Franciscans, constructed the mission of San Xavier del Bac (Huckell 1993; Ravesloot 1987). However, due to the paucity of historic documents and archaeological research, little can be said regarding this inadequately understood period.

Spanish and Mexican Periods (A.D. 1694-1856)

Spanish exploration of southern Arizona began at the end of the seventeenth century A.D. Early Spanish explorers in the Southwest noted the presence of Native Americans living in what is now the Tucson area. These groups comprised the largest concentration of population in southern Arizona (Doelle and Wallace 1990). In 1757, Father Bernard Middendorf arrived in the Tucson area, establishing the first local Spanish presence. Fifteen years later, the construction of the San Agustín Mission near a Native American village at the base of A-Mountain was initiated, and by 1773, a church was completed (Dobyns 1976:33).

In 1775, the site for the Presidio of Tucson was selected on the eastern margin of the Santa Cruz River floodplain. In 1776, Spanish soldiers from the older presidio at Tubac moved north to Tucson, and construction of defensive and residential structures began. The Presidio of Tucson was one of several forts built to counter the threat of Apache raiding groups who had entered the region at about the same time as the Spanish (Thiel et al. 1995; Wilcox 1981). Spanish colonists soon arrived to farm the relatively lush banks of the Santa Cruz River, to mine the surrounding hills, and to graze cattle. Many indigenous settlers were attracted to the area by the availability of Spanish products and the relative safety provided by the Presidio. The Spanish and Native American farmers grew corn, wheat, and vegetables, and cultivated fruit orchards, and the San Agustín Mission was known for its impressive gardens (Williams 1986).

In 1821, Mexico gained independence from Spain, and Mexican settlers continued farming, ranching, and mining activities in the Tucson Basin. By 1831, the San Agustín Mission had been abandoned (Elson and Doelle 1987; Hard and Doelle 1978), although settlers continued to seek the protection of the Presidio walls.

American Period (1856-Present)

Through the 1848 settlement of the Mexican-American War and the 1853 Gadsden Purchase, Mexico ceded much of the Greater Southwest to the United States, establishing the international boundary at its present location. The U.S. Army established its first outpost in Tucson in 1856 and, in 1873, founded Fort Lowell at the confluence of the Tanque Verde Creek and Pantano Wash, to guard against continued Apache raiding.

Railroads arrived in Tucson and the surrounding areas in the 1880s, opening the floodgates of Anglo-American settlement. With the surrender of Geronimo in 1886, Apache raiding ended, and the region's settlement boomed. Local industries associated with mining and manufacturing continued to fuel growth, and the railroad supplied the Santa Cruz River valley with the commodities it could not produce locally. Meanwhile, homesteaders established numerous cattle ranches in outlying areas, bringing additional residents and income to the area (Mabry et al. 1994).

By the turn of the twentieth century, municipal improvements to water and sewer service and the eventual introduction of electricity, made life in southern Arizona more hospitable. New residences and businesses continued to appear within an ever-widening perimeter around Tucson, and city limits stretched to accommodate the growing population. Tourism, the health industry, and activities centered around the University of Arizona and Davis-Monthan Air Force Base have contributed significantly to growth and development in the Tucson Basin in the twentieth century (Sonnichsen 1982).

History of Fort Lowell

Fort Lowell was established at its current location in 1873 as Camp Lowell, moving from downtown Tucson following complaints about boisterous soldiers and poor living and sanitary conditions. The fort remained in use until 1891, housing army and cavalry units, some of whom engaged Apache warriors throughout southern Arizona. Following the pacification of the Apache, the fort was abandoned and its contents auctioned off (see Thiel and Theriot 2008).

Fort Lowell-Adkins Steel Property History

Detailed historical research on the Fort Lowell-Adkins Steel Property has recently been compiled in two reports that are available on the Pima County Archaeology website (Thiel and Theriot 2008; Thiel 2009). A very brief summary is presented here.

The portion of the fort within the project area housed three Officer's Quarters with kitchens and latrines, the adjutant's office, bakery, guardhouse, a portion of the Parade Ground, and several acequias. The three Officer's Quarters (No. 1-3), the kitchens for No. 1 and 2, and the guardhouse are visible today as standing structures or ruins. In addition, a portion of the bakehouse was exposed during removal of an underground fuel storage tank.

These structures were largely stripped of usable building materials; however, several of the Officers Quarters remained standing and were probably occupied by Mexican-American families following abandonment. By the early 1900s the Officers Quarters 2 and 3 were occupied and used as a sanatorium by members of the Dolly Cate family. Members of the Adkins family purchased the property from Dolly Cate in 1928 and lived on the property for over 70 years. The Adkins operated a rest home on the southern portion of the property and ran a steel tank fabrication business in the middle and northern portions of the property by the mid-1930s. Two residences, a large shed, a windmill and tank, and a variety of other structures were built during the Adkins family occupation of the property.

The City of Tucson acquired the property following a complex land exchange deal in 2006. Following acquisition, a cleanup effort removed scrap and debris from the site, the Fort-era structures were consolidated, and the Master Plan completed (Thiel and Theriot 2008; Thiel 2009).

SIGNIFICANCE ASSESSMENT

National Register of Historic Places

The National Register of Historic Places (National Register) is the nation's inventory of historic sites. It was established after the passage of the National Historic Preservation Act of 1966 to promote preservation and study of historic resources. Most projects involving federal agencies, federal land, or federal funds require evaluation and mitigation of their impacts on properties eligible for the National Register. In addition, many state and local laws, ordinances, and regulations require similar evaluations.

For a property to be listed in the National Register, it must meet integrity requirements and at least one of four significance criteria. These criteria are: A) association with events that have made a significant contribution to the broad patter of our history; B) association with the lives of persons significant in our past; C) embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, of that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or D). that have yielded, or may be likely to yield, information important in prehistory of history.

An important aspect of significance is a property's historic context (cultural affiliation and dates of use). If a historic context cannot be established, or if the property cannot be shown to be significant within its historic context, it does not meet eligibility requirements for inclusion in the National Register. Further, except in special circumstances, properties must be at least 50 years old to be considered for inclusion in the National Register.

The Fort Lowell-Adkins Steel property was included in the Fort Lowell Multiple Resource Area which as nominated to the National Register of Historic Places in 1977 and was listed on the National Register on 10 April 1978. The property is eligible for listing under Criterion A for the events associated with Fort Lowell, under Criterion C for to the distinctive architectural elements of Officers' Quarters 3, and under Criterion D due to the archaeological

resources that are likely to be present dating to the prehistoric and historic periods (Thiel et al. 2008:47-48).

ARCHAEOLOGICAL BACKGROUND

Archaeological investigations have been conducted in the Fort Lowell area since 1935, when the Arizona Archaeological and Historical Society and the University of Arizona Anthropology Department went to Fort Lowell and filled treasure-hunters holes around many buildings (Thiel and Theriot 2008).

A records check was conducted at ASM and on the Internet at AZSITE. Cultural resource survey and site information reported in this section reflects records available in June 2010. Archaeological investigations have been conducted in the Fort Lowell area since 1935, when the Arizona Archaeological and Historical Society and the University of Arizona Anthropology Department went to Fort Lowell and filled treasure-hunters holes around many buildings (Thiel and Theriot 2008).

Archaeological projects, primarily surveys, conducted within 1 mile of the project area are listed in Table 2. Archaeological sites identified within 1 mile of the project area between 1979 and the present, are listed in Table 3 (Figure 4). Of the 24 sites, two are of primary importance: the Hardy Site, AZ BB:9:14 (ASM), and historic Fort Lowell, AZ BB:9:40 (ASM).

Table 2. Previous cultural resources surveys conducted within 1 mile of the project area.

ASM Project No.	Project Name	Organization	Sponsor
1979-31	Pima County Bridge Survey	Arizona State Museum	Pima County
1979-51	TEP 138 kV Survey, NE Substation to E Loop Substation through Snyder Substation	Arizona State Museum	Tucson Electric Power
1980-158	Rio Verde Vista II, East of Craycroft, North and South of River Road	Arizona State Museum	Broadway Realty & Trust
1980-227	ROW Along Grant/Kolb Road	Arizona State Museum	Arizona Department of Transportation
1980-228	Reconstruction/Widening of Grant Road, Sahuara to Wilmot Road	Arizona State Museum	Arizona Department of Transportation
1980-55	Primavera, SW Corner of Craycroft and River Road	Arizona State Museum	Continental Homes
1981-8	Cloverleaf Townhouses	Arizona State Museum	
1982-142	Hill Farms II, Ft. Lowell and Craycroft	Arizona State Museum	Cienega, Ltd.
1982-148	Sahuaro Village, Grant and Sahuaro	Arizona State Museum	Sun Country Development
1984-212	OPW South Rillito Sanitary Interceptor Survey	Arizona State Museum	Osborn, Petterson, Walbert and Associates
1985-79	Archaeological Clearance Survey of La Sonrisa Development Area, Pima County	Arizona State Museum	Lovstrom and Associates
1986-168	Clearance Survey for a Reclaimed Water Pipeline, North-Central Tucson	Arizona State Museum	Brown and Caldwell, Consulting Engineers

Table 2. Continued.

ASM Project No.	Project Name	Organization	Sponsor
1987-139	Archaeological Monitoring during Construction of the Ft. Lowell Park Reclaimed Water Main	Arizona State Museum	R. E. Miller Paving and Construction
1987-213	Alamo Wash: Glenn Street to Rillito River, W.O. 4FAWFL	Institute for American Research	Pima County Transportation and Flood Control District
1989-121	Phase I Archaeological Reconnaissance of the Proposed Rillito Creek Recharge Site	Louis Berger and Associates	Camp Dresser & McKee
1989-2	Rillito Testing Project	Statistical Research	US Army Corps of Engineers, LA District
1990-162	Archaeological Survey of Speedway/Pima Widening Project	Desert Archaeology	City of Tucson
1990-240	Fort Lowell Park Expansion	Desert Archaeology	City of Tucson
1991-89	Calle Chueca Main Replacement Survey	Desert Archaeology	City of Tucson
1994-87	Rillito Creek Recharge Feasibility Study	Bureau of Reclamation	Bureau of Reclamation
1996-42	Swan Road	Desert Archaeology	City of Tucson
1996-467	Parcel C, Fort Lowell at Swan Road	Arizona State Museum	University of Arizona
1996-468	Parcel B, Fort Lowell at Swan Road	Arizona State Museum	University of Arizona
1997-120	Ft Lowell/Orlando	Professional Archaeology Services & Technologies	The DeGrazia Company
1997-319	Archaeological Survey of the Fort Lowell Alignment Extension between Vista del Forte and Swan Road	Desert Archaeology	City of Tucson
1997-9	Archaeological Assessment of 5.6 Acre Parcel Near River and Craycroft Roads	Tierra Archaeology	Rogers Civil Engineering
1998-148	Swan / Sunrise Main Survey	Desert Archaeology	City of Tucson
1998-303	Presidio/Craycroft Rd. NWC	Professional Archaeology Services & Technologies	Planners Ink Corporated
1998-571	Canciones Survey	Tierra Archaeology	Rob Paulus Architect
1998-61	Traffic Signal Survey: Grant/Rosemont	Desert Archaeology	City of Tucson
2000-264	Pantano Wash Bank Protection Project	Statistical Research	Pima County
2000-423	Craycroft Road Survey	SWCA	Engineering and Environmental Consultants
2000-790	TMC - Acadia Wash (Lots 13 & 14)	Professional Archaeology Services & Technologies	TMC Healthcare - Plant Services
2001-174	River Road-Tanuri Drive-Calle Vista Ciudad Buried Cable Survey	Old Pueblo Archaeology Center	Comcast Cable Communications
2001-502	Tanque Verde Wash Survey	Aztlan	American Pacific Engineering LLC
2001-53	Camp Lowell and Swan Survey	SWCA	Park West Development
2002-146	River-Craycroft Survey	Tierra Archaeology	Broadway Realty & Trust
2002-154	TMC Site Archaeological Survey	SWCA	Planning Resources
2003-425	East Lawn Survey	Tierra Archaeology	KB Home Tucson

Table 3. Previously recorded archaeological sites within 1 mile of the project area.

ASM Site Number / Name	Site Type	Site Age	Year Recorded
AZ BB:9:118/Hill Farm	Artifact scatter	Prehistoric	1982
AZ BB:9:13	Artifact scatter	Prehistoric	1937
AZ BB:9:14/Hardy Site	Village	Prehistoric	1979
AZ BB:9:19	Artifact scatter	Prehistoric	1938
AZ BB:9:20	Habitation area	Prehistoric	1938
AZ BB:9:219	Artifact scatter	Prehistoric, Historical	1987
AZ BB:9:220	Outhouse pit	Historical	1987
AZ BB:9:24	Artifact Scatter	Prehistoric	1938
AZ BB:9:25	Possible habitation area	Prehistoric	1938
AZ BB:9:26	Artifact scatter and possible wall alignment	Prehistoric	1938
AZ BB:9:302	Well and water control	Historical	1996
AZ BB:9:309	Habitation area and trash deposits	Prehistoric, Historical	1996
AZ BB:9:310	Trash deposits	Historical	1996
AZ BB:9:314	Roasting pit	Prehistoric	1997
AZ BB:9:315	Habitation area	Prehistoric	1997
AZ BB:9:324/Quarter Master's Dump	Trash deposits	Historical	1998
AZ BB:9:325/Corbett Canal	Canal	Historical	1998
AZ BB:9:356	Homesite	Historical	2000
AZ BB:9:366	Artifact scatter and possible wall alignment	Prehistoric	2002
AZ BB:9:377	Hearth and artifact scatter	Prehistoric, Historical	2003
AZ BB:9:387	Pipe culvert and ditch	Historical	2004
AZ BB:9:40/Fort Lowell	Military fort and site	Historical	1960
AZ BB:9:54	Habitation area	Prehistoric	1969
AZ BB:9:72/ Bank Quarters, Kitchen	Military building and site	Historical	1973
AZ BB:9:95	Trash mound and artifact scatter	Prehistoric	1980
Nearby Historic Buildings			
MPAEXP-8133	Commissary and Quartermaster Offices		
MPAEXP-8134	Commissary and Quartermaster Offices		
MPAEXP-8135	Commissary Cellar		
MPAEXP-8138	Sutler¹s Store; Post Trader¹s Store and Riallito House		
MPAEXP-8140	Sutler¹s Storehouse		
MPAEXP-8141	Fort Lowell District building		
MPAEXP-8142	Fort Lowell District building		
MPAEXP-8143	Fort Lowell District building		
MPAEXP-8144	Fort Lowell District building		
MPAEXP-8145	Fort Lowell District building		
MPAEXP-8146	Fort Lowell District building		
MPAEXP-8147	Fort Lowell District building		
MPAEXP-8148	Fort Lowell District building		

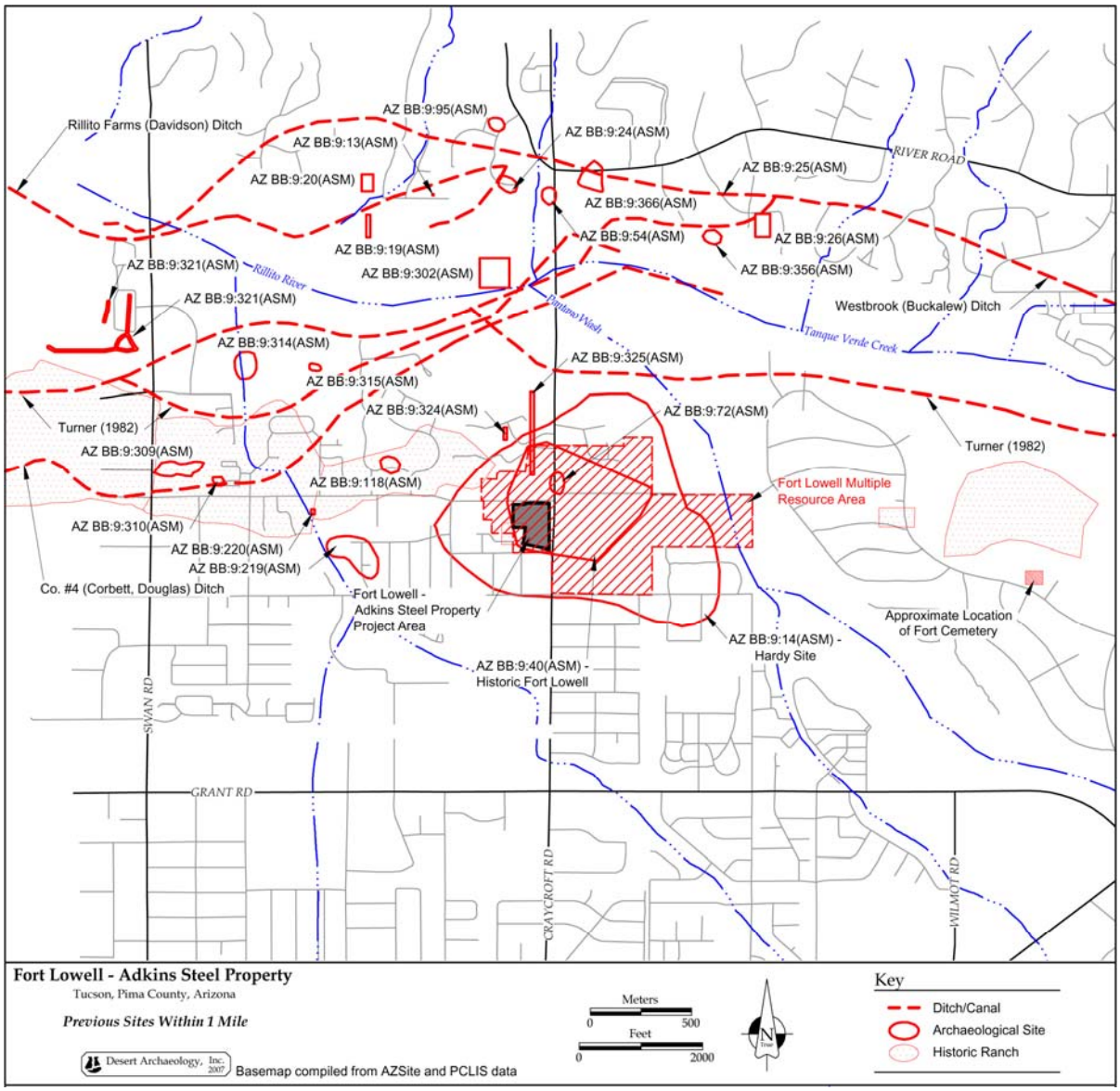

Figure 4. Previously recorded archaeological sites within 1 mile of the project area.

Prehistoric Archaeology

Prehistoric archaeological resources were first noted at Fort Lowell in 1884 by Adolf Bandelier (Gregonis 1997:viii). On Thanksgiving Day in 1917, Dr. Robert F, Gilder, an archaeologist at the University of Nebraska, spent several hours wandering about the ruins. He was surprised to find prehistoric pottery sticking out of the adobe walls. His explorations led him to the borrow pits, where the dirt for the adobe was mined, and there he found additional pottery. Badger holes were a source of pottery and grinding stones. Gilder collected examples of pottery, two ceramic disks, and five manos, probably for the University of Nebraska collections (*Tucson Citizen*, 1 December 1917).

An archaeological excavation was conducted between 1976 and 1978 by ASM. Linda Gregonis subsequently prepared a site card for the Hardy site in 1979. This prehistoric Hohokam site encompasses a large area surrounding historic Fort Lowell.

The 1976-1978 excavations took place on the eastern side of the park near the pecan grove near the baseball diamond, and 36 features were documented in a relatively small area. These included nine pit structures, "caliche borrow pits, possible storage pits, a work area, roasting pits, a cemetery-offertory area, and enigmatic groups of postholes" (Gregonis 1997:11). The features dated from about A.D. 650 to A.D. 1300, and indicate the occupation was both lengthy and intensive.

Two Snaketown phase (A.D. 700-750) features were documented, consisting of a pithouse and a possible storage pit. Only a small portion of the pithouse was uncovered, and its orientation is unknown. Other features from this phase are likely located nearby.

Two nearby pithouses may date to either the late Snaketown or the early Cañada del Oro phase (A.D. 750-850). Only small portions were uncovered. A plastered cemetery-offertory area and three caliche borrow pits dating to this phase were also located. The caliche was mined to make plaster, probably for pithouse floors. The cemetery-offertory area yielded human remains in two small pits, a number of reconstructible vessels, and a human figurine (Gregonis 1997:11, 31).

A number of pithouses and pits dating to the Rillito phase (A.D. 850-950) were located. Most of the Rillito phase features were heavily damaged by later prehistoric construction activities, so only fragments of the houses survived. In contrast, the three Late Rincon (possibly Tanque Verde) phase (A.D. 1100-1300) pithouses were well preserved. Two of the pithouses were arranged in a courtyard setting; two roasting pits, an activity area, and an ash pile dating to this period were also uncovered. A few Tanque Verde phase artifacts, dating to about A.D. 1150-1300, were found scattered throughout the area.

Gregonis excavated a relatively small area. The density of features was very high in the area explored. Large numbers of features are almost certainly present in the surrounding area.

Work at a nearby prehistoric site, located north of Fort Lowell between the Rillito River and River Road, was conducted in 1982 by ASM personnel. AZ BB:9:54 (ASM) was on the western side of Craycroft Road, and was excavated during a road-widening project. Four pit structures and two caliche mining pits were documented dating to the late Sedentary period, around A.D. 1100. The site may be associated with the Hardy site, perhaps representing a farmstead where residents lived while tending crops along the Rillito (Huntington 1982).

Sometime around A.D. 500 populations in southern and central Arizona began to aggregate into large villages. These villages would remain the focal point of habitation for the next 600 years. Though information about the Hardy site is limited, it appears to be one of these primary villages (Gregonis 1997). Located above the confluence of the Pantano and Tanque Verde washes, occupants of the Hardy site would have been well positioned to take advantage of arable land and relatively plentiful water. While the exact size of the village is

not known, Gregonis (1997) shows 14 trash mounds at the site. At other sites in the Tucson Basin, trash mounds have been shown to be reliable indicators of pithouse clusters or courtyard groups. The number of trash mounds identified, in conjunction with the likelihood that many others were destroyed, points to a village-sized population living at the Hardy site.

Ceramics dating from the Sweetwater phase (circa A. D. 650-700) and a possible structure dating to that same time indicate settlement of the village occurred during the phase of early village formation in southern Arizona (Gregonis 1997). Habitation continued through the succeeding Colonial period (A.D. 750-950) and Sedentary period (A.D. 950-1150). Like many of the large villages, the Hardy site appears to have been abandoned by the Tanque Verde phase (A.D. 1150-1300), with the inhabitants moving to the nearby University Indian Ruin, AZ BB:9:33 (ASM) (Gregonis 1997).

Historical Archaeology

Fort Lowell was assigned site number AZ BB:9:40 (ASM) by William Wasley in August 1960 (ASM site card). Additional site numbers have been assigned to the fort by other archaeologists—AZ BB:9:72 (ASM) for the band quarters and kitchen and AZ BB:9:324 (ASM) for the quartermaster's dump—but both should be considered part of BB:9:40.

Alfred Johnson excavated a portion of Fort Lowell in 1960, prior to construction of a parking lot (Hodge 1960; Johnson 1960). During Johnson's project, one of the officer's quarters was completely excavated, the commanding officer's quarters were partially excavated, three other officer's quarters were tested, and several outhouses were excavated, as was a trash-filled pit. Johnson (1960) noted that buildings were constructed from unfired adobe bricks measuring 20 inches by 12 inches by 4 inches (50 cm by 30 cm by 10 cm). Interior walls of these structures were plastered, whereas exterior walls were left unplastered.

Artifacts from this excavation are housed at ASM and are contained within 22 boxes (6 glass, 2 ceramic, 2 glass/ceramic, 9 mixed, 1 glass/plaster/ceramic, 1 metal, and 1 glass/wood/ceramic). These items have never been formally analyzed. A brief examination of the artifacts indicates that many are from the post-fort period and represent items discarded by Mexican families living in the abandoned structures, as shown by items with maker's marks that postdate 1891. The Arizona Historical Society (AHS) in Tucson has a manuscript on file containing information about the project (MS 265, AHS). This material includes the original maps drawn by Johnson, drawings of architectural elements found in other buildings and reported to be from Fort Lowell, and a variety of black-on-white photographs.

Excavations in 1982 documented the band quarter's kitchen, where members of the regimental band had a mess hall, kitchen, and storage room during the fort's occupation (Huntington 1982). This structure is located on the eastern side of Craycroft Road and widening of that road necessitated the project, which documented the structure and recovered associated artifacts. At about the same time, excavations were conducted at the cavalry stables and corral, resulting in the documentation of standing portions of the wall, as well as recovering a small number of artifacts (Huntington 1982).

In 1988, the Institute for American Research (now Desert Archaeology, Inc.) conducted monitoring of water line trenches dug along the eastern side of North Craycroft Road, between Glenn Street and St. Gregory's High School (Dart 1988). Eight archaeological features were documented. Three of these features, two pithouses and a roasting pit, were prehistoric. One pithouse yielded Middle Rincon phase (A.D. 1000-1100) ceramics. Five other features dated to the Historic era. Four were associated with Fort Lowell and consisted of the area of the commanding officer's quarters, two pits, and a midden area. Another feature was a possible irrigation ditch from the Fort Lowell occupation or later.

On 3 October 1990, Jonathan Mabry of Desert Archaeology surveyed the Adkins Steel property for the City of Tucson. He noted the presence of prehistoric and historic artifacts scattered about the property, as well as the three officer's quarters and the guardhouse of Fort Lowell (Mabry 1990).

Architectural evaluations conducted in 1994 and 1997 at the Hardy homesite, located at the northeastern corner of Craycroft and Fort Lowell roads, and at the Quartermaster and Commissary Storehouse at the northwestern corner of these streets, indicated that features associated with Fort Lowell and the Hardy sites were also likely to be found in these areas (Thiel 1994, 1997).

Monitoring of the emergency stabilization work for the second officer's quarters and kitchen was conducted in August 2007. Portions of the wooden floor in the southeastern room of this structure were removed so that wall bracing elements could be installed. A whiteware cup and a stoneware Dundee Marmalade jar were found beneath the floor, suggesting additional fort-era refuse may be present in this and other rooms. Newspapers from the 1930s were present beneath the deteriorated linoleum on the southern side of the quarters, in the area of a former porch. Other newspapers from 1920 were present beneath the cement capping elements that once lined the parapet of the quarters and its adjacent kitchen (Thiel and Theriot 2008).

Removal of a underground storage tank in 2007, on the western side of the Adkins steel barn, located a fragmentary brick foundation or floor support pier and an ash deposit associated with the post bakery. The uncovered portion was six bricks long, two bricks wide, and several courses tall. Only a small area was uncovered, and the full extent of the feature is not known. It was unclear how much of the bakery had been destroyed by placement of the storage tank (Thiel and Theriot 2008).
Removal of a fuel line running from the underground storage tank, uncovered portions of the rock foundation of the guardhouse. The guardhouse foundations are partially visible on the ground surface, and additional rock alignments were visible in the trench for the fuel line (Thiel and Theriot 2008).

Artifact-collecting activities have also taken place on the property, focused especially on the latrine features associated with the officer's quarters. The Fort Lowell Museum contains displays with a number of artifacts purchased from an artifact collector. Some items have also been discovered on the surface within the park, or during excavation of trenches for utility lines. Despite these disturbances, it is very likely that many subsurface features

associated with the prehistoric and historic-era occupation of the site remain undisturbed, hidden beneath the modern ground surface.

MONITORING AND DISCOVERY PLAN

Research Questions

Three research questions will guide the monitoring and data recovery efforts on the Fort Lowell-Adkins Steel parcel. The research questions are designed to be applicable for the entire property.

The Prehistory of Fort Lowell

The prehistoric Hardy site, AZ BB:9:14 (ASM), lies beneath the later historic Fort Lowell. First noted in 1884 by Adolf Bandelier, relatively little work has been conducted by archaeologists at the site (Thiel et al. 2008:30-32). A small portion excavated within Fort Lowell Park from 1976 to 1978 uncovered pit structures, pits, and a cremation area, with artifacts dating from A. D. 650 to 1300 (Gregonis 1997). Other prehistoric features have been located on the west side of Craycroft Road, north of Fort Lowell Road (Huntington 1982).

The small amount of work and the extensive disturbance of the modern ground surface have left many questions about the prehistory of the Fort Lowell area unanswered. These include:

1) Is an undiscovered Early Agricultural period settlement present at the site? Work since 1994 has revealed that the Tucson Basin was the location of extensive Early Agricultural period settlements, primarily located immediately adjacent to flowing streams (Gregory 2001; Mabry 1998; Thiel and Mabry 2006). The areas along the Rillito would seem to be a prime location for Early Agricultural period villages, but to date none have been located.

2) Was the site continuously occupied from the Hohokam Pioneer to Sedentary periods? How did the village move across the landscape through time? To date our understanding of the Hardy site has relied on limited excavations and monitoring projects beneath Craycroft Road (Gregonis 1997, Huntington 1982). The discovery of features with datable artifacts or ethnobotanical materials suitable for radiocarbon dating should provide a better understanding of the chronology of the site and how settlement patterns changed throughout the history of the site.

3) Is there evidence for craft manufacture at the household or community level at the site? A number of villages in the Tucson Basin were likely the locations of craft specialization. Pottery was manufactured at the Julian Wash, West Branch, and Valencia sites. There is also evidence that pottery was made at the Hardy site and distributed to the northeastern portion of the Tucson Basin (Heidke 1999). Turquoise may have been collected for trade and small,

decorated ground stone bowls were made at the Redtail site (Thiel and Elson 2010). Other ground stone production has been noted at Sunset Mesa, Valencia, and Sleeping Snake sites (e.g., Adams 2000, 2003). Evidence for household level production of shell jewelry has been found at the Julian Wash, Sunset Mesa, and West Branch (Vokes 2000, 2005, 2009). Analysis of artifacts recovered from prehistoric features, including the examination of ceramics to determine temper source and manufacturing location, has the potential to extend our understanding of activities at the Hardy site (Lindeman 2006).

Daily Life and the Organization of Outdoor Spaces at Fort Lowell

The Fort Lowell-Adkins Steel parcel contains the southwestern corner of historic Fort Lowell, in operation from 1873 through 1891. Three officer's quarters, their kitchens, their privies, the Adjutant's Office, the Bakery, the Guardhouse, and a portion of the Parade Ground are present on the parcel. Surface or subsurface remains are known for all except the Parade Ground (which may be difficult to locate physically) and the Adjutant's Office. Extensive archival information has been collected for these structures (Thiel and Theriot 2008).

The southern half of the Fort Lowell-Adkins Steel Property contains portions of the three quarters and two of their freestanding kitchens are present. The kitchen associated with Officers Quarters 3 is not visible on the ground surface. The three privies associated with the Officer's Quarters are reported to have been looted by artifact collectors and are not visible. Adobe walls separated the Quarters from each other and the foundation of the wall between Officers Quarters 2 and 3 is visible on the modern ground surface.

The northern half of the property contains the Adjutant's Office, the Bake House, and the Guard House. Portions of the stone and mortar foundation of the Guard House are visible on the ground surface and were also noted when a modern gas line was removed in 2008. A fired-brick feature associated with the Bake House, perhaps a floor joist support, was noted in 2008 when an underground fuel storage tank was removed. As noted above no physical remains of the Adjutant's Office have been located to date.

Extensive archival information survives on the lives of the soldiers and officers living at Fort Lowell. Living conditions, floor plans for buildings, the types of crops raised at the nearby gardens, animals and grain procured from nearby farmers and ranchers, and other information is available. Period photographs show portions of most of the structures. Despite this wealth of information, some areas of interest remain unknown.

The material culture of the residents of the Officer's Quarters is poorly documented. The looting of privy features may have destroyed an opportunity to examine the types of dishes, clothing, toys, and other mundane artifacts used by the officers, their wives, their servants, and their children. It is possible that other trash-filled features dating to the fort era may be present in backyard areas, and if located, these could provide insights into the possessions and diets of these households.

The presence of walls enclosing the backyards of the Officers Quarters suggests the desire for privacy was strong for these households. There is the possibility that features associated with the fort era backyards may be located- such as planting holes, postholes for clothesline poles, animal burials. There is also some question as to whether Officers Quarters 3 ever had a backyard kitchen building. The potential is high that new information regarding the organization and use of backyard spaces may be discovered.

Two research goals could be addressed during work in this area. One would be to identify and document the architectural remnants of the buildings once present. The second would be to identify associated features, such as planting pit, privies, hitching posts, etc. The information recovered during the work could provide basic information on how the buildings and surrounding areas were used during the Fort era.

A very basic goal would be to locate the Adjutant's Office. This adobe brick building was apparently 50 ft square with a porch on the south, east, and north sides. Despite being invisible on the ground surface, the likelihood is high that some of the adobe brick foundations can be found. Although not noted in fort records, it seems likely that some sort of privy would have been present behind (to the west) of the building. This building was stripped of materials and gradually fell into disrepair. In 1937 it was reported to be in ruins. The discovery of its location would allow for future interpretation for the structure, as well as the accurate placement of interpretative signs.

The Bakery location has probably been heavily disturbed by an underground fuel storage tank, which was removed in 2008. This adobe brick building was L-shaped and measured about 36 ft by 28 ft. Again, the discovery of its foundations would allow for future interpretation. A well was present immediately north of the Bakehouse. This structure was depicted on the 1876 map of the fort. The well provided water for bakers and its discovery provides another interpretative opportunity.

Lastly, the Guardhouse was present to the north of the Bake House. Remnants of its stone and mortar foundation are visible. The removal of contaminated soils around the foundations should provide an opportunity to more accurately map this building. The building was 52 ft square with an attached 48 ft x 28 ft yard where prisoners could exercise. It seems probable that a privy was located in the yard and this may be determined during removal of contaminated soils.

Health Seekers in Early Twentieth Century Tucson

Tuberculosis, frequently called "consumption" or "lung trouble," was a deadly disease prior to the discovery of effective drug treatments in the 1940s. Large numbers of Americans succumbed to the disease, whose cause and preventative measures were vigorously debated by scientists, politicians, and medicine manufacturers. Some people believed that foul air, contaminated water, or heredity caused the disease. By the late 19th century scientists had discovered that a bacteria was the culprit, and that spitting and coughing were two factors that led to the spread of the illness. However, convincing the American public that a seemingly invisible, microscopic organism could kill them took a long time (Kravetz and Kimmelman 1998:23-26).

Prior to drug treatments, some people afflicted with tuberculosis moved to Arizona, believing that the dry climate and near-constant sunshine would help them regain their health. Among these were prominent Tucson businessman Samuel Hughes, who arrived from California in 1858 (Sonnichsen 1987:45). The railroad arrival in 1880 increased the number of consumptives arriving, many of whom soon died from the effects of the disease.

Richard "Dixie" and Dolly Cate also moved to Tucson hoping to cure Dixie's tuberculosis. In June 1908, Dixie purchased land in the former Fort Lowell. Unfortunately, he passed away in December 1908. His wife Dolly then opened "Mrs. Cate's Tuberculosis Sanatorium" on the property, using the Officer's Quarters and kitchens as housing for 13 male patients in 1920 (Thiel and Theriot 2008:18). She sold the property to Harvey and Fronia Adkins in 1928. The Adkins had come to Tucson in 1926 with their ailing daughter Dicey, who passed away from tuberculosis at the Cate rest home in June 1927. The Adkins, in turn, operated Adkins Rest Home, with 13 patients (10 men and three women) in 1930. The rest home was operated until at least 1950 (Thiel and Theriot 2008:18-19).

Sanatoriums and rest homes for tubercular people closed in the 1950s as new antibiotics were developed and the treatment of patients passed from private individuals to medical professionals. Tuberculosis remains a health threat today, especially due to the development of antibiotic resistance strains. However, few people know how devastating the disease was in the late 19th and early 20th century in Arizona.

Work on the southern portion of the former Fort Lowell-Adkins Steel property may result in the discovery of trash-filled features associated with the Cate and Adkins sanatoria. No previous archaeological projects have taken place at sanatoriums or rest homes in Arizona. Although tuberculosis-related proprietary medicine bottles are often recovered at Territorial-era archaeological sites in Tucson and Phoenix, these all come from private home contexts, where family members were apparently being treated by medicines that were widely available via local pharmacies or by mail order.

As a result, the material culture and diet of the residents and staff members of sanatoria and rest homes in Arizona is not known. While it is likely that majority of the items used would be similar to contemporary households in Arizona (e.g., whiteware and decal printed ceramics, commercially produced food and hygiene containers, etc.), it is also likely that residents would have items associated with their struggle to regain their health. Medicine bottles and devices would probably be present in larger quantities than contemporary households. It might be expected that the diet of residents would have been more nutritious than their contemporaries, and conversely there would be less evidence for alcohol or tobacco consumption. The discovery and excavation of a sample of features associated with the Cate/Atkins Rest Home would likely provide a new perspective on what life was like for the residents of a tuberculosis sanatorium in early 20th century Tucson.

Preparation

An Arizona Antiquities Act Project-specific permit, an Arizona State Museum accession number, and an Arizona State Museum Burial Agreement will be obtained for this project.

Desert Archaeology personnel will undergo 40-hour Hazardous Waste Operator (HAZWOPR) training prior to the start of the project.

Human remains may be discovered during the course of the construction project. In 1990, the State of Arizona passed two laws to provide protection for human remains and associated artifacts located on private or state lands. These were the *Discovery of Human Remains, Sacred Ceremonial Object, Object of National and Tribal Patrimony* (Arizona Rev. Stat. 41-844) and *Disturbing Human Remains or Funerary Objects on Lands Other Than State Lands* (Arizona Rev. Stat. 41-865).

The laws provide guidelines to follow should human remains be discovered during the course of ground disturbing activities. ASM coordinates consultations under the state laws relating to the discovery of human remains.

Notification

Desert Archaeology will subcontract with a backhoe operator who is highly skilled at working at archaeologically sensitive sites. We will coordinate a schedule with the City of Tucson and SCS. Once initiated, monitoring will proceed on as-needed basis. It is extremely important that any contractors working on the project be notified about the need for an archaeological monitor during all ground-disturbing activities. As work progresses, it will be the responsibility of the City of Tucson and all contractors to keep the archaeological monitor informed of the work schedule and any changes therein.

Removal of Contaminated Soil

The remediation area is shown on the Sampling and Analysis Plan figure produced by the City of Tucson (Figure 4). Contaminated soil will be stripped away in 15 cm layers and stockpiled in roll-off containers. The exact boundaries and depth of the stripped areas will be determined during the course of the project through soil sampling analysis. If testing shows that the contamination continues to be present in the underlying soil, additional soil will be stripped away, and testing conducted again. Stripping will be terminated once environmental testing has indicated the soils are acceptable.

Dust control will take place during the project to prevent fugitive dust from leaving the property. An Activity Permit will be acquired from Pima County Department of Environmental Quality (PDEQ). Water will be used for dust abatement. A fire hydrant is located at the north side of the property and will be metered to obtain water. One of the five Desert Archaeology employees with HAZWOPER training will apply water to the ground prior to backhoe stripping using either a fire hose connected to the hydrant or a hose attached to a portable tank. Sections of fabric covered panel fencing, on portable stands, will be positioned around the sides of the fort-era adobe buildings while the soil is removed from around them and water is applied to the soil. The fencing will be placed 1 m from the side of the building, anchored to the ground, and will act as a barrier to prevent water from the hose from splashing onto the buildings. This will prevent any damage caused by the water.

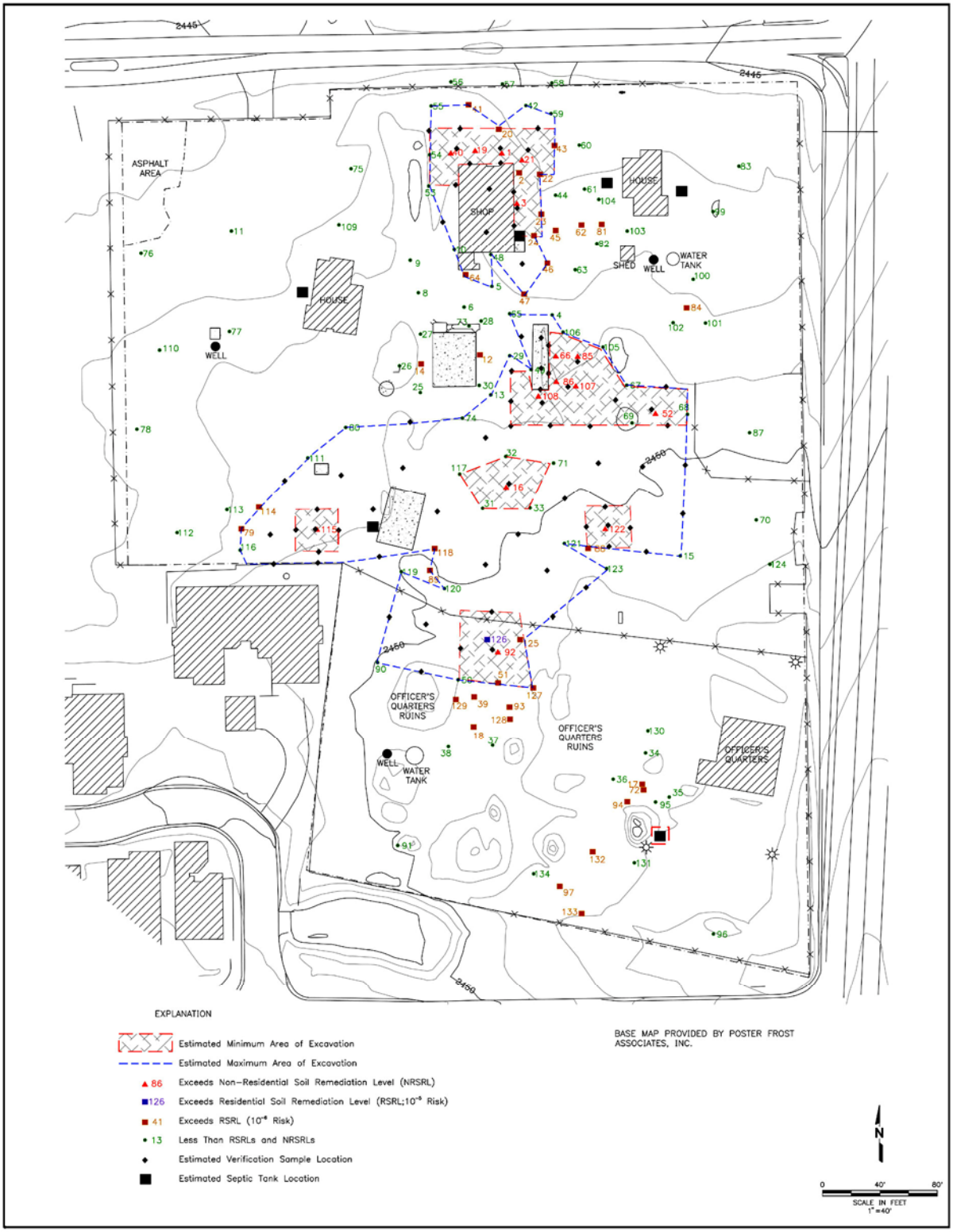

Figure 5. Planned excavation areas and sample locations (map provided by City of Tucson).

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The proposed work has the possibility of adversely affecting subsurface cultural resources on the Fort Lowell-Adkins Steel property. These affects will be mitigated by archaeological monitoring, the excavation of a sample of exposed archaeological features, and the mapping and preservation in place of the remaining features. More detailed descriptions of these methods are discussed below.

Excavation Monitoring

A professional, supervisory-level archaeologist will monitor earthmoving activity. The goal of monitoring is to preserve information about archaeological materials that might otherwise be destroyed. Collections of artifacts observed during monitoring and the careful recording of archaeological features contribute to this goal. The amount of effort proposed for the current project is consistent with the limited impacts of the proposed contamination mitigation work. It is, however, designed to maximize the collection of information that can be used to address the research issues outlined above.

During removal of contaminated soils, the archaeological monitor will observe progress, visually inspect backdirt (where possible), and collect diagnostic artifacts. Diagnostic artifacts include items that can be dated or that can be used to help answer research questions. Additionally, notes will be taken on sediment types encountered. Once subsurface archaeological features are located, the archaeologist will mark their location with white spray paint and contaminated soil removal will proceed around the features, leaving them in situ. A standardized field form will be completed for each feature, with the data collected including the size, shape, type of fill, presence of artifacts, and suspected date of the feature. The boundaries and depth of all excavated areas and the locations of all features will be mapped using a GPS device.

Special care will be taken to avoid damaging the adobe walls known to be present within the project area, including the dividing walls associated with the backyards of the Officers Quarters. Once located and delineated, orange plastic mesh fencing may be installed on temporary metal fence posts to direct mechanical traffic away from these fragile architectural remains.

Limited Feature Excavation

If significant subsurface remains are encountered, additional effort will be directed toward limited archaeological excavation.

Given the long and complex history of the site, there is the possibility that a wide variety of features may be located. A sampling strategy that will include the mapping of all features and the excavation of 50 percent of prehistoric pithouses, 30 percent of non-burial features, and 100 percent of burial features has been proposed. This estimate is subject to change depending on what is actually found, what can be preserved in place, and the degree of contamination present. Features will be selected that have the likelihood for providing answers to the research questions posed. Features with abundant, diagnostic artifacts would be targeted for excavation. However, preservation in place of features is also desired, so some features will only be mapped, with a set of diagnostic artifacts and samples collected. Other features will be partially excavated, leaving a portion untouched.

Desert Archaeology has projected the excavation and documentation of up to six historic trash pits, two historic building foundations, one deep historic pit feature (a privy or well), 10 prehistoric extramural pits, two prehistoric pithouses, one inhumation burial, and five cremation burials. A final scope and budget will be developed in consultation with the City of Tucson as the number of features present is determined.

Archaeological excavation will include placement of rectangular or square units over larger features, such as pit structures, and the excavation of stratigraphic levels, where possible. Archaeologists will dig 10 or 20 cm thick arbitrary levels when natural stratigraphy cannot be discerned. All sediments will be screened through ¼ inch mesh. Flotation samples will be collected from each stratum during excavation. Artifacts will be cleaned, sorted and bagged by material type. Standardized forms will be completed for each level in each unit and for the overall feature. Scale drawings of profiles will be made and plan view maps prepared. Digital photographs will be taken of excavated features.

Burial Treatment

Prior to the start of fieldwork, Desert Archaeology, Inc., will apply to the Arizona State Museum for a Burial Agreement. Should human remains be located during fieldwork, the protocols established in the Agreement will be followed. Typically, if human remains are encountered during construction, or if they are suspected based on feature characteristics or artifacts, work will be discontinued in the area until the notification procedures outlined in the Burial Agreement have taken place. This may take up to several days, but work may continue elsewhere during the delay.

Artifact and Sample Analyses

All artifacts and samples will be taken to the Desert Archaeology, Inc. laboratory for processing. The materials will be treated in accordance with ASM curation standards and then analyzed using established procedures.

Artifact types that may be collected during monitoring and data recovery include flaked stone, ground stone, Native American ceramics, shell, faunal bone, ethnobotanical materials, historic ceramics, metal, glass, and other historic materials (e.g., plastic, hard rubber, paper, etc.). Analysis will include the identification of all artifacts and the comparison of the collection with assemblages from similar sites.

All project materials including artifacts, processed non-artifact samples, original field notes, maps, analysis records, and photographs will be submitted to the Arizona State Museum for curation. Human remains and associated artifacts will be repatriated according to the Burial Agreement.

Report Preparation

A combined monitoring and data recovery report that documents all findings will be prepared following the completion of the field effort and artifact and sample analyses. The report will include a brief cultural history of the project area, a discussion of the soil stratigraphy, detailed descriptions of the features encountered, and analyses of the artifacts recovered. The Arizona State Museum site cards for Fort Lowell, AZ BB:9:40 (ASM) , and the Hardy site, AZ BB:9:14 (ASM), will be updated. The draft report will be completed within six months of the completion of fieldwork. The draft will be reviewed by the City of Tucson. The final report will be submitted to the City of Tucson and the Arizona State Museum.

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