811-827 Court Street, Utica, NY 13502

Brownfield Cleanup Program
Remedial Investigation Work Plan

Lofts at Globe Mill, L.P.
Utica, NY
KCG Development
11555 M Meridian Street, Suite 400
Carmel, IN 46032
(BCP Site C633084)

March 2018
EFI Project Number: 94705-10427

EFI Global

Engineering, Fire & Environmental Services

I _Jason Brydges_ certify that I am currently a NYS Registered Professional Engineer/Qualified Environmental Professional as defined in 6 NYCRR Part 375 and that this Remedial Investigation Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).;

3-6-18

Jason Brydges, PE, MS/MBA
Senior Engineer

Margaret A. Silva
Project Manager

Catherine Dare
Engineer

Submitted to:

Ms. Rachel Gardner
NYSDEC
Division of Environmental Remediation
317 Washington Street
Watertown, NY 13601

Brownfield Cleanup Program

Remedial Investigation Work Plan

Lofts at Globe Mill Site

Prepared for:
Lofts at Globe Mill, LP
KCG Development
11555 M Meridian Street, Suite 400
Carmel, IN 46032

Prepared by:
EFI Global.
242 Old New Brunswick Road
Suite 414
Piscataway, NJ 08854
Tel: 732-629-7930
TF: 866-390-3274
Fax: 732-629-7934
www.efiglobal.com
Fax 716 667 0279

In Conjunction With:
Catherine Dare
9372 Kirk Road
Westernville, NY 13486
Tel: 315-334-3140

EFI Project Number:
94705-10427

Date:
March 2018

Table of Contents

Figures

Tables

Appendices

1. Introduction

On October 27, 2017, Lofts at Globe Mill, L.P. entered into a Brownfield Cleanup Program (BCP) Agreement (BCA) Index No. C633084-09-17 with the New York State Department of Environmental Conservation (NYSDEC) for an approximately 4.874-acre BCP Site located at the southeast corner of the intersection of Stark and Court Streets in Utica, New York (Site), see Figure 1. The Site is located at 811-827 in Utica New York, Oneida County (Tax Lot 318.40-4-6). The buildings at the Site are currently occupied by Bank of New York Mellon (Offices), New York State Department of Transportation (Project Engineer's Office), Quanterian (Reliability Analysis), Wright Lighting (Storage), Murray Kirshtein (Law Office), and Mohawk Hospital Supply (Storage). The buildings at the Site addressed as 925 Stark Street and 933 Stark Street are unoccupied and are used for storage.

This Remedial Investigation (RI) Work Plan addresses the entire 4.874-acre Site. Information obtained from the Oneida County Assessor's Department indicated that the tax assessment parcel number associated with the Site is 318.40-4-6. The Lofts at Globe Mill, L. P. plan to renovate the current building footprint for mixed-use, mixed-income, and historic adaptive re-use including modern loft style apartment homes. The EFI Global team has prepared this RI Work Plan (RIWP) for investigation of the Site in accordance with the NYSDEC's BCP requirements.

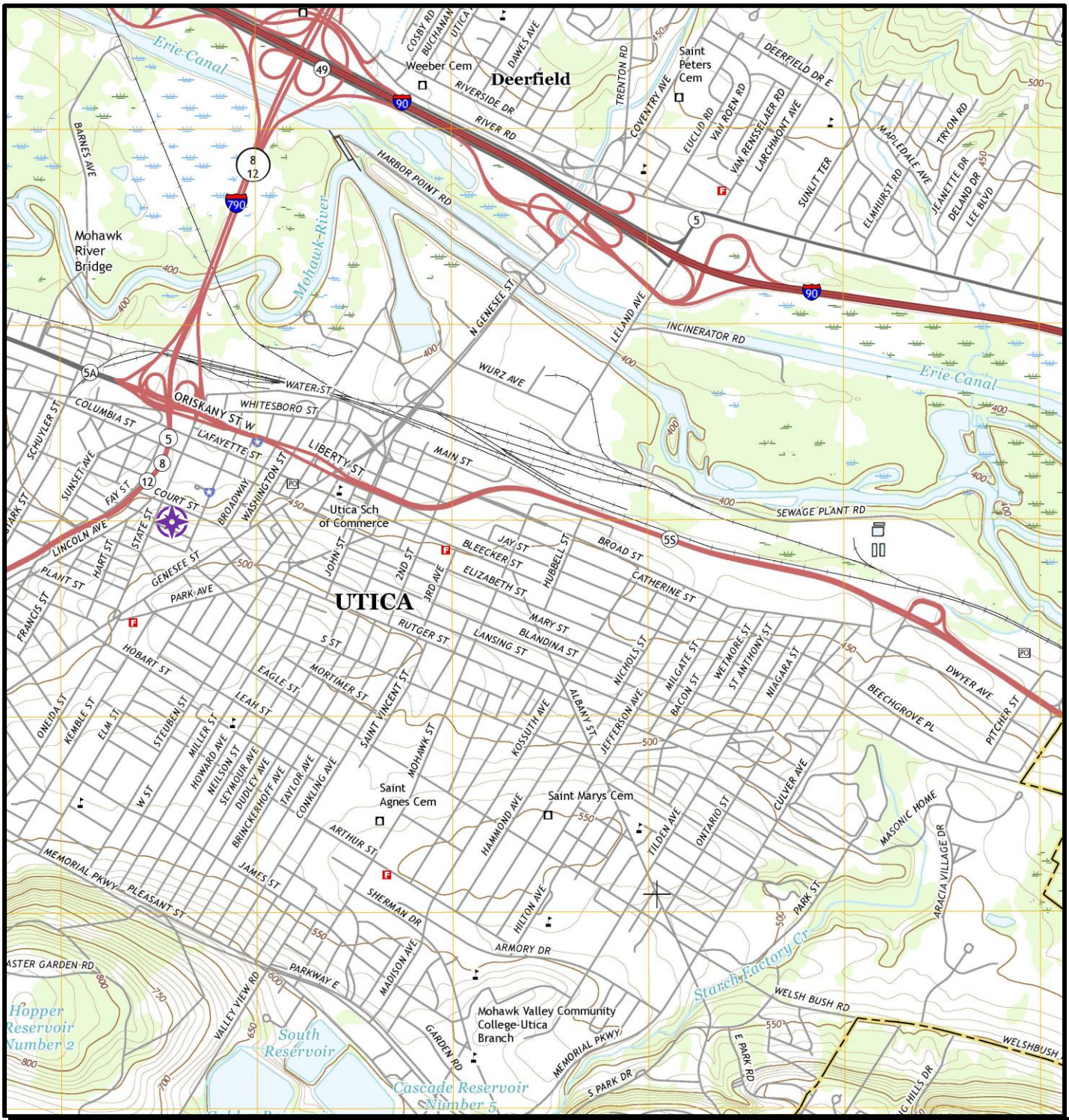
1.1. Site History

As shown on Figure 1, the Site is located at the southeast corner of the intersection of Stark and Court Streets in Utica, New York and consists of 4.874 acres. The Site is zoned Planned Development – Extraordinary, which supports the planned reuse of the on-Site buildings for affordable house use, and the area surrounding the Site is primarily residential and commercial.

For an approximate 110-year period beginning in 1840, historic site operations on the Site included woolen and worsted mills in support of the former Globe Mills operations. In the 1950's, the buildings were converted to office/warehouse type uses. The former dye building associated with the mill activity is located at 933 Stark Street. It is likely that solvents and petroleum were used during the wool manufacturing. Additionally, historical records indicate a 10,000-gallon diesel underground storage tank (UST) was removed in 1994. While the reported spill incident was closed by the NYSDEC after the UST removal, not all contamination associated with the UST was remediated based on a more recent Phase II Investigation.

The Site is improved with six one-, two-, three-, and four-story buildings with full and partial basements totaling just under 160,000 square feet (sf). The six buildings are combined into two separate structures. The eastern portion of the Site is improved with asphalt-paved parking areas. In 1968, the buildings were converted into university classroom spaces and were subsequently converted into mixed-use space in 1989.

N W E S	**Site Location Map** **Lofts at Globe Mill** **Utica, New York**	**Scale:**	1'' = 165'	EFI Global Engineering, Fire & Environmental Services
		Created By:	C. Dare	
		Revision:	1.0.0	
		Date:	11/08/2017	
		Source:	Google Earth	**Figure 1**



N W E S	**Site Topographic Map** **Lofts at Globe Mill** **Utica, New York** **= Site**	**Scale:**	1'' = 2000'	EFI Global Engineering, Fire & Environmental Services
		Created By:	C. Dare	
		Revision:	1.1.0	
		Date:	02/24/2018	
		Source:	USGS Topo Map	**Figure 2**

Structures immediately adjacent to the Site include the FX Matt Brewery immediately to the north beyond by Court Street; the Boilermaker Road Race headquarters, Tiger Lily Quilt Company, Hirt Park, and single-family residences to the east; single-family residences to the south; and single-family residences and In Tune Automotive to the west immediately beyond Stark Street. Refer to Figure 3.

Ground cover at the Site consists primarily of asphalt parking with limited landscaping and with the ground surface sloping gently to the north. Access to the Site can be gained from Court Street to the north via one drive, from Stark Street to the west via one drive, and from Warren Street to the south via one drive. Based upon topographic information in Figure 2 and general observations, the inferred direction of groundwater flow is toward the Mohawk River, which is located approximately one mile to the north of the Site.

Sanborn maps from the historical records review show a pond located on the southeastern side of the Site near the buildings addressed as 933 Start Street/Dye House #4 and 811-827 Court Street until sometime between 1925 and 1950. The pond previously drained into Nail Creek, which discharged to the northeast. The pond was filled, and Nail Creek was routed into a subterranean concrete channel that is located near the center of the former pond. Currently, the subterranean creek drains to the northeast and exits the Site along Court Street.

Wool and worsted mills typically used a weak sulfuric acid mixture in the thickening process, with soda ash (sodium chloride) utilized to neutralize the sulfuric acid. Ultraviolet light, potassium permanganate, iodine, alcohols, glycerol, tribrombetanaphthol, tetrachloroethane, formaldehyde, mercuric salts, xylene, Stoddard solvent, and tetrachloroethylene were historically used from the bacteriological standpoint.

1.2. Site Improvements

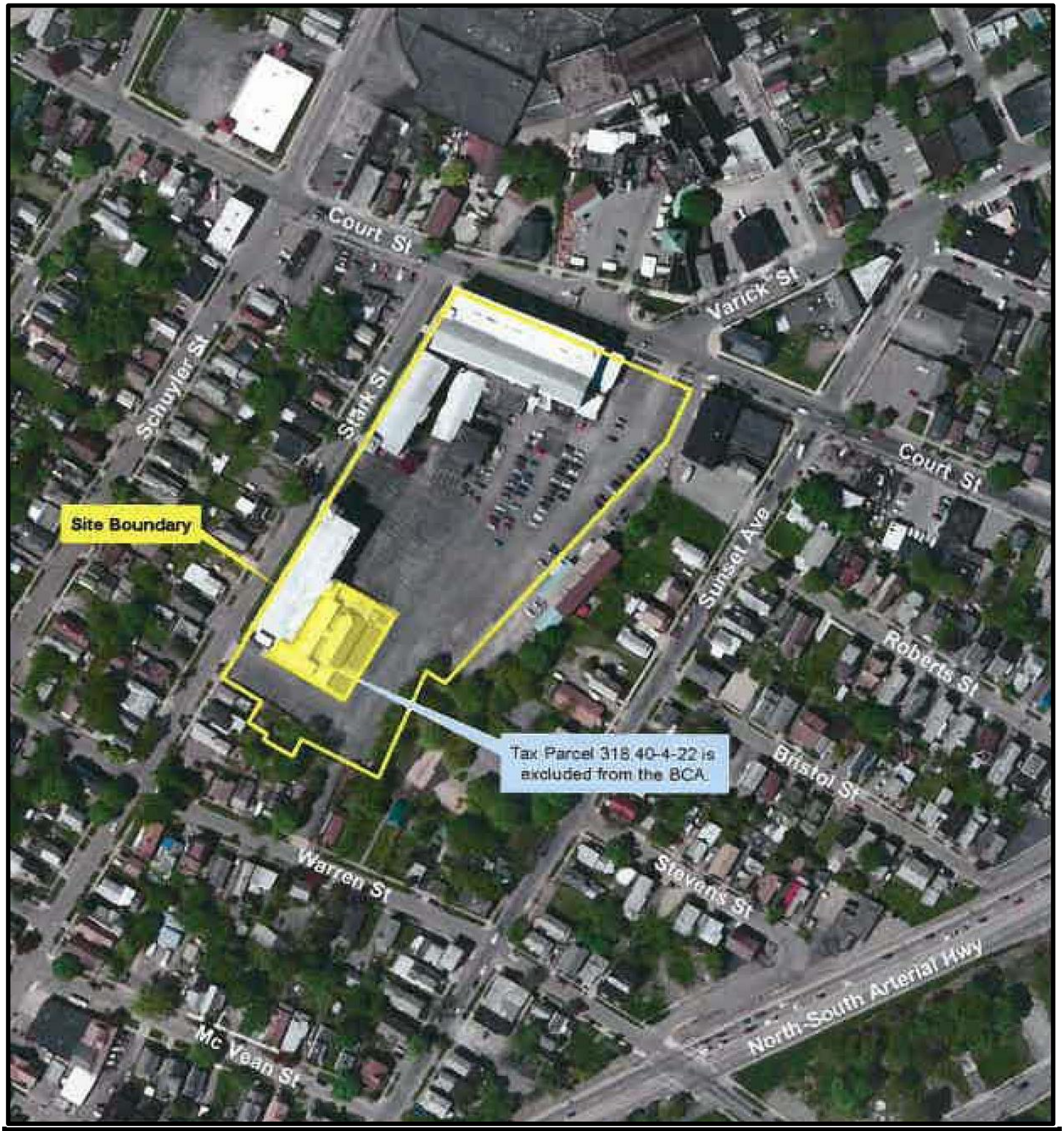
As previously noted, the Site was historically improved with six one-, two-, three-, and four-story buildings with full and partial basements totaling just under 160,000 sf. The six buildings are combined into two separate structures. The Dye House building is currently not part of the BCP Site. The eastern portion of the Site is improved with asphalt-paved parking areas.

The buildings located on the Site were originally constructed as wool and worsted mills in 1888, were converted to offices in 1950, were converted to university classroom space in 1968, and were mixed-use space beginning in 1989. The buildings are of wood-frame construction and are finished on the exterior with brick. The Site buildings have a flat rubber membrane roof. Further details associated with the buildings at the Site are provided below and are depicted in Figure 4:

- Building 1 - 827 Court Street - Four-stories - Basement
- Office Building - 815 Court Street - Two-stories - No Basement
- Boiler Room - One-story - Partial Basement

N W E S	**Surrounding Land Use** **Lofts at Globe Mill** **Utica, New York**	**Scale:**	Not to Scale	EFI Global Engineering, Fire & Environmental Services
		Created By:	C. Dare	
		Revision:	1.0.0	
		Date:	11/08/2017	
		Source:	EFI Global	**Figure 3**

N W E S	**Building Construction Summary** **Lofts at Globe Mill** **Utica, New York**	**Scale:**	Not to Scale	EFI Global Engineering, Fire & Environmental Services
		Created By:	C. Dare	
		Revision:	1.0.0	
		Date:	11/08/2017	
		Source:	EFI Global	**Figure 4**



N W E S	**Currently Excluded Buildings** **Lofts at Globe Mill** **Utica, New York**	**Scale:**	1" = 120 '	EFI Global Engineering, Fire & Environmental Services
		Created By:	C. Dare	
		Revision:	1.0.0	
		Date:	11/08/2017	
		Source:	EFI Global	**Figure 5**

- Building 2 - Four-stories - Partial Basement
- Building 6 - 811 Court Street - Two-stories - No Basement
- Building 4 - 925 Stark Street - Four-stories – Basement
- Former Dye Building - 933 Stark Street - One- & Two-stories - No Basement [Currently not part of the Site]

No surface water features were observed during historical site reconnaissance. Potable water is supplied to the Site by the Mohawk Valley Water Authority, and sanitary sewer service and storm sewer service is supplied by the Oneida County Department of Water Quality and Pollution Control. Electricity and natural gas are supplied by National Grid.

1.3. Previous Investigations

Over the past two years, four separate environmental investigations were completed at the Site. These reports also include the currently excluded lot on which the Dye House is present and include:

- Lu Engineers, Phase I Environmental Site Assessment for 811-827 Court Street & 925 and 933 Stark Street, City of Utica, Oneida County, New York, dated March 2016.
- EFI Global, Inc., Phase I Environmental Site Assessment Report, Lofts at Globe Mill, 925 Stark Street, Utica, NY 13502, Prepared for Lofts at Globe Mill, LP, dated March 2, 2017.
- EFI Global, Inc., Phase II Limited Subsurface Investigation Report, Loft at Globe Mill, 811-827 Court Street, 925 Street, and 933 Stark Street, Utica, New York, Prepared for: KCG Development, dated March 30, 2017.
- EFI Global, Inc., Phase II Limited Subsurface Investigation Report, Lofts at Globe Mill, 811-827 Court Street, 925 Stark Street, and 933 Stark Street, Utica, New York, Prepared for: Lofts at Globe Mill, LP, dated, May 16, 2017.

The scope and findings of each of these investigations are summarized below:

1.3.1. Lu Engineers, Phase I Environmental Site Assessment

In 2016, Lu Engineers prepared a Phase I Environmental Site Assessment for 811-827 Court Street & 925 and 933 Stark Street, City of Utica, Oneida County, New York Site. Based on the assessment performed, Lu Engineers believed the past uses of the Site did not identify any environmental concerns. However, Lu Engineers did indicate that, at the time of the site reconnaissance, parts of the buildings had water damage and peeling paint. Lu Engineers also noted that several spills had been recorded at the brewery located to the north of the Site over the course of its operations which began in the late 1800s. In addition, Lu Engineers noted that a 10,000-gallon UST was previously located adjacent and to the south of the Boiler Room at the Site. The removal of contaminated soil in 1994 along with the UST was documented. The contamination associated with the historical UST represents a Historical Recognized Environmental Concern (HREC) relating to the Site.

Lu Engineers recommended soil vapor sampling prior to building occupancy; building surveys for asbestos containing material (ACM), mold, and lead based paint (LBP), and removal and proper disposal of all hazardous substances that could remain from various past uses.

1.3.2. EFI Global, Inc., Phase I Environmental Site Assessment Report

This assessment was performed to support a bona fide landowner defense to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) liability prior to potential acquisition and to delineate potential business environmental risk.

EFI Global, Inc. reviewed regulatory databases and files from federal, state, and local environmental regulatory agencies to identify use, generation, storage, treatment or disposal of hazardous materials or release incidents of such materials that may impact the Site. The records reviewed included, but were not limited to, the following:

*

- Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS);
- National Priorities List (NPL);
- Resource Conservation Recovery Information System (RCRIS);
- Treatment, Storage and Disposal Facilities (TSD);
- Large and Small Quantity Generators;
- Emergency Response Incidence Logs;
- State-registered USTs;
- State leaking underground storage tank (LUST) incident reports;
- State solid waste facilities/landfill sites (SWF/LS);
- State hazardous waste sites (SHWS); and
- Other local records.

No RECs were noted based on the regulatory database search.

The Site was identified on the UST and NY Spills database due to a heating oil release in 1994 observed during the removal of a 10,000 gallon UST. The incident was closed by the NYSDEC in 1994; therefore, EFI Global, Inc. considered this listing a HREC.

The northern adjacent property was identified on the NY Spills database for several incidents. However, because the site is located down gradient and the spills were all issued regulatory closures, the further assessment was noted.

The assessment revealed the following:

- Based on the site's historical use as a wool mill from the late 1880s to the 1950s, which utilized paints, oils, and solvents, and then as Resource Conservation and Recovery Act (RCRA) generators in the 1980s and 1990s, which utilized solvents and metals, the historic uses are considered a REC.

The following HREC was identified during EFI Global, Inc.'s assessment:

- The Site formerly maintained a 10,000-gallon UST that was utilized to store No. 2 fuel oil, which was removed in September 1994. During the removal operations, contamination was observed around the fill port. Remedial actions were conducted and the regulatory file on this release incident was closed on December 8, 1994.

EFI Global, Inc. also evaluated ACM, radon, LBP, lead in drinking water, wetlands, and mold. The following were noted:

- Based on the pre-1900 date of construction, some of the building materials may contain asbestos. The suspect ACM consists of friable gypsum drywall and joint compound, friable ceiling tiles, and non-friable floor tiles, mastic, and roofing material. These materials were observed in fair to good condition at the time of the reconnaissance. It should be noted that although the United States Environmental Protection Agency (USEPA) allows suspect or ACM to be managed in place under an operations and maintenance (O&M) program, sampling would be required to document the presence or absence of ACM.

The following environmental concerns were also noted:

- The anticipated use of the renovated buildings is to be for residential purposes. Therefore, due to the construction date of buildings (pre-1978), LBP may be present. Several areas of peeling and flaking were observed within the buildings during the reconnaissance. If documentation cannot be provided that all LBP has been removed, then an O&M program should be implemented prior to residential occupancy.
- Three aboveground storage tanks (ASTs) that are no longer in use were observed in the boiler room (see Figure 4). If the ASTs are not going to be utilized

*

for the redevelopment of the Site, then they should be removed and disposed of in accordance with local, state, and federal regulations and guidelines.

1.3.3. EFI Global, Inc., Phase II Limited Subsurface Investigation Report, March 2017

The objective of the investigation was to further evaluate the extent of contamination in the subsurface of the Site, based on the information obtained during the EFI Global, Inc. Phase I Environmental Site Assessment Report which concluded that it was likely that solvents and petroleum were used during wool manufacturing.

During the Phase II investigation, six borings (B-1 through B-6) were completed to assess the following areas of interest which were identified in the EFI Global, Inc.'s Phase I Environmental Site Assessment Report:

- B-1: Near Dye House #4 / Sheet Metal Works
- B-2: Former pond (suspected effluent discharge area)
- B-3: Mill #3 / Carpenter Shop and Welding
- B-4: Mill #5 / Paint Shop and Oil Storage
- B-5: Maintenance Shop
- B-6: Northeast corner of Mill #1

Soil samples that were collected from borings B-1 through B-6 were analyzed for volatile organic compounds (VOC) and poly-nuclear aromatic hydrocarbons (PAHs). Soil samples from borings B-1 and B-2 were also analyzed for metals. Groundwater was encountered in borings B-1 through B-5 with each boring converted into a temporary well and labeled as TW-1 through TW-5, respectively. Groundwater samples were extracted from each temporary well and analyzed for VOCs and PAHs. Like the soil samples, the groundwater samples from TW-1 and TW-2 were analyzed for metals (total and dissolved).

Two Areas of Concern (AOC) were noted during the Phase II investigation, a former maintenance shop (AOC-1) and the former pond (AOC-2). Borings, which were completed in these areas, included B-5/TW-5 at AOC-1 and B-2 at AOC-2.

Benzene was detected in soil sample B-5 at 0.36 milligrams per kilogram (mg/kg), which exceeds the NYSDEC Unrestricted Use Soil Cleanup Objective (UUSCO) of 0.06 mg/kg. Mercury was detected in soil sample B-2 at 1.2 mg/kg, which exceeds the NYSDEC UUSCO of 0.18 mg/kg, and arsenic was detected in soil sample B-2 at 13 mg/kg, which is equal to the UUSCO.

Benzene was detected in groundwater sample TW-5 at 63 micrograms per liter (ug/l), which far exceeds the applicable NYSDEC Technical & Operations Guidance Series (TOGS) Ambient Water Quality Standard and Guidance Value of 1 ug/l. Additionally, benzo(b)fluoranthene was detected in groundwater sample TW-5 at 1.1 ug/l, which far exceeds the NYSDEC TOGS criteria of 0.002 ug/l.

Further evaluation of the extent of the subsurface contamination present at the Site was recommended.

All soil sampling results are presented in Table 1. The location of the first round of borings are presented in Figure 6 and Figure 10.

1.3.4 EFI Global Inc., Phase II Limited Subsurface Investigation Report, May 2017

Based on the March 2017 investigation, an expanded Phase II investigation was conducted in April 27, 2017, which was documented in this May 2017 Report, to further investigate AOC-1 and AOC-2. During the expanded investigation, 12 soil borings (2B-1 through 2B-12) were completed.

*

Sample ID	**B-1**	**B-2**	**B-3**	**B-4**	**B-5**	**B-6**	**B-3**	**B-4**	**B-5**	**B-6**	**NYSDEC**	**NYSDEC**	**NYSDEC**	**NYSDEC**
Sample Depth	6-7'	3-4'	4-5'	6-7'	4-5'	3-4'	4-5'	6-7'	4-5'	3-4'	Unrestricted	Residential	Residential	Protection of
Sample Date	3/15/17	3/15/17	3/15/17	3/15/17	3/15/17	3/15/17	3/22/17	3/22/17	3/22/17	3/22/17	Use (SCO)	Use	Restricted Use	Groundwater
VOC														
Acetone	0.008	0.0057	0.0033	0.0026	0.028	ND	NA	NA	NA	NA	0.05	100	100	0.05
Benzene	ND	ND	ND	ND	**0.36**	ND	NA	NA	NA	NA	0.06	2.9	4.8	0.06
2-Butanon (MEK)	ND	ND	ND	ND	0.005	ND	NA	NA	NA	NA				
Carbon Disulfide	ND	ND	ND	ND	0.0064	ND	NA	NA	NA	NA	*	***77***	***77***	*
Chloroform	ND	ND	0.0039	ND	ND	ND	NA	NA	NA	NA	0.37	10	49	0.37
Ethylbenzene	ND	ND	ND	ND	0.00044	ND	NA	NA	NA	NA	1	30	41	1
Methylene Chloride	0.0017	ND	0.00083	ND	ND	ND	NA	NA	NA	NA	0.05	51	100	0.05
Styrene	ND	ND	ND	ND	0.0002	ND	NA	NA	NA	NA	*	600	600	*
Toluene	ND	ND	ND	ND	0.016	ND	NA	NA	NA	NA	0.7	100	100	0.7
m&p-Xylene	ND	ND	ND	ND	0.00058	ND	NA	NA	NA	NA	0.26	100	100	1.6
SVOC														
Acenaphthylene	ND	0.19	NA	NA	NA	NA	ND	ND	ND	ND	100	100	100	98
Benzo[b]fluoranthene	ND	0.39	NA	NA	NA	NA	ND	ND	ND	ND	1	1	1	1.7
Chrysene	ND	0.092	NA	NA	NA	NA	ND	ND	ND	ND	1	1	3.9	1
Fluoranthene	0.024	0.077	NA	NA	NA	NA	ND	ND	ND	ND	100	100	100	1000
Fluorene	ND	0.019	NA	NA	NA	NA	ND	ND	ND	ND	30	100	100	386
Indeno[1,2,3-cd]pyrene	ND	0.088	NA	NA	NA	NA	ND	ND	ND	ND	0.5	0.5	0.5	8.2
Naphthalene	ND	0.78	NA	NA	NA	NA	ND	ND	ND	ND	12	100	100	12
Phenanthrene	0.021	0.2	NA	NA	NA	NA	ND	ND	ND	ND	100	100	100	1000
Pyrene	ND	0.71	NA	NA	NA	NA	ND	ND	ND	ND	100	100	100	1000
Metals														
Barium	57	220	NA	NA	NA	NA	NA	NA	NA	NA	350	350	400	820
Chromium	14.4	7.2	NA	NA	NA	NA	NA	NA	NA	NA	*	***22^{Cr+6}/36^{Cr+3}***	***110^{Cr+6}/180^{Cr+3}***	***19^{Cr+6}/NS^{Cr+}***
Lead	22.8	8.4	NA	NA	NA	NA	NA	NA	NA	NA	63	400	400	450
Selenium	ND	2.3	NA	NA	NA	NA	NA	NA	NA	NA	3.9	36	180	4
Mercury	0.055	***1.2***	NA	NA	NA	NA	NA	NA	NA	NA	0.18	0.81	0.81	0.73

Concentrations reported in micrograms per kilogram (mg/kg)

ND - Not Detected **NA - Not Analyzed**

Bold concentrations exceed the Unrestrictive Soil Cleanup Objective

Bold **concentrations exceed the Residential Soil Cleanup Objective**

USEPA Residential RSL – *Italic*

Table 1- Soil Analytical Results

Sample ID	**2B-1**	**2B-2**	**2B-3**	**2B-4**	**2B-5**	**2B-6**	**2B-8**	**2B-9**	**2B-10**	**2B-11**	**2B-12**	**NYSDEC**	**NYSDEC**	**NYSDEC**	**NYSDEC**
Sample Depth	7-8'	5-6'	7-8'	5-6'	7-8'	7-8'	5-6'	5-6'	5-6'	5-6'	4-5'	Unrestricted	Residential	Residential	Protection of
Sample Date	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	Use(SCO)	Use	Restricted Use	Groundwater
VOC															
Acetone	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	0.05	100	100	0.05
Benzene	NA	NA	NA	NA	NA	NA	ND	ND	ND	0.00523	0.00181	0.06	2.9	4.8	0.06
Chloroform	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	0.37	10	49	0.37
Ethylbenzene	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	1	30	41	1
Methylene Chloride	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	0.05	51	100	0.05
Styrene	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	*	600	600	***120***
Tetrachloroethene	NA	NA	NA	NA	NA	NA	0.00365	ND	ND	ND	ND	1.3	5.5	19	1.3
Toluene	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	0.7	100	100	0.7
Trichloroethene	NA	NA	NA	NA	NA	NA	0.00380	ND	ND	ND	ND	0.47	10	21	0.47
m&p-Xylene	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	0.26	100	100	1.6
SVOC															
Anthracene	NA	NA	NA	NA	NA	NA	0.0847	ND	0.102	ND	ND	100	100	100	1000
Acenaphthene	NA	NA	NA	NA	NA	NA	0.0249	ND	ND	ND	ND	20	100	100	98
Acenaphthylene	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	100	100	100	107
Benzo[a]anthracene	NA	NA	NA	NA	NA	NA	0.372	ND	0.252	ND	0.389	1	1	1	1
Benzo[a]pyrene	NA	NA	NA	NA	NA	NA	0.357	ND	0.244	ND	0.459	1	1	1	22
Benzo[b]fluoranthene	NA	NA	NA	NA	NA	NA	0.409	ND	0.345	0.0125	0.682	1	1	1	1.7
Benzo[g,h,i]perylene	NA	NA	NA	NA	NA	NA	0.333	ND	0.231	0.00937	0.483	100	100	100	1000
Benzo[k]fluoranthene	NA	NA	NA	NA	NA	NA	0.108	ND	0.125	ND	0.207	0.8	1	3.9	1.7
Chrysene	NA	NA	NA	NA	NA	NA	0.355	ND	0.310	0.0082	0.471	1	1	3.9	1
Dibenz[a,h]anthracene	NA	NA	NA	NA	NA	NA	0.101	ND	0.0775	ND	ND	0.33	0.33	0.33	1000
Fluoranthene	NA	NA	NA	NA	NA	NA	0.577	ND	0.619	ND	0.834	100	100	100	1000
Fluorene	NA	NA	NA	NA	NA	NA	0.0218	ND	ND	ND	ND	30	100	100	386
Indeno[1,2,3-cd]pyrene	NA	NA	NA	NA	NA	NA	0.259	ND	0.183	ND	0.381	0.5	0.5	0.5	8.2
Naphthalene	NA	NA	NA	NA	NA	NA	0.0417	ND	ND	ND	ND	12	100	100	12
Phenanthrene	NA	NA	NA	NA	NA	NA	0.279	ND	0.334	ND	0.171	100	100	100	1000
Pyrene	NA	NA	NA	NA	NA	NA	0.553	ND	0.478	ND	0.688	100	100	100	1000
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	0.0238	ND	ND	ND	ND	00	00	00	000

*

Table 1- Soil Analytical Results

Sample ID	**2B-1**	**2B-2**	**2B-3**	**2B-4**	**2B-5**	**2B-6**	**2B-8**	**2B-9**	**2B-10**	**2B-11**	**2B-12**	**NYSDEC**	**NYSDEC**	**NYSDEC**	**NYSDEC**
Sample Depth	7-8'	5-6'	7-8'	5-6'	7-8'	7-8'	5-6'	5-6'	5-6'	5-6'	4-5'	Unrestricted	Residential	Residential	Protection of
Sample Date	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	4/27/17	Use(SCO)	Use	Restricted Use	Groundwater
Metals															
Arsenic	12.2	***59.6***	***19.5***	10.7	**15.1**	13.0	NA	NA	NA	NA	NA	13	16	16	16
Barium	83.9	142	141	94.8	129	121	NA	NA	NA	NA	NA	350	350	400	820
Beryllium	–	–	–	–	–	–	–	–	–	–	–	7.2	14	–	47
Cadmium	ND	0.769	2.35	ND	0.953	ND	NA	NA	NA	NA	NA	2.5	4	7.5	7.5
Chromium	**24.6**	13.9	**25.4**	19.1	21.9	21.6	NA	NA	NA	NA	NA	1/30	***22*** $^{Cr+6}$***/36*** $^{Cr+3}$	***110*** $^{Cr+6}$***/180*** $^{Cr+3}$	***19*** $^{Cr+6}$***/NS*** $^{Cr+3}$
Copper	–	–	–	–	–	–	–	–	–	–	–	50	–	–	1720
Total Cyanide	–	–	–	–	–	–	–	–	–	–	–	27	27	27	40
Lead	13.1	22.9	**170**	**311**	**244**	**112**	NA	NA	NA	NA	NA	63	400	400	450
Manganese	–	–	–	–	–	–	–	–	–	–	–	1600	2000	2000	2000
Nickel	–	–	–	–	–	–	–	–	–	–	–	30	140	310	130
Selenium	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA	3.9	36	36	4
Silver	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA	2	36	36	8.3
Zinc	–	–	–	–	–	–	–	–	–	–	–	109	2200	10,000	2480
Mercury	0.0305	0.0278	**0.729**	**0.211**	***1.02***	**0.59**	NA	NA	NA	NA	NA	0.18	0.81	0.81	0.73

Concentrations reported in micrograms per kilogram (ug/kg)
ND - Not Detected
NA - Not Analyzed
NS - Not Specified

Bold concentrations exceed the Unrestrictive Soil Cleanup Objective
Bold **concentrations exceed the Residential Soil Cleanup Objective**
USEPA Residential RSL – ***Italic***

*

N W E S	**March 2017 Boring Location Map** **Lofts at Globe Mill** **Utica, New York**	**Scale:**	1 '' = ~ 115 '	EFI Global Engineering, Fire & Environmental Services
		Created By:	C. Dare	
		Revision:	1.0.0	
		Date:	11/08/2017	
		Source:	Google Earth	**Figure 6**

To address AOC-2, borings 2B-1 through 2B-6 were completed as follows:

- Boring 2B-1 was completed 30 feet east and 2 feet south of the northeast corner of Dye House #4.
- Boring 2B-2 was completed 108 feet east and 2 feet south of the northeast corner of Dye House #4.
- Boring 2B-3 was completed 57 feet east and 43 feet south of the northeast corner of Dye House #4.
- Boring 2B-4 was advanced 120 feet east and 15 feet north of the northeast corner of Dye House #4.
- Boring 2B-5 was advanced 90 feet east and 30 feet north of the northeast corner of Dye House #4.
- Boring 2B-6 was advanced 100 feet east and 120 feet north of the northeast corner of Dye House #4.

To address AOC-1, borings 2B-8 through 2B-12 were completed as follows:

- Boring 2B-8 was completed 72 feet west and 29 feet south of the southeast corner of the former Mill #1 structure.
- Boring 2B-9 was completed three feet east and 13 feet south of the southeast corner of the former Turbine Building that is present to the east of the former Mill #2 structure.
- Boring 2B-10 was completed 107 feet west and 75 feet south of the southeast corner of the former Mill #1 structure.
- Boring 2B-11 was completed 160 feet west and 25 feet south of the southeast corner of the former Mill #1 structure.
- Boring 2B-12 was completed 133 feet west and 40 feet south of the southeast corner of the former Mill #1 structure.

Each of the soil borings was completed to 12 feet below grade level (BGL), except for boring 2B-2, which was completed to 10 feet BGL where refusal in the form of gravel was encountered. Groundwater at each of the borings was encountered at depths ranging of approximately five feet BGL (borings 2B-7 and 2B-12) to 10 feet BGL (2B-9). Soil encountered across the Site consisted of mixtures of various fill materials such as brick, glass, and wood, combined with gravelly sand in the shallower soil grading to sandy and gravelly clay near the water table to the boring termini.

Soil samples were continuously collected from borings 2B-1 through 2B-12 with a four-foot long stainless-steel macro core and disposable polyvinyl chloride (PVC) sleeves. The soil samples collected from each boring were field screened to the terminal depths with a photo-ionization detector (PID) to determine if volatile organic vapors were present. There were no field screening readings, olfactory, or visual indications of contamination detected in soil samples collected from borings 2B-1 through 2B-6 addressing AOC-2.

Based upon the absence of PID detections and field observations indicative of contamination, soil samples were collected for metal analysis from each of these borings above the water table and within the capillary fringe. Specifically, the soil samples were collected for metals analysis from seven to eight feet BGL at 2B-1, 2B-3, and 2B-6, from five to six feet BGL at 2B-2 and 2B-4, and from six to seven feet at 2B-5. At borings 2B-8

and 2B-9, there were no field screening readings, olfactory, or visual indications of contamination detected in the soil. Therefore, soil samples were collected from these two borings for analysis of VOCs and PAH above the water table and within the capillary fringe. Specifically, the soil samples for laboratory analysis were collected from five to six feet at boring 2B-8 and from nine to ten feet at boring 2B-9. At borings 2B-10, 2B-11, and 2B-12 elevated PID readings were detected in the soil present within the groundwater saturated zone ranging from 0.8 to 5.8 parts per million (PPM) at boring 2B-10, 5.8 to 12.1 PPM at boring 2B-11, and 3.0 to 3.6 PPM at boring 2B-12. No elevated PID measurements were noted in unsaturated soil. Therefore, samples of soil for VOC and PAH analyses were collected from each of these borings above the water table and within the capillary fringe. Specifically, soil was collected for VOC and PAH analyses from borings 2B-10 and 2B-11 at five to six feet BGL and from boring 2B-12 at four to five feet BGL. Boring 2B-7 was not advanced to specifically address either AOC-1 or AOC-2, rather this boring was advanced to install a temporary well point at what is estimated to be the down gradient side of the Site. As such, no soil samples were collected from boring 2B-7 for chemical analysis.

Groundwater was encountered in borings 2B-1 through 2B-12 at depths ranging from five to 10 feet BGL. Temporary groundwater monitoring wells were installed in borings 2B-1 through 2B-9 and labeled 2TW-1 through 2TW-9, respectively, to collect groundwater samples for laboratory analysis. The temporary wells were constructed of one-inch diameter schedule 40 PVC well screen and riser pipe. A centrifugal pump with disposable polyvinyl and silicone tubing was used to extract the groundwater from 2TW-1 through 2TW-9, which was transferred directly into the laboratory supplied glassware. Temporary wells were not placed in borings 2B-10, 2B-11, or 2B-12 due to the presence of a significant layer of light non-aqueous phase liquid (LNAPL) upon the water table at these locations. The LNAPL appeared to consist of fuel oil. Therefore, no groundwater samples were collected for laboratory analysis from these borings. The LNAPL is most likely from the former 10,000-gallon UST and possibly other maintenance operations.

Temporary wells 2TW-1 through 2TW-6 were installed to address AOC-2. The groundwater collected from these temporary wells was analyzed for VOCs, metals, and dissolved metals. Temporary wells 2TW-8 and 2TW-9 were installed to address AOC-1. Groundwater samples from 2TW-8 and 2TW-9 were analyzed for VOCs and PAHs. Temporary well 2TW-7 was installed as a down gradient well point at the Site. The groundwater sample from this temporary well was analyzed for VOCs, PAHs, metals, and dissolved metals.

The borings were abandoned in accordance with New York regulations following the collection of the soil and groundwater samples. The locations of the second round of borings are shown in Figure 7 and Figure 10.

Analytical reports show that:

- Arsenic was detected in sample 2B-2 at 59.6 mg/kg; in 2B-3 at 19.5 mg/kg; in 2B-5 at 15.1 mg/kg; and in 2B-6 at 13 mg/kg. These concentrations exceed or equal the NYSDEC UUSCO of 13 mg/kg.
- Lead was detected in 2B-3 at 170 mg/kg; in 2B-4 at 311 mg/kg; in 2B-5 at 244 mg/kg; and in 2B-6 at 112 mg/kg. These concentrations exceed the NYSDEC UUSCO of 63 mg/kg.

- Mercury was detected in 2B-3 at 0.729 mg/kg; in 2B-4 at 0.211 mg/kg; in 2B-5 at 1.02 mg/kg; and in 2B-6 at 0.59 mg/kg. These concentrations exceed the NYSDEC UUSCO of 0.18 mg/kg.
- Chromium was detected in soil samples 2B-1 at 24.6 mg/kg; in 2B-2 at 13.9 mg/kg; in 2B-3 at 25.4 mg/kg; in 2B-4 at 19.1 mg/kg; in 2B-5 at 21.9 mg/kg; and in 2B-6 at 21.6 mg/kg. There is no specific NYSDEC regulatory criteria for chromium. The UUSCO for trivalent chromium is 30 mg/kg, and the UUSCO for hexavalent chromium is 1 mg/kg.

The detected chromium is likely trivalent chromium given that chromium was used by the textile industry as a catalyst in the dyeing process and as a dye for wool. Therefore, a possible source for the chromium at the former pond is effluent discharge from the former Dye House #4, which is currently excluded from the Site (see Figure 5). No other metals were detected in the soil samples at concentrations exceeding the applicable regulatory criteria, and no VOCs or PAHs were detected in the soil samples at concentrations exceeding the applicable regulatory criteria. The soil analytical results are summarized in Table 1.

Analytical reports show that:

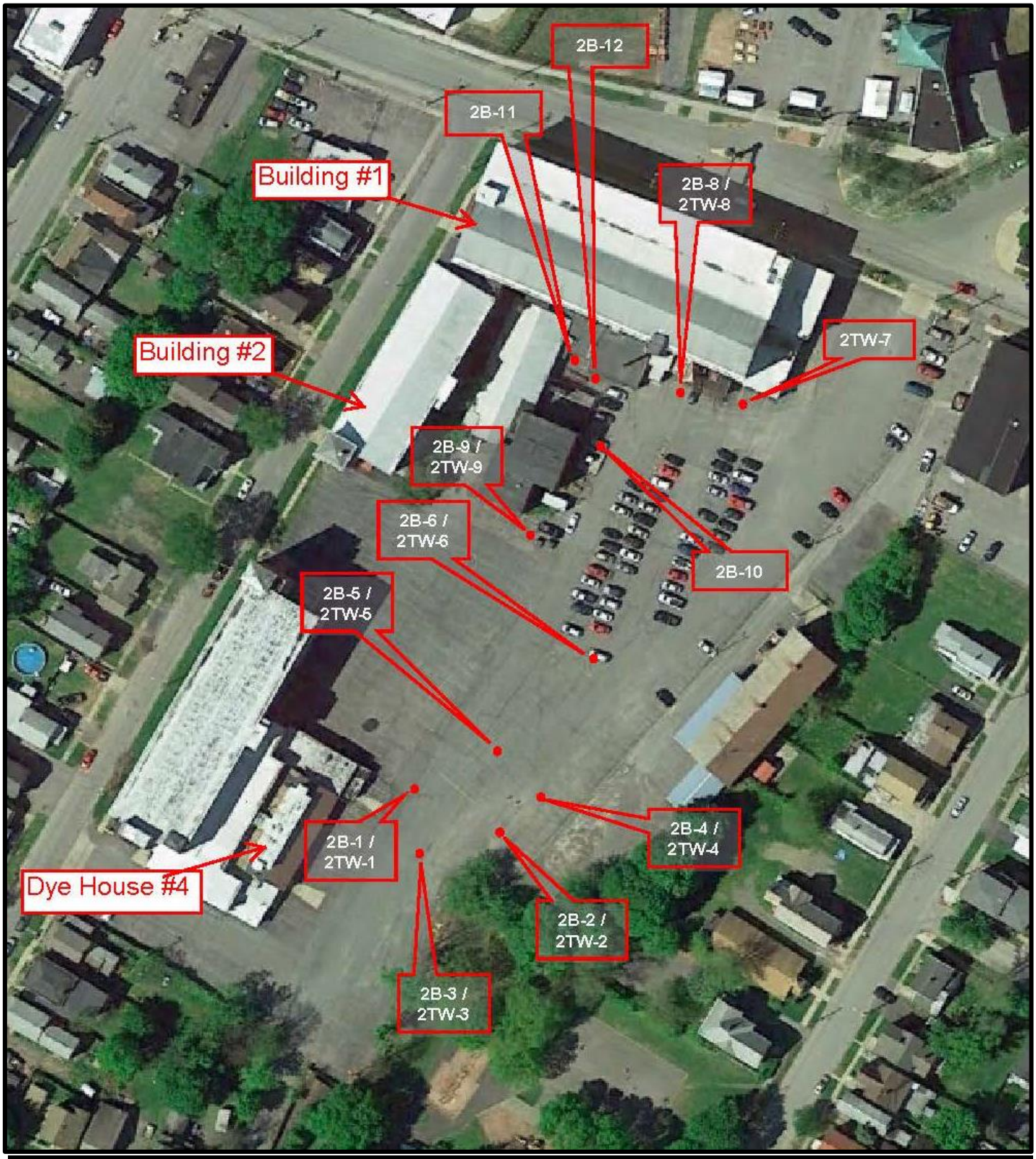
- Chrysene was detected in sample 2TW-9 at 0.135 ug/l, which exceeds the applicable NYSDEC TOGS Ambient Water Quality Standards and Guidance Values criteria of 0.002 ug/l. No other PAHs were detected in the groundwater samples and no VOCs were detected in the groundwater samples.
- Arsenic, barium, cadmium, chromium, lead, and selenium were detected at concentrations exceeding the applicable NYSDEC TOGS criteria in most of the unfiltered samples.
- Dissolved barium was detected in samples 2TW-1 through 2TW-7.
- Dissolved lead was detected in samples 2TW-3 through 2TW-6.
- Dissolved selenium was detected in samples 2TW-3 and 2TW-6.

There are no state standards for dissolved metals; however, the concentration of dissolved selenium in samples 2TW-3 and 2TW-6 exceeds the NYSDEC TOGS criteria for total selenium. The groundwater analytical results are summarized in Table 2.

1.4. Site Development Plan

Lofts at Globe Mill, L.P. intends to develop the three main structures located at the corner of Court Street and Stark Street into the Lofts at Globe Mill, a mixed-use, mixed-income, and historic adaptive reuse property which will deliver affordable, modern loft style apartment homes to downtown Utica, NY. The Lofts at Globe Mill, L.P. redevelopment is intended to become the next premier mixed-use housing and commercial development in downtown Utica, NY.

With the help of Carmina Wood Morris Architects and Charles A. Gaetano Construction Corporation, proposed redevelopment calls for the creation of 131 apartment homes and approximately 36,000 sf of ground floor commercial and office space.



N W E S	**April 2017 Boring Location Map** **Lofts at Globe Mill** **Utica, New York**	**Scale:**	1 '' = ~ 115 '	EFI Global Engineering, Fire & Environmental Services
		Created By:	C. Dare	
		Revision:	1.0.0	
		Date:	11/08/2017	
		Source:	Google Earth	**Figure 7**

Table 2- Groundwater Analytical Results															
Sample ID	TW-1	TW-2	TW-3	TW-4	TW-5	2TW-1	2TW-2	2TW-3	2TW-4	2TW-5	2TW-6	2TW-7	2TW-8	2TW-9	NYSDEC
Sample Date	3/15/2017	3/15/2017	3/15/2017	3/15/2017	3/15/2017	4/27/2017	4/27/2017	4/27/2017	4/27/2017	4/27/2017	4/27/2017	4/27/2017	4/27/2017	4/27/2017	TOGS
VOC															
Acetone	ND	ND	ND	0.0026	13	ND	ND	ND	ND	ND	ND	ND	ND	ND	50
Benzene	ND	ND	ND	ND	**63**	ND	ND	ND	ND	ND	ND	ND	ND	ND	**1**
Carbon Disulfide	ND	ND	ND	ND	0.34	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
2-Butanone (MEK)	ND	ND	ND	ND	2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	50
Chloroform	2.4	ND	2.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7
Ethylbenzene	ND	ND	ND	ND	0.47	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Methylene Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Tetrachloroethene	0.27	ND	0.13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.7
Toluene	ND	ND	ND	ND	1.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Cyclohexane	ND	ND	ND	ND	2.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
Isopropylbenzene	ND	ND	ND	ND	3.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
N-Propylbenzene	ND	ND	ND	ND	8.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
sec-Butylbenzene	ND	ND	ND	ND	2.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
tert-Butylbenzene	ND	ND	ND	ND	0.33	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
n-Butylbenzene	ND	ND	ND	ND	8.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
Methylcyclohexane	ND	ND	ND	ND	4.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
o-Xylene	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
PAH															
Anthracene	ND	0.59	ND	ND	7.3	NA	NA	NA	NA	NA	NA	ND	ND	0.0728	50
Acenaphthene	ND	ND	ND	ND	8.6	NA	NA	NA	NA	NA	NA	ND	0.652	0.938	20
Acenaphthylene	ND	0.19	ND	ND	12	NA	NA	NA	NA	NA	NA	ND	0.0715	1.04	*
Benzo[a]anthracene	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	ND	ND	0.0983	*
Benzo[b]fluoranthene	ND	ND	ND	ND	**1.1**	NA	NA	NA	NA	NA	NA	ND	ND	ND	0.002
Chrysene	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	ND	ND	**0.135**	0.002
Fluoranthene	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	ND	ND	0.403	50
Fluorene	ND	ND	ND	ND	19	NA	NA	NA	NA	NA	NA	ND	0.160	0.613	50

Table 2- Groundwater Analytical Results															
Sample ID Sample Date	TW-1 3/15/2017	TW-2 3/15/2017	TW-3 3/15/2017	TW-4 3/15/2017	TW-5 3/15/2017	2TW-1 4/27/2017	2TW-2 4/27/2017	2TW-3 4/27/2017	2TW-4 4/27/2017	2TW-5 4/27/2017	2TW-6 4/27/2017	2TW-7 4/27/2017	2TW-8 4/27/2017	2TW-9 4/27/2017	NYSDEC TOGS
Phenanthrene	ND	ND	ND	ND	50	NA	NA	NA	NA	NA	NA	ND	ND	0.0720	50
Pyrene	ND	ND	ND	1.4	3.7	NA	NA	NA	NA	NA	NA	ND	ND	1.85	50
1-Methylnaphthalene	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	ND	0.407	ND	*
Metals															
Arsenic	22.2	**484**	NA	NA	NA	**65.0**	**427**	**634**	45.0	26.0	**230**	**88.6**	NA	NA	50
Arsenic Dissolved	ND	18	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	NA	NA	*
Barium	122	**1450**	NA	NA	NA	702	**1,340**	737	374	213	**1,760**	404	NA	NA	1000
Barium Dissolved	39.3	99.8	NA	NA	NA	71.0	53.8	39.5	81.1	105	86.4	63.1	NA	NA	*
Cadmium	ND	**6.4**	NA	NA	NA	ND	**12.4**	**36.6**	**6.10**	ND	**19.2**	ND	NA	NA	5
Cadmium Dissolved	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	NA	NA	*
Chromium	25.3	**275**	NA	NA	NA	**86.5**	**179**	**174**	**84.3**	**145**	**258**	**145**	NA	NA	50
Chromium Dissolved	2.4	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	NA	NA	*
Lead	**40.6**	**1500**	NA	NA	NA	**109**	**393**	**419**	**293**	**524**	**2,540**	**175**	NA	NA	25
Lead Dissolved	ND	6.7	NA	NA	NA	ND	ND	6.96	5.44	8.77	6.06	ND	NA	NA	*
Selenium	4.4	**47.3**	NA	NA	NA	ND	**16.9**	**112**	ND	ND	**47.3**	**20.3**	NA	NA	10
Selenium Dissolved	4.9	8.4	NA	NA	NA	ND	ND	72.1	ND	ND	11.0	ND	NA	NA	*
Silver	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	NA	NA	50
Silver Dissolved	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	NA	NA	*
Mercury	ND	7.5	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	NA	NA	*
Mercury Dissolved	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	NA	NA	*

Concentrations reported in micrograms per liter (ug/l)

ND - Not Detected

NA - Not Analyzed

Bold concentrations exceed the state standards

* - No Specific State Standard

2. Purpose

A RI is planned to further characterize the Site and support planned development in accordance with the requirements of the NYSDEC BCP. Based on the historical use of the Site and documented characterization results, the EFI Global team has developed a work scope to define conditions at the Site. This RIWP details specific tasks that will facilitate characterization of contaminants of concern (COCs) to achieve compliance with the NYSDEC BCP requirements. Specifically, when used in concert with results of previous investigations, the findings of the RI will be used to:

- Delineate the extent, amount, concentration, persistence, mobility, form (e.g., solid, liquid), and other significant characteristics of the contamination present.
- Define hydrogeological factors [e.g., depth to saturated zone, hydrologic gradients (if practical), proximity to a drinking water aquifer, and wetlands proximity].
- Define the thickness and aerial extent of fill material at the Site and characterize the COCs of the fill material.
- If applicable, define the extent to which the COCs have potential to migrate, and whether potential future migration may pose a threat to human health or the environment.
- Determine the extent to which contaminant levels pose an unacceptable risk to public health and the environment.
- Provide sufficient information to allow for the identification of potentially feasible remedial alternatives.
- Develop Remedial Action Objectives (RAOs) for the Site based on the contaminant investigation results and the intended residential end use of the Site. It is our team's intent to propose a remedy that will meet the BCP's Track 4 clean up approach for achieving Restricted Residential use. Based on the EFI Global team's knowledge of potential site issues, the RAOs for the Site may require implementation of remedial actions designed to remove source and, treat, contain, or cover remaining affected soil/fill material, if any, that exceed Part 375 restricted residential Soil Cleanup Objectives (SCOs).
- Activities to be performed includes:
    - Assessment of structures for asbestos, lead paint, and PCB containing media;
    - Definition of the historical pond footprint for dye impacts and pesticide runoff (i.e., organics, pesticides, metals);
    - Definition of the LNAPL plume (i.e., organics, and metals);
    - Definition of the fill profile (TCL and TAL lists); and
    - Definition of subslab soil gas and indoor air impacts from the LNAPL plume.

3. Investigation Scope of Work

The RI phase will be implemented following the USEPA's Triad approach with sampling proceeding until the approximate limits of contamination within all media are defined. The maximum number of samples proposed to be collected for analytical testing from each environmental media type, including appropriate quality assurance (QA) samples, is summarized in Table 3. Locations of proposed boreholes are shown on Figure 11; however, the locations are subject to change pending the results of the surrounding samples and utility mark-out. The proposed permanent groundwater monitoring wells locations are subject to change following review of the analytical results for the soil samples collected via direct push test borings to be completed at each proposed monitoring well location prior to well installation. Sampling by each media group should proceed in numerical order as currently proposed to allow for the best decision-based sampling approach. Because the RI process is dynamic and iterative, the proposed sampling activities may be modified during the site characterization process to incorporate new information and refine project objectives, as necessary. In addition, if any chemicals analyzed are below the applicable standards, then these chemicals will be removed from future sampling events pending NYSDEC's approval.

Environmental data collected previously from the site confirms the presence of contaminants (VOCs, PAHs, and metals) in subsurface soil at concentrations above the UUSCOs. Additional characterization is necessary to sufficiently define the extent of contamination at the Site, as the available body of data is not enough to sufficiently determine the nature, concentration, and extent of environmental contamination of the Site or to characterize the soil/fill and groundwater. The proposed RI scope of work is designed to complement the existing data to provide a complete environmental characterization of the Site and to support the evaluation of potential health risks and the identification of remedial goals and alternatives.

Our focus is further delineation of the LNAPL noted in prior investigations. No permanent groundwater monitoring wells were installed on the Site in previous investigations, yet VOCs and elevated metals results were detected in samples collected from temporary wells.

Global Positioning System (GPS) data will be collected from each sample location to allow for plotting of sample locations in Google Earth.

To achieve the objectives of the NYSDEC BCP, the RI will include the tasks below. The number of soil samples to be collected is approximated to no more than 60 samples. All quality control (QC) samples are listed in Table 3. The number of QC samples for soil may change based on the actual number of soil samples collected.

- Collection and analysis of surface soil/fill samples from five soil borings and 10 monitoring well locations from 0 to 6 inches BGL. Nine of these locations are along the Site perimeter to bound the fill area (15 locations, 15 samples);
- Collection of subsurface soil samples during the advancement of 15 soil borings, 10 for monitoring well placement and five soil borings. Samples will be collected based on field observations, i.e. PID readings, visual staining, etc., and data required to evaluate the contamination, both horizontally and vertically, in accordance with the BCP. (15 locations, number of samples will be field determined);
- Collection of six paired subslab and indoor air samples and one ambient/outside air sample (13 summa canister samples); and
- Installation and sampling of 10 groundwater monitoring wells (10 samples).

After NYSDEC approval of the RIWP and the Citizens Participation Plan and passage of the requisite public comment period, EFI Global, Inc. will initiate the RI and prepare a Remedial Investigation Report (RIR). The major tasks and elements associated with this RIWP are described in detail within this section. Table 3 provides a summary of samples to be collected during the RI.

3.1. Soil/Fill Characterization

Soil sampling of both surface soil/fill and subsurface soils will be completed in a manner consistent with 6 NYCRR Part 375 and DER-10. Field Standard Operating Procedures (SOPs) are included in Appendix E and include additional sampling detail.

3.1.1. Surface Soil/Fill Sampling Program

Redevelopment of the Site includes the removal of the zero to four inches of asphalt to be replaced with a new asphalt parking lot and brick paved or concrete sidewalks. In addition, new grass and landscaped areas will have the current asphalt and underlying soils removed from zero to approximately one foot below land surface. EFI informed the NYSDOH of the redevelopment plans and concurred that surficial sampling from the zero to two inches below land surface is not required. Figure 8 identifies the proposed pattern for the parking lot, pathways, and landscaped areas. Samples of the uppermost six inches BGL of surface soil/fill will be sampled at 15 locations across the Site. Surface soil/fill samples will be collected at the same locations as proposed soil borings and monitoring wells. As outlined in Table 3, soil samples will be analyzed for Target Compound List (TCL) VOCs, Semi Volatile Organic Compounds (SVOCs), polychlorinated biphenyls (PCBs), pesticides, target analyte list (TAL) metals, cyanide, formaldehyde, and pH. Figure 11 illustrates the proposed surface soil sample locations.

3.1.2. Subsurface Soil/Fill Sampling Program

Subsurface soil/fill samples collected during previous investigations contained elevated concentrations of VOCs and metals at concentrations above the NYS UUSCOs. The elevated VOCs and metals appear to be associated with the past location of the 10,000-gallon UST and the former pond. An evaluation of any subsurface utilities, structures, and/or other preferential pathways to identify additional sampling may be warranted.

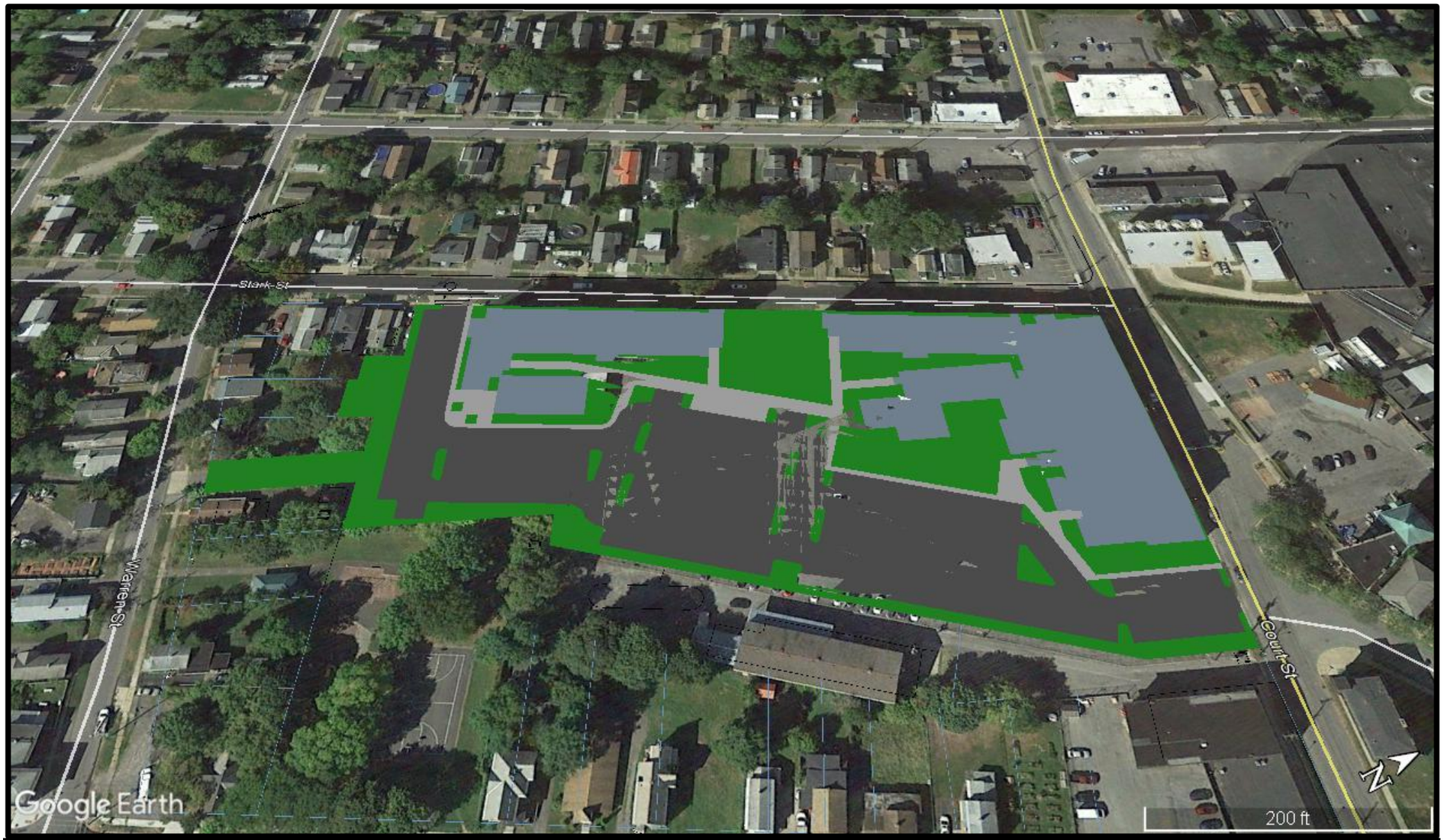
Additional sampling of the subsurface soil/fill will be performed across the Site to further characterize the nature, concentration, and extent of contamination in the subsurface soil/fill. Information obtained from previous investigations did not specify the thickness of the subsurface soil/fill at the Site. Subsurface samples will be collected from 15 locations, at depth and will be determined based on field observations and data required to evaluate the contamination, both horizontally and vertically, in accordance with the BCP. See Figure 11 for the proposed locations.

3.1.2.1. Drilling of Soil Borings

Soil/fill will be characterized by drilling 15 soil borings as shown in Figure 11. A drilling rig capable of advancing a borehole using rotary hollow stem auger and split spoon drilling methods will be used to advance 15 soil borings through the soil/fill and a minimum of one to two feet into the underlying native soil. Soil borings will be drilled to a depth sufficient to expose the underlying native soil layer.

With an anticipated maximum fill thickness of 10 feet BGL, the total depth of the borings is anticipated to be a maximum of 14 feet BGL. Upon retrieval of each two-foot split spoon sample of soil/fill, the soil/fill samples will be screened for total organic vapors using a PID. The organic vapor measurements will be recorded, and the soil/fill material will be described in detail on boring logs by trained staff in a manner consistent with unified soil classification system, which is set forth in ASTM 2488 or New York State Department of Transportation Soil Description Procedure Soil Mechanics Bureau GTP-2, dated August 2015.

Based on information obtained during previous site investigations, groundwater is anticipated to be encountered at a depth between five and 10 feet BGL across the Site. Groundwater within the soil/fill interval will be characterized by permanent groundwater monitoring wells within the soil borings.



	Site Features Map **Lofts at Globe Mill** **Utica, New York**	**Legend:**		**Scale:**	As Shown
			Asphalt	**Created By:**	C. Dare
			Concrete / Sidewalks	**Revision:**	1.0.0
			Grass Areas	**Date:**	02/28/2018
			Structures	**Source:**	Google Earth

EFI Global
Engineering, Fire & Environmental Services

Figure 8

Table 3

Analytical Summary - Sample QA/QC, Holding Times and Containers

ANALYTICAL PARAMETER	ANALYTICAL METHOD	QA/QC REQUIREMENTS											SAMPLE HOLDING TIMES	CONTAINER TYPE/# PER SAMPLE		
		SOIL*				GROUNDWATER				AIR / WIPE						
		# OF SAMPLES	FIELD DUPLICATE	MS/MSD	RINSE BLANK	# OF SAMPLES	FIELD DUPLICATE	MS/MSD	RINSE BLANK	# OF SAMPLES	BLANK	FIELD DUPLICATE		SOIL	GROUNDWATER	WIPE /AIR- VOCs
TCL Volatile Organics (VOCs)	5035/ 8260B TO15 SIM	60	3	3	3	10	1	1	1	13	1	2	Soil: 14 days GW: 14 days	5 g Plastic Cores (Encore, 3 each) Zero head space/ Cool/4° C	**WIPE:** 40mL (Amber Glass) 1:4 Acetone:Hexane **GROUNDWATER:** 3x 40mL VOA vial with PTFE-lined septum caps Zero head space/ Cool 4° C/ HCL to pH<2	Summa Canister
TCL Semivolatile Organics (SVOCs)	8270D	60	3	3	3	10	1	1	1	--	--	--	Soil: 14 days until extraction GW: 7 days until extraction 40 days after extraction both	4-oz Amber Glass (2 each) Cool/4° C	1 L Amber Glass (2 each) Cool/4° C	--
TCL Pesticides	8081	60	3	3	3	10	1	1	1	--	--	--	Soil: 14 days until extraction GW: 7 days until extraction 40 days after extraction both	4-oz Amber Glass (2 each) Cool/4° C	500 ml Amber Glass (2 each) Cool/4° C	--

ANALYTICAL PARAMETER	ANALYTICAL METHOD	SOIL*				GROUNDWATER				AIR / WIPE				CONTAINER TYPE/# PER SAMPLE		
		# OF SAMPLES	FIELD DUPLICATE	MS/MSD	RINSE BLANK	# OF SAMPLES	FIELD DUPLICATE	MS/MSD	RINSE BLANK	# OF SAMPLES	BLANK	FIELD DUPLICATE	SAMPLE HOLDING TIMES	SOIL	GROUNDWATER	WIPE- PCBs/AIR
TCL PCBs	8082	60	3	3	3	10	1	1	1	2	1	1	Soil: 14 days until extraction GW: 7 days until extraction 40 days after extraction both	4-oz Amber Glass (2 each) Cool/4° C	1 L Amber Glass (2 each) Cool/4° C	4-oz Amber Glass (1 each) Cool/4° C 1:4 Acetone:Hexane 14 days until extraction
TAL Metals / Hg (total)	6010C/ 7470A/ 7471B	60	3	3	3	10	1	1	1	2	2	1	Metals: 180 days Hg: 28 days Wipe Hg: 28 days	4-oz Amber Glass (2 each) Cool/4° C	500 ml Plastic (2 each) Cool/4° C HNO_3 to pH <2	--
TAL Metals / Hg (dissolved – preserve at lab))	6010C/ 7470A/ 7471B	60	3	3	3	10	1	1	1	2	2	1	Filte – 7 days Metals: 180 days Hg: 28 days Wipe Hg: 28 days	4-oz Amber Glass (2 each) Cool/4° C	500 ml Plastic (2 each) Cool/4° C HNO_3 pH <2 at lab	--
Formaldehyde	8315A	60	3	3	3	10	1	1	1	--	--	--	3 days	4-oz Amber Glass (2 each) Cool/4° C	1 L Amber Glass (1 each) HNO3, pH<2 / Cool 4° C	--
Cyanide	9012B	60	3	3	3	10	1	1	1	--	--	--	14 days	4-oz Amber Glass (1 each) Cool/4° C	250 ml Plastic (1 each) Cool/4° C NaOH to pH >12	--
pH	9040C	24	2	3	3	10	1	1	1	--	--	--	Immediate	4-oz Amber Glass (1 each) Cool/4° C	250 ml Plastic (1 each) Cool/4° C	--

NOTES: *Approximate number of samples to be analyzed

NA= not applicable

MS= matrix spike

MSD= matrix spike duplicate

3.1.3. Monitoring Well Installation

Overburden monitoring wells will be constructed of 2-inch ID, flush joint, Schedule 40 PVC, with 0.010-inch slotted screen a maximum of 10 feet in length. Refer to the SOPs for details on determination of the monitoring zone and placement of the assembled screen and riser. Following determination of the monitoring zone and placement of the assembled screen and riser, the annular space of the borehole will be backfilled. Generally, this will include the placement of a sand filter pack consisting of Morie #0 sand around the well screen such that the sand extends a minimum of one foot above the top of the screen. A minimum 2-foot layer of bentonite pellets will be placed above the sand filter, tap water will be poured over the bentonite pellets and they will be allowed time to hydrate. A mixture of cement/bentonite extending to approximately three feet BGL will be placed above the bentonite seal. The monitoring well will be completed by placing a flush-mounted protective casing over the riser. Each riser pipe will be secured using an expandable plug capable of being locked. The actual length of the well screen may vary depending upon subsurface conditions encountered. Attempts will be made to limit the well screen to the zone being monitored. Schematics of the well construction details are provided in Appendix C.

3.1.4. Well Development

The newly installed monitoring wells will be developed no sooner than 24 hours after construction has been completed. The development procedure will require purging of the groundwater and periodically surging the water in the well to loosen and remove suspended fines from the well screen and sandpack. Measurements of the water volume removed and water quality parameters including temperature, pH, conductivity, dissolved oxygen (DO), and turbidity will be recorded at regular intervals throughout the development process. Development will continue until water quality measurements stabilize to within 10% of the previous measurement.

3.1.4.1.Groundwater Sample Collection

Prior to initiating sample collection, a water level measurement will be collected, noting the reference point from which the measurement is made (typically a mark on the north lip of the inner casing). Also, a sounding of the bottom of the monitoring well and agitating/loosening accumulated silt/sediment (this assumes sounding indicates minimal sediment accumulation and no need for well redevelopment) will also be performed in conjunction with an LNAPL measurement.

Groundwater will be collected from each monitoring well using low flow sampling techniques by dedicated plastic flex tubing and a pump. If low-flow sampling is not feasible due to insufficient groundwater recharge rate, new and dedicated disposable bailers may be used to collect the groundwater samples. If sufficient groundwater volume is available, each well will be sampled for TCL VOCs, SVOCs, pesticides, PCBs, TAL metals (filtered and unfiltered), cyanide, and pH. Samples collected for filtered metals analysis must be unpreserved.

Groundwater field parameters will be monitored during well purging prior to sampling including pH, specific conductivity, temperature, turbidity, and dissolved oxygen reduction potential. This information will support a natural attenuation assessment.

All groundwater samples will be collected in pre-cleaned and pre-preserved laboratory sample bottles in accordance with protocols for analyses shown in Table 3. Appropriate QA/QC samples will be collected for the groundwater sampling event including one trip blank, one field blank, one matrix spike (MS), one matrix spike duplicate (MSD), and one field duplicate sample.

Once field parameters have stabilized in a manner consistent with USEPA low flow sampling procedures as outlined in the SOPs, groundwater will be collected for laboratory analysis. Groundwater for VOC analysis will be collected first.

Two or three (depending on laboratory-specific requirements) 40-ml glass vials (with Teflon septa) will be used to collect samples for VOCs. The vials will be filled by gently pouring water from the top of the bailer into the vial until a convex meniscus is formed. The vials will be filled concurrently and alternating between vials. The vials will then be capped, inverted, and inspected for air pockets/bubbles that may be present on the inside surfaces of the vial. If any bubbles or aggregate of bubbles are observed, then a new sample will be obtained either using a new vial or the same vial.

Subsequent sampled water will be collected for the remaining analyses. The remaining sample bottles will be filled sequentially in the following order:

- TCL VOCs (8260B);
- TCL SVOCs (8270D);
- TCL Pesticides (8081)
- TCL PCBs (8082);
- Formaldehyde (8315A)
- TAL metals (6010C);
- pH (9040C)

After sample collection, all groundwater samples will be placed on ice and shipped under chain of custody to the selected analytical laboratory.

3.1.5. Hydraulic Assessment

Hydraulic assessment includes the completion of hydraulic conductivity tests and the measurement of water levels in monitoring wells. Hydraulic conductivity testing will be performed on the newly installed monitoring wells using a variable head method. Variable head tests will be completed using a stainless steel or PVC slug to displace water within the well or by removing water from the well with a bailer or pump. The recovery of the initial water level is then measured with respect to time. Data obtained using this test procedures will be evaluated using procedures presented in “The Bouwer and Rice Slug Test - An Update”, Bouwer, H., Groundwater Journal, Vol. 27, No. 3, May-June 1989, or similar method.

3.2 Site Survey

A map of the Site will be prepared locating the site boundary, pertinent Site features, monitoring wells, and sample locations.

Vertical and horizontal control will be established for newly installed monitoring wells and completed test borings as well as the limits of the Site. Vertical measurements will include the ground surface, top of casing, and top of riser at each monitoring well and the ground surface only at the test borings/soil sampling locations. A mark made into the north side of the top of the riser will serve as the water level monitoring point. Vertical measurements will be made relative to the National Geodetic Vertical Datum. Monitoring point measurements and top of protective casing measurements will be accurate to within 0.1 foot. Horizontal measurements will be accurate to within 0.1 foot.

Data from the land survey will be utilized for the development of a base map. The base map will include site boundary lines and other key site features (e.g., structures). The site property lines will be determined via a boundary survey. All physical improvements to the site that are visible will be noted as part of the overall Site reconnaissance (i.e., storm water catch basins).

3.3 Building Survey

Building Assessments will be performed at a later date either during assessment activities or after completion of the soil, soil/vapor, and groundwater assessment to evaluate the contaminant sources including:

- USEPA National Emission Standards for Hazardous Air Pollutants regulations require all friable regulated ACM to be removed prior to renovation/demolition. Asbestos containing building materials have been identified as part of a cursory assessment. New York State Department of Labor regulations require that any ACM that will be disturbed during renovations shall be removed prior to any renovations. In accordance with 12 NYCRR 56, no renovation work shall be commenced by any owner or agent prior to completion of asbestos abatement performed by a licensed asbestos abatement contractor. A detailed building asbestos inventory is proposed to determine the level of effort necessary for preparation of an asbestos abetment plan.

- The Occupational Safety and Health Administration’s (OSHA's) Lead in Construction Standard requires the protection of workers performing lead related work tasks. Lead containing waste disposal is also regulated per USEPA RCRA regulations. A cursory lead assessment was performed and lead containing materials were identified. A detailed LBP risk assessment is proposed to determine the presence, type, severity, and location of LBP hazards (including lead hazards in paint, dust, and soil) and provides suggested ways to control them.

- PCBs are regulated by USEPA Toxic Substances Control Act regulations and can be contained in dielectric fluid, light ballasts, and caulks/mastics. Abandoned

transformers are frequently vandalized for scrap copper resulting in surface and soil contamination. Capacitors from light ballasts can contain PCB oil and potting material which can also contain PCBs. A detailed building PCB inventory is proposed to determine the level of effort necessary for preparation of a PCB abatement plan. A detailed listing of all caulks and mastics types should be categorized. Wipe samples should be collected in accordance with 40 CFR §761Sub-Part P of representative media. Sufficient sample sizes need to be collected to ensure a detection limit that allows quantification of the data relative to the USEPA action concentration of 10 µg per 100 square centimeter (cm^2) (0.1 µg/cm^2). Samples should be collected from representative surfaces such as window sills, floors, horizontal surfaces, and counters for analysis by modified EPA Method 8270C.

- Mold screening to prepare a baseline survey of readily observable mold and conditions conducive to mold in the structures on the Site will be performed consistent with ASTM Standard Practice E 2418-06: *Standard Guide for Readily Observable Mold and Conditions Conducive to Mold in Commercial Buildings: Baseline Survey Process* and will include a limited interview, document review, and physical observation of sufficient detail to prepare an opinion on whether any identified conditions warrant further action. It should be noted that interviews will be limited to two knowledgeable persons from property management or engineering staff, and documents reviewed will be limited to only those relevant documents made readily available in a timely manner. Physical observations will be limited to certain Heating, Ventilation, and Air Conditioning (HVAC) system areas and other readily accessible building areas likely to become subject to water damage, plumbing leaks, and flooding. Unless otherwise noted, observations will be limited to HVAC equipment room(s) and readily accessible mechanical rooms. In buildings with package units in the ceiling at least one unit per floor will be observed. Readily accessible areas of the basement (or lowest level), the top floor, the roof (including any penthouse areas) and at least one mid-level floor (if applicable) will be viewed. For multi-story buildings, the total number of floors observed (inclusive of those already mentioned) will be up to 10 percent of the total number of floors (if readily accessible).

- Electrical components such as thermostats, switches, and fluorescent lights may contain mercury. OSHA regulates mercury for exposure to workers and USEPA regulates waste disposal of mercury containing media. Electrical components should also be inventoried to determine appropriate steps for managing any mercury containing media.

- Radioactive isotopes have been associates with heat/smoke detectors and luminescent clock dials. A building inventory shall be performed which itemizes any potential sources.

- Hazardous waste containing media may include process vessels, piping, drums, tank systems, waste lines, and traps. The integrity of the tanks/systems shall be checked as they may contain hazardous waste.

3.4 Soil Gas / Indoor Air Sampling

When VOCs are detected near buildings, assessment of vapor intrusion is warranted. Under such conditions, subslab vapor samples should be collected within a building footprint in at least one central location away from foundation footings, and from the soil or aggregate immediately below the basement slab or slab-on-grade.

The number of subslab vapor samples that should be collected in a building depends upon the number of slabs (e.g., multiple slabs-on-grade in a large warehouse) and foundation types (e.g., combined basement and slab-on-grade in a residence). At least one subslab vapor sample should be collected from each representative area.

All subslab vapor samples should be co-located with indoor air samples collected simultaneously. NYS recommends that 24 hour samples be collected for assessment of residential exposure scenarios. It is currently proposed that six subslab vapor samples, six indoor air samples, and one outside/ambient air sample be collected.

Any soil vapor assessment will be completed in accordance with the NYSDOH “Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York,” dated October 2006.

To be representative of worst case conditions, subslab vapor samples and indoor air samples are collected during the heating season because soil vapor intrusion is more likely to occur when a building's heating system is in operation and doors and windows are closed. Areas should be heated for approximately 48 hours to 65 to 70 degrees Fahrenheit prior to initiating sampling.

In NYS, heating systems are generally expected to be operating routinely from November 15th to March 31st, per Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York, October 2006, as amended from time to time. This soil vapor investigation is anticipated to be performed within the 2017-2018 heating season.

4. Qualitative Human Health Risk Assessment

A qualitative human health risk assessment will be conducted to determine if the presence and concentrations of chemicals in the environmental media at the Site are above applicable SCOs thereby posing potential human health concerns. The assessment will focus on, on-site risks in comparison with the results of the SCO comparative analysis used as one of the criteria to determine the most appropriate future actions at the Site. These actions may range from no further action, to additional data collection, to quantitative health risk assessment, or to the establishment of risk-based action levels. The assessment will begin with the construction of a Conceptual Site Model (CSM), which serves as a graphic illustration that outlines chemical source areas, possible chemical release mechanisms, environmental media that currently show or may show in the future the presence of chemicals, possible exposure pathways, possible points of exposure for human receptors, possible exposure routes, and possible human receptors. The CSM will be based on current conditions and surrounding land use, and project future conditions. The data evaluation will entail comparison of detected chemical concentrations in the various media sampled to appropriate NYSDEC risk-based standards and criteria and will include an evaluation of any off-site impacts identified through the RI. Chemicals detected in concentrations greater than these standards and criteria will be identified as chemicals of potential concern to be addressed by proposed actions.

5. Sample Collection Quality Assurance/Quality Control (QA/QC)

Additional data quality information can be found in the Laboratory Quality Manual in Appendix D.

5.1. Sample Collection

The selection and rationale for the RI sampling program was discussed in Section 3. Methods and protocol to be used to collect environmental samples (i.e., soil and groundwater) for this investigation are described in the SOPs presented in Appendix E. The number and types of environmental samples to be collected is summarized on Table 3. Sample parameter lists, holding times, and sample container requirements are also summarized on Table 3. The sampling program and related site activities are discussed below. To the extent allowed by existing physical conditions at the facility, sample collection efforts will adhere to the specific methods presented herein. If alternative sampling locations or procedures are implemented in response to facility specific constraints, then each will be selected on the basis of meeting data objectives.

5.1.1. Custody Procedures

Sample custody is controlled and maintained through the chain-of-custody procedures. Chain of custody is how the possession and handling of samples will be tracked from the source (field) to their final disposition, the laboratory. A sample is in a person's custody if it is in the person's possession or it is in the person's view after being in his or her possession or it was in that person's possession and that person has locked it in a vehicle or room. Sample containers will be cleaned and preserved at the laboratory before shipment to the Site. The following section and SOPs for Sampling, Labeling, Storage, and Shipment, located in Appendix E, describe procedures for maintaining sample custody from the time samples are collected to the time they are received by the analytical laboratory.

5.1.2. Sample Storage

Samples are stored in secure limited-access areas. Walk-in coolers or refrigerators are maintained at 4 degrees Celsius (°C), ± 2°C, or as required by the applicable regulatory program. The temperatures of all refrigerated storage areas are monitored and recorded a minimum of once per day. Deviations of temperature from the applicable range require corrective action, including moving samples to another storage location if necessary.

5.1.3. Sample Custody

Sample custody is defined by this document as when any of the following occur:

- It is in someone's actual possession.
- It is in someone's view after being in his or her physical possession.
- It was in someone's possession and then locked, sealed, or secured in a manner that prevents unsuspected tampering.
- It is placed in a designated and secured area.

Samples are removed from storage areas by the sample custodian or analysts and transported to secure laboratory areas for analysis. Access to the laboratory and sample storage areas is restricted to laboratory personnel and escorted visitors only. All areas of the laboratory are therefore considered secure. If required by the applicable regulatory program, then internal chain-of-custody is documented in a log by the person moving the samples between laboratory and storage areas. Laboratory documentation used to establish chain of custody and sample identification may include the following:

- Field chain of custody forms or other paperwork that arrives with the sample.
- The laboratory chain of custody.
- Sample labels or tags are attached to each sample container.
- Sample custody seals.
- Sample preparation logs (i.e., extraction and digestion information) recorded in hardbound laboratory books that are filled out in legible handwriting and signed and dated by the chemist.
- Sample analysis logs (e.g., metals, GC/MS, etc.) information recorded in hardbound laboratory books that are filled out in legible handwriting and signed and dated by the chemist.
- Sample storage log (same as the laboratory chain of custody).
- Sample disposition log, which documents sample disposal by a contracted waste disposal company.

5.1.4. Sample Tracking

All samples are maintained in the appropriate coolers prior to and after analysis. The analysts remove and return their samples as needed. Samples that require internal chain of custodies are relinquished to the analysts by the sample custodians. The analyst and sample custodian must sign the original chain of custody relinquishing custody of the samples from the sample custodian to the analyst. When the samples are returned, the analyst will sign the original chain of custodies returning sample custody to the sample custodian. Sample extracts are relinquished to the instrumentation analysts by the preparatory analysts. Each preparation department tracks internal chain of custody through their logbooks/spreadsheets. Any change in the sample during the time of custody will be noted on the chain of custody (e.g., sample breakage or depletion).

5.2. Analytical Methods

All samples collected during the RI will be analyzed using USEPA-approved analytical methods that follow the most recent edition of the USEPA's "Test Methods for Evaluating Solid Waste" (SW-846), Methods for Chemical Analysis of Water and Wastes" (EPA 600/4-79-020), and Standard Methods for Examination of Water and Wastewater" (prepared and published jointly by the American Public Health Association, American Waterworks Association and Water Pollution Control Federation).

5.3. Laboratory

The subcontracted laboratory will be certified by the NYSDOH to perform Contract

Laboratory Program (CLP) analysis on all media to be sampled during this investigation. The laboratory will perform the sample analysis in accordance with the most recent NYSDEC Analytical Services Protocol (ASP). Integrated Analytical Laboratories, LLC of 273 Franklin Road, Randolph, NJ 07869 has been selected 973-361-4252

5.4. Data Submittal

Analytical data will be submitted in complete ASP category B data packs. Procedures for chain of custody, laboratory instrumentation calibration, laboratory analyses, reporting of data, internal quality control, and corrective actions shall be followed as per SW-846 and as per the laboratory's Quality Manual. Where appropriate, trip blanks, field blanks, field duplicates, and MS/MSD shall be performed at a rate of 5% and will be used to assess the quality of the data. The laboratory's in-house QA/QC limits will be utilized whenever they are more stringent than those suggested by the USEPA methods.

5.4.1. Level of QC for Samples

Field blank, method blank, trip blank, field duplicate, laboratory duplicate, laboratory control, standard reference materials, and MS samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. QC samples are discussed below.

- Field and trip blanks consisting of distilled water will be submitted to the analytical laboratories to provide the means to assess the quality of the data resulting from the field-sampling program. Field blanks should be prepared in the field to assess for environmental impacts. Field (equipment) blank samples are analyzed to check for procedural chemical constituents at the facility that may cause sample contamination associated with sample collection activities. Trip blanks are used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage.
- Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures.
- Duplicate samples are analyzed to check for sampling and analytical reproducibility.
- MS/MSD and MS/Duplicate samples provide information about the effect of the sample matrix on the digestion and measurement methodology. Depending on site-specific circumstances, one MS/MSD or MS/Duplicate should be collected for every 20 or fewer investigative samples to be analyzed for organic and inorganic chemicals of a given matrix.

The general level of QC effort will be one field (blind) duplicate and one field blank (when non-dedicated equipment is used) for every 20 or fewer investigative samples of a given matrix. Additional sample volume will also be provided to the laboratory to allow one site-specific MS/MSD or MS/Duplicate for every 20 or fewer investigative samples of a given matrix. One trip blank consisting of distilled, deionized water will be included along with each sample delivery group of aqueous VOC samples.

5.4.2. QC Procedures for Samples

Data quality objectives (DQOs) for measurement data in terms of sensitivity and the PARCC parameters (precision, accuracy, representativeness, comparability, and completeness) are established so that the data collected are sufficient and of adequate quality for their intended uses. Data collected and analyzed in conformance with the DQO process described in this document will be used in assessing the uncertainty associated with decisions related to this site.

- Sensitivity - The sensitivity or detection limit desired for each analysis or compound is established by NYSDEC as part of the ASP-CLP. It is understood that such limits are dependent upon matrix interference. Quantitation limits are defined for each parameter and matrix within the NYSDEC ASP.
- Precision - The laboratory objective for precision is to equal or exceed the precision demonstrated for the applied analytical methods on similar samples. Precision is evaluated thru the assessment of laboratory and field duplicates. Laboratory duplicate analyses will be performed once for every twenty samples as specified in the NYSDEC ASP.
- Relative Percent Difference (RPD) - RPD criteria, prescribed by the NYSDEC, and those determined from laboratory performance data, are used to evaluate precision between duplicates. A matrix spike duplicate will be performed once for every twenty samples.
- Precision - The reproducibility of measurements under a given set of conditions. Is determined by precision. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average value. Precision is usually stated in terms of standard deviation but other estimates such as the coefficient of variation, relative standard deviation, range (maximum value minus minimum value), and relative range are common, and may be used pending review of the data. Overall system (sampling plus analytical) precision will be determined by analysis of field duplicate samples. Analytical results from laboratory duplicate samples will provide data on measurement (analytical) precision. Precision will be determined from field duplicates, as well as laboratory matrix duplicate samples for analyses, and matrix spikes and matrix spike duplicates for organic analyses. It will be expressed as the relative percent difference (% RPD):

  % RPD = 100 x (X1 - X2) / (X1 + X2)

  where:

  X1 and X2 are reported concentrations for each duplicate sample and subtracted differences represent absolute values.

  Criteria for evaluation of laboratory duplicates are specified in the applicable methods. The objective for field duplicate precision is < 50% RPD for all matrices.
- Accuracy - The laboratory objective for accuracy is to equal or exceeding the accuracy demonstrated for the applied analytical method on similar samples. Percent recovery criteria, published by the NYSDEC as part of the ASP, and those determined from laboratory performance data, are used to evaluate accuracy in matrix (sample) spike and blank spike quality control samples. A matrix spike and

blank spike will be performed once for every sample delivery group as specified in the ASP. This will apply to inorganics and volatile and semi-volatile organics analyses. Other method-specific laboratory QC samples (such as laboratory control samples for metals, and continuing calibration standards) may also be used in the assessment of analytical accuracy. Sample (matrix) spike recovery is calculated as:

%R = (SSR-SR)/SA x 100,
where:
SSR = Spiked sample Result
SR = Sample Result, and
SA = Spike Added

- Accuracy – Accuracy measures the bias in a measurement system. It is difficult to measure accuracy for the entire data collection activity. Accuracy will be assessed through use of known QC samples. Accuracy values can be presented in a variety of ways. Accuracy is most commonly presented as percent bias or percent recovery. Percent bias is a standardized average error, that is, the average error divided by the actual or spiked concentration and converted to a percentage. Percent bias is unitless and allows accuracy of analytical procedures to be compared. Percent recovery provides the same information as percent bias. Routine organic analytical protocol requires a surrogate spike in each sample. Surrogate recovery will be defined as:

  % Recovery = (R/S) x 100
  where:
  S = surrogate spike concentration
  R = reported surrogate concentration

  Recovery criteria for laboratory spikes and other laboratory QC samples through which accuracy may be evaluated are established in the applicable analytical method.
- Representativeness - The representativeness of data is only as good as the representativeness of the samples collected. Sampling and handling procedures, and laboratory practices, are designed to provide a standard set of performance-driven criteria to provide data of the same quality as other analyses of similar matrices using the same methods under similar conditions. Representativeness will be determined by a comparison of the quality controls for these samples against data from similar samples analyzed at the same time.
- Comparability - Comparability of analytical data among laboratories becomes more accurate and reliable when all labs follow the same procedure and share information for program enhancement. Some of these procedures include:
  - Instrument standards traceable to National Institute of Standards and Technology (NIST), the USEPA, or the NYSDOH or NYSDEC;
  - Using standard methodologies;
  - Reporting results for similar matrices in consistent units;
  - Applying appropriate levels of quality control within the context of the laboratory quality assurance program; and,
  - Participation in inter-laboratory studies to document laboratory performance.

  By using traceable standards and standard methods, the analytical results can be

compared to other labs operating similarly. The QA Program documents internal performance. Periodic laboratory proficiency studies are instituted as a means of monitoring intra-laboratory performance.

- Completeness - The goal of completeness is to generate the maximum amount possible of valid data. The highest degree of completeness would be to find all deliverables flawless, valid and acceptable. The lowest level of completeness is excessive failure to meet established acceptance criteria and consequent rejection of data. The completeness goal is 95% useable data. It is acknowledged that this goal may not be fully achievable; for example, individual analytes (e.g., 2-hexanone) may be rejected within an otherwise acceptable analysis. The impact of rejected or unusable data will be made on a case-by-case basis. If the site investigation can be completed without the missing datum or data, no further action would be necessary. However, loss of critical data may require resampling or reanalysis.

5.5 Calibration Procedures and Frequency

This section describes the calibration procedures and the frequency at which these procedures will be performed for field instruments. The procedures for laboratory instruments is included in the Laboratory Quality Manual in Appendix D.

5.5.1 Field Instrument Calibration

Quantitative field data to be obtained during groundwater sampling include pH, turbidity, specific conductance, temperature, DO, and depth to groundwater. Quantitative water level measurements will be obtained with an electronic sounder or steel tape, which require no calibration. Quantitative field data to be obtained during soil sampling include screening for the presence of volatile organic constituents using a PID. SOPs located in Appendix E describe the field instruments used to monitor for these parameters and the calibration methods, standards, and frequency requirements for each instrument. Calibration results will be recorded on the appropriate field forms and in the Project Field Book.

5.6 Analytical Procedures

Samples collected during this investigation field sampling activities will be analyzed by a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified analytical laboratory.

5.6.1 Headspace Screening

Soil/fill screening will be performed by headspace screening with the PID. A representative portion of each two-foot sample interval will first be collected for potential VOC analysis and containerized to minimize loss of potential VOC constituents present in the soil/fill sample. The remainder of each sample interval will be placed into PVC container bags and allowed to equilibrate to ambient temperature. The container will be

slightly opened and the PID probe will be placed within the headspace of the container to allow for a reading of the VOCs within the headspace. The PID readings will be recorded on the boring logs and the field book.

5.6.2 Groundwater Field Testing Procedures

Field testing of groundwater will be performed during purging of wells prior to sampling for laboratory analyses. Field QC checks of control limits for pH, specific conductance (conductivity), turbidity, temperature, and DO are detailed below. The calibration frequencies discussed below are the minimum. Field personnel can and should check calibration more frequently in adverse conditions, if anomalous readings are obtained, or subjective observations of instrument performance suggest the possibility of erroneous readings. Field data for temperature, pH, conductivity, turbidity, temperature, and DO will be collected using a Horiba U-10 or equivalent.

5.7 Data Usability Summary Report

The data package will be sent to a qualified, independent, data validation specialist for evaluation of the accuracy and precision of the analytical results. A Data Usability Summary Report (DUSR) will be prepared to describe the compliance of the analyses with the analytical method protocols detailed in the NYSDEC ASP. The DUSR will provide a determination of whether the data meets the project-specific criteria for data quality and data use. The validation effort will be completed in accordance with NYSDEC Division of Environmental Remediation DUSR guidelines.

5.7.1 Procedures Used to Evaluate Field Data Usability

Procedures to validate field data for this project will be facilitated by adherence to the SOPs identified in Appendix E. The performance of all field activities, calibration checks on all field instruments at the beginning of each day of use, manual checks of field calculations, checking for transcription errors and review of field log books is the responsibility of the Field Team Leader.

5.7.2 Procedures Used to Evaluate Laboratory Data Usability

Data evaluation will be performed by the third-party data validator using the most current methods and quality control criteria from the USEPA's CLP National Functional Guidelines for Organic Data Review, and CLP National Functional Guidelines for Inorganic Data Review. The data review guidance will be used only to the extent that it is applicable to the SW-846 methods. SW-846 methodologies will be followed primarily and given preference over CLP when differences occur. Also, results of blanks, surrogate spikes, MS/MSDs, and laboratory control samples will be reviewed/evaluated by the data validator. All sample analytical data for each sample matrix shall be evaluated. The third-party data validation expert will also evaluate the overall completeness of the data package. Completeness checks will be administered on all data to determine whether deliverables specified in the Quality Manual are present. The reviewer will determine whether all required items are present and request copies of missing deliverables.

5.7.3 Field Analytical Procedures

Field procedures for collecting and preserving groundwater and soil samples are described in Appendix E.

6. Health and Safety

Field tasks will be performed using industry standard health and safety procedures. The site-specific Health and Safety Plan (HASP) used for the Phase II investigations (included in Appendix A) will be reviewed and updated if needed prior to mobilization and utilized by the field team during all field activities. This HASP will detail known and potential hazards of the Site and field tasks as well as air monitoring and emergency procedures.

6.1 Community Air Monitoring

All of the planned RI work will be completed on the Site. Where intrusive drilling operations are planned, community air monitoring will be performed to protect the downwind community. An EFI Global team representative will continually monitor the breathing air in the vicinity of the immediate work area using PID instrumentation capable of measuring total VOCs in air at concentrations as low as 1 PPM. The air in the work zone also will be visually monitored for dust generation. If sustained VOC measurements above 5 PPM, or visible dust generation is observed, the intrusive work will be temporarily halted and a more rigorous monitoring of VOCs and dust using recordable meters will be implemented in accordance with the NYSDOH Generic Community Air Monitoring Plan (CAMP). A copy of the CAMP is provided in Appendix B.

7. Project Organization

The principal organizations involved in verifying achievement of data collection goals for the Lofts at Globe Mill Site include: the NYSDEC, NYSDOH, Lofts at Globe Mill, L.P. (Applicant), EFI Global (Consultant), the drilling subcontractor(s), the independent environmental laboratory, and the independent third party data validator. Roles, responsibilities, and required qualifications of these organizations are discussed in the following subsections.

7.1 NYSDEC and NYSDOH

It is the responsibility of the NYSDEC, in conjunction with NYSDOH, to review the RIWP and supporting documents, for completeness and conformance with the site-specific cleanup objectives and to make a decision to accept or reject these documents based on this review. The NYSDEC also has the responsibility and authority to review and approve all QA documentation collected during brownfield cleanup construction and to confirm that the Quality Manual was followed.

7.2 BCP Volunteer – Lofts at Globe Mill, L.P.

The Volunteer, through its team of Qualified Environmental Professionals, will be responsible for complying with the QA requirements as specified herein and for monitoring and controlling the quality of the Brownfield cleanup construction. The Volunteer will also have the authority to select Remedial Action Contractor(s) to assist them in fulfilling these responsibilities. The designated EFI Project Manager is responsible for implementing the project and has the authority to commit the resources necessary to meet project objectives and requirements.

7.3 EFI Global

EFI Global is the prime consultant on this project and is responsible for the performance of all services required to implement each phase of the RIWP, including, but not limited to, field operations, laboratory testing, data management, data analysis and reporting. EFI Global has established a project team for the Site whose collective qualifications and experience are strongly suited for successful completion of the project. Any one member of EFI Global team's staff may fill more than one of the identified project positions (e.g., field team leader and site safety and health officer). The proposed responsibilities of the key staff are summarized below:

Margaret Silva, P.G., will be the Project Manager for the work. In this capacity, Ms. Silva will be responsible for the successful completion of each task including coordination and supervision of engineers and scientists, and adherence to the RIWP, schedule, and budget.

Ewa Gut, will be the Quality Leader, responsible for the development of the RIWP, coordination of subcontractors, direction of the field program including maintaining QA policies that pertain to all aspects of sampling, well drilling, and development. They will

have direct access to corporate executive staff as necessary, to resolve any QA disputes, and is responsible for auditing the implementation of the QA program in conformance with the demands of specific investigations and EFI Global team's policies, and NYSDEC requirements. The QA Officer has sufficient authority to stop work on the investigation as deemed necessary in the event of serious QA issues.

Greg Bodnurak, will be the field geologist/engineer responsible for implementing the field effort. Responsibilities will include sample collection, well development, and directing EFI Global team's drilling subcontractors, and ensuring the successful completion of all field activities. For this project, they will also serve as the Site Safety and Health Officer. As such, they are responsible for implementing the procedures and required components of the HASP, determining levels of protection needed during field tasks, controlling site entry/exit, briefing the field team and subcontractors on site-specific health and safety issues, and all other responsibilities as identified in the HASP.

7.4 Integrated Analytical Laboratories, LLC

Integrated Analytical Laboratories, LLC of 273 Franklin Road, Randolph, NJ will be responsible for complying with all QA requirements. USEPA and NYSDEC approved sample collection and handling techniques will be used. Samples for chemical analysis will be analyzed, in accordance with USEPA SW-846 methodology to meet the definitive-level data requirements, by a NYSDOH ELAP CLP-certified laboratory. A full (Category B) deliverables package will be provided for all site characterization samples. Analytical results for site characterization samples will be evaluated by a third-party data validation expert for evaluation of the accuracy and precision of the analytical results. A DUSR will be prepared to describe the compliance of the analyses with the analytical method protocols detailed in the NYSDEC ASP. The DUSR will provide a determination of whether the data meets the project-specific criteria for data quality and data use. The validation effort will be completed in accordance with NYSDEC Division of Environmental Remediation DUSR guidelines.

7.5 NYEG Drilling, LLC

NYEG Drilling LLC, of 5664 Mud Mill Road, Brewerton, NY will be providing investigation support services.

8. Citizens Participation Plan

A Citizen Participation Plan has been prepared for the Site and approved by the NYSDEC on December 11, 2017, in accordance with the requirements outlined in NYSDEC's DER-23 Citizen Participation Handbook for Remedial Programs, issued January 2010, as amended. The Citizen Participation Plan provides for issuance of fact sheets and/or public meetings at various stages in the investigation/remedial process. A fact sheet will be prepared by NYSDEC to announce the availability of the RIWP for review, followed by a 30-day comment period. A public meeting will be held, if requested, during the public comment period. A copy of this RIWP will be made available for public review at the NYSDEC Region 6 office and the Utica Public Library, and an announcement will be issued in the Environmental Notice Bulletin.

The major components of the Citizen Participation Plan are as follows:

- Names and addresses of the interested public as set forth on the Brownfield site contact list provided with the BCP application;
- Identification of major issues of public concern related to the site and that may be encountered during the remediation project;
- A description of citizens participation activities already performed and to be performed during remediation;
- Identification of document repositories for the project; and,
- A description and schedule of public participation activities that are either required by law or needed to address public concerns related to the Site.

Fact sheets documenting the goals and progress of the project will be prepared at key milestones during the project and distributed to those on the project mailing list. The distribution list is included in the Citizens Participation Plan. A copy of the Citizens Participation Plan is not included with the appendices as a copy is available with the NYSDEC.

9. Reporting

Following receipt of the validated analytical results, the EFI Global team will prepare the RIR and a Remedial Action Work Plan (RAWP), which will include a Soil/Fill Management Plan (S/FMP). Preparation of the RIR will entail a summary of fieldwork performed to date, and data collected, and will include appropriate summary data tables, soil boring and well construction logs, analytical results, photos, and maps. The RIR will also include the EFI Global team's recommendations for further characterization of the Site, if necessary. If no additional characterization is required, as anticipated, the RIR will include a Qualitative Human Health Risk Assessment. If additional investigation is required, the Qualitative Human Health Risk Assessment will be completed following the receipt of validated results of the additional characterization.

The RAWP will include an evaluation of remedial alternatives. Data obtained during previous investigations will be utilized along with the planned end use to identify, select, and evaluate remedial action alternatives for the Site and select the preferred remedial alternative for this Site. Potential Site constituents and migration pathways will be categorized as follows:

- Soil Vapor Intrusion and impact on Indoor Air.
- Airborne dust from inhalation hazards such as asbestos and lead based paint.
- Soil/Fill.
- Groundwater.

Once the degree of contamination associated with these media and other site characteristics are quantified, general response Alternatives for site remediation will be defined. The general response alternatives that are considered will include the "no action" measure as a baseline against which other remedial measures, if necessary, can be compared.

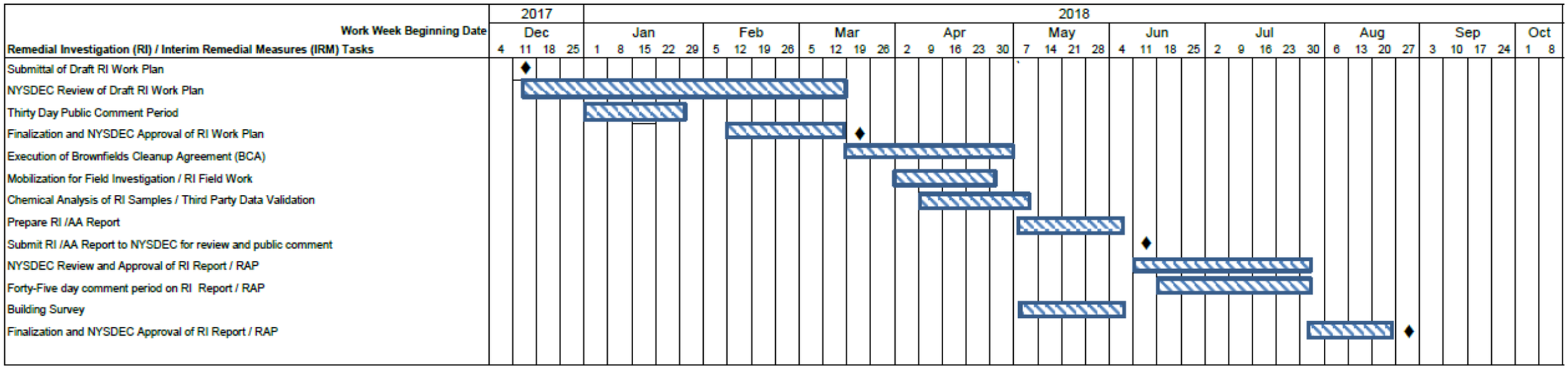
The RAWP will also include a S/FMP, which will describe a plan for characterization and handling of excavated soil/fill based on NYSDEC SCOs, as specified in 6 NYCRR Subparts 375-1, 375-3, and 375-6.8.

10. Project Schedule

A schedule showing the planned remedial investigation activities and assessment of remedial alternatives is included in Figure 9.

FIGURE 9

SCHEDULE OF PLANNED REMEDIAL INVESTIGATION



11. References

ASTM, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, ASTM Designation E 1527-05, Published November 2005.

ASTM Standard Guide for Readily Observable Mold and Conditions Conducive to Mold in Commercial Buildings: Baseline Survey Process. ASTM Designation E 2418-06, Published March 1, 2006.

EFI Global Inc., January 2017, Phase I Environmental Site Assessment Report for Lofts at Globe Mill 925 Stark Street, Utica, NY 13502.

EFI Global Inc., March 2017, Phase II Limited Subsurface Investigation Report, for 811-827 Court Street & 925 and 933 Stark Street, City of Utica, Oneida County, New York.

EFI Global Inc., April 2017, Phase II Limited Subsurface Investigation Report, Lofts at Globe Mill, 811-827 Court Street, 925 Stark Street, and 933 Stark Street Utica, New York, Prepared for: Lofts at Globe Mill, LP.

Lu Engineers, March 2016, Phase I Environmental Site Assessment for 811-827 Court Street & 925 and 933 Stark Street, City of Utica, Oneida County, New York.

New York State, 6 NYCRR Part 375, Environmental Remediation Programs, Subparts 375-1, 375- 3, & 375-6, Effective December 14, 2006

New York State Department of Environmental Conservation. DER-10; Technical Guidance for Site Investigation and Remediation. May 2010.

New York State Department of Environmental Conservation. DER-13; Final, Strategy for Evaluating Soil Vapor Intrusion at Remedial Sites in New York, October 2006, as amended.

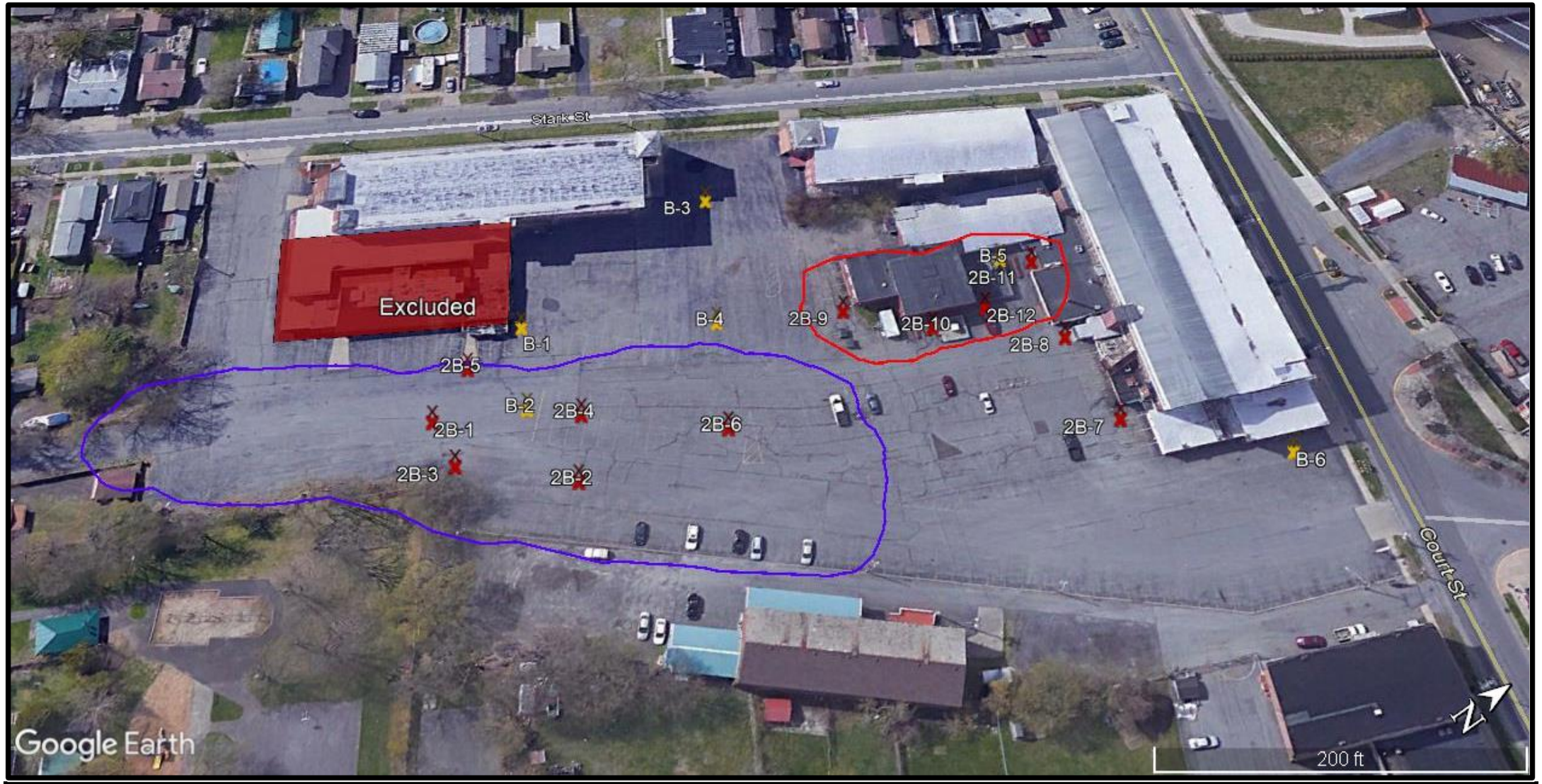
U.S. Environmental Protection Agency. Requirements for Quality Assurance Project Plans for Environmental Data Operations (EPA QA/R-5). October 1998.

U.S. Environmental Protection Agency, Region II. CERCLA Quality Assurance Manual, Revision I. October 1989.

U.S. Environmental Protection Agency, Methods for Chemical Analysis of Water and Wastes, EPA 600/4-70-020. 1983b.

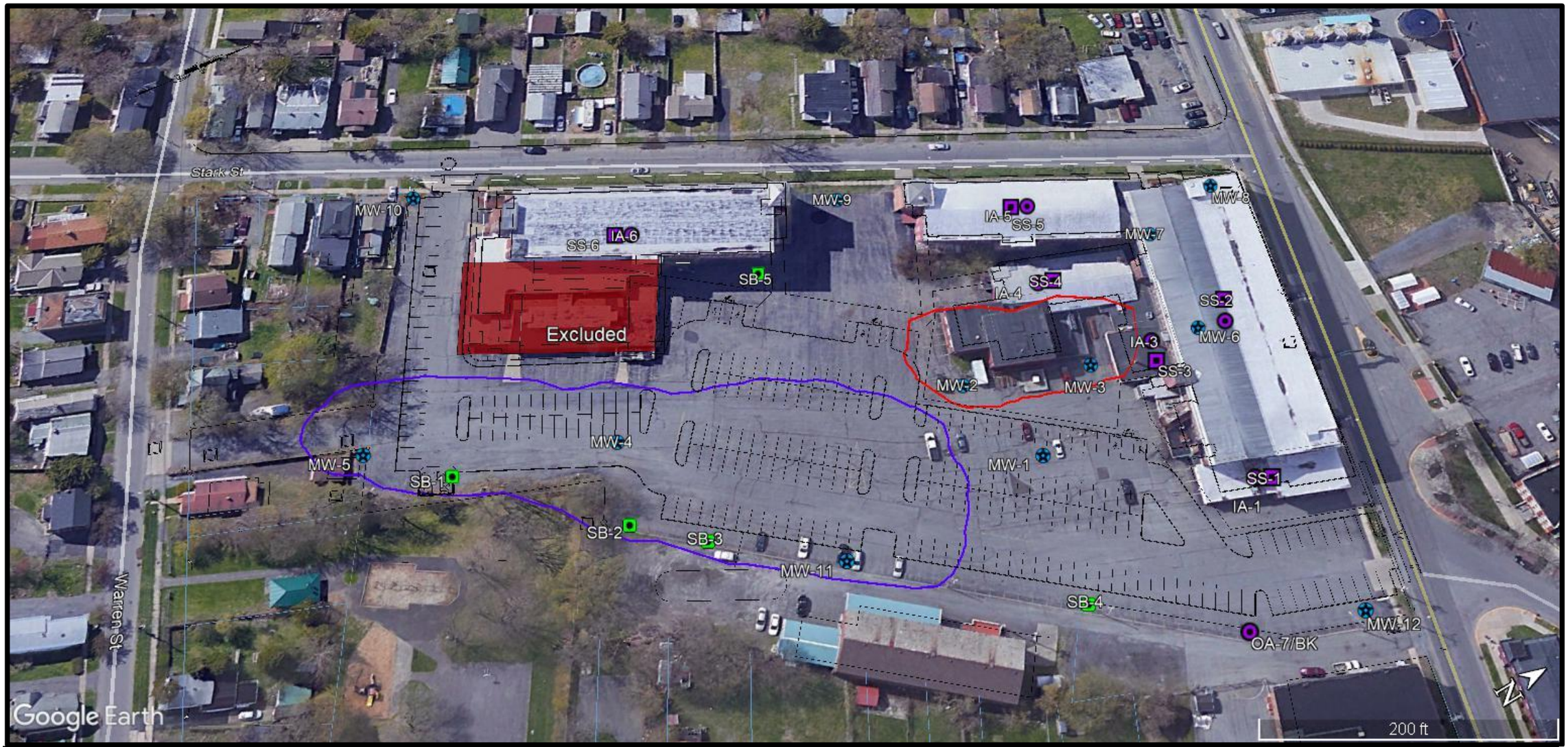
U.S. Environmental Protection Agency. National Functional Guidelines for Organic Data Review (EPA-540/R-94-012), 1994a.

U.S. Environmental Protection Agency. National Functional Guidelines for Inorganic Data Review (EPA-540/R-94-013), 1994b.



	Historical Sample Locations **Lofts at Globe Mill** **Utica, New York**	**Legend:**		**Scale:**	As Shown
		✕	**Existing Location-Mar**	**Created By:**	C. Dare
		✕	**Existing Location-Apr**	**Revision:**	1.0.0
			Estimated Groundwater Impact	**Date:**	02/26/2018
			Estimated Former Pond Limits	**Source:**	Google Earth
					Figure 10

EFI Global
Engineering, Fire & Environmental Services



Proposed Sample Locations **Lofts at Globe Mill** **Utica, New York**	**Legend:**			**Scale:**	As Shown	EFI Global Engineering, Fire & Environmental Services
	Subslab Soil Gas Pair Sample			**Created By:**	C. Dare	
	Indoor Air Paired Sample/Background	- -	**Proposed Features**	**Revision:**	1.1.0	
	Proposed Soil Boring		**Groundwater Impact**	**Date:**	02/26/2018	
	Proposed Monitoring Well/Soil Boring		**Former Pond Limits**	**Source:**	Google Earth	**Figure 11**

Appendix A

Health and Safety Plan (HASP)

SITE SPECIFIC HEALTH AND SAFETY PLAN

Loft at Globe Mill

811-827 Court Street and 925/933 Stark Street

Utica, NY 13502

Greg Bodnaurk
Field Professional

_____

Dale Lanier
Senior Project Manager/Health & Safety Officer

_____

EFI Global, Inc.
5104 Reagan Drive, Suite 4
Charlotte, North Carolina 28206
Phone: 704-246-2424 Fax: 704-246-2421

EFI Global
Engineering, Fire & Environmental Services

SITE SPECIFIC HEALTH AND SAFETY PLAN

Project Name: Loft at Globe Mill
Project Manager: Dale Lanier

A. SITE DESCRIPTION

Property Address: 811-827 Court Street and 925/933 Stark Street
Cross Streets:
Map Page No: N/A Grid No.: N/A

Area Affected: see map
Topography: Flat
Weather Conditions:

One Call No.: ADT

Is a confined space entry permit required? No

See attached site location map for more detail.

B. SITE/HAZARD OVERVIEW

Suspect Hazard Impact		Suspect Contaminant		Status of Facility	
High		Gasoline (Benzene)	X	Active	
Moderate		Heating oil	X	Inactive	
Low	X	Solvents		Decommission	X
None		Oil		Confined Space	
Unknown		Metals	X	Unknown	

Physical Waste Type(s)		Waste Characteristics		Type/Form of Hazard	
Gas/Vapor		Toxic		Dust (heavy metal)	
Liquid		Corrosive		liquid	
Sludge		Ignitable		Respiratory	
Solid	X	Volatile		Vapors	
Unknown		Biological		Dermal Contact	X
Other		Reactive		Ingestion	
		Unknown	X	Other	
Comments:					

C. PROJECT BACKGROUND AND SCOPE

A wool mill occupied the Property from the 1840s until the 1950s, when it was converted to office/warehouse type uses. The former dye building is located at 925 Stark Street. It is likely that solvents and petroleum were used during the wool manufacturing. Additionally, EFI understands a 10,000-gallon diesel UST was removed in 1994 and the incident was closed by the New York State Department of Environmental Conservation (NYSDEC). EFI also understands that the Property is being converted to residential use, and the client would like to insure that there are no environmental issues based on historic site use.

EFI completed a Phase II Limited Site Assessment at the Property on March 12 and 23, 2017. The purpose of the investigation was to determine if the historical use of the Property has impacted the subsurface of the Property. During the investigation, six soil borings (B-1 through B-6) and five temporary monitoring wells (TW-1 through TW-5) were completed at the Property. Two Areas of Concern (AOC) were identified during the investigation. These areas are a former maintenance shop (AOC-1) and a former pond (AOC-2). Borings that were completed in these areas included B-5/TW-5 at AOC-1 and B-2 at AOC-2.

Benzene was detected in soil sample B-5 at 0.36 milligrams per kilogram (mg/kg), which exceeds the NYSDEC Unrestricted Use Soil Cleanup Objective (UUSCO) of 0.06 mg/kg. Additionally, mercury was detected in soil sample B-2 at 1.2 mg/Kg, which exceeds the NYSDEC UUSCO of 0.18 mg/kg, and arsenic was detected in soil sample B-2 at 13 mg/kg, which is equal to the UUSCO.

Benzene was detected in ground water sample TW-5 at 63 micrograms per liter (ug/l), which exceeds the applicable NYSDEC Technical & Operations Guidance Series (TOGS) Ambient Water Quality Standard and Guidance Value of 1 ug/l. Additionally, benzo(b)fluroanthene was detected in ground water sample TW-5 at 1.1 ug/l, which exceeds the TOGS criteria of 0.002 ug/l.

The work to be conducted under this Health and Safety Plan (HSP) shall comply with standards set by the Occupational Safety and Health Administration (OSHA,). The company injury and illness prevention program (IIPP) shall be followed during conduct of any work under this HSP. Notwithstanding any requirements stated in this HSP, the scope of work shall be performed in accordance to any stipulated requirements contained within 29 CFR 1910.120.

The drilling company is responsible for maintaining and implementing its own corporate health and safety programs and ensuring compliance with all applicable federal, state and local laws and regulations. When site conditions and activities come within the scope of 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response, then this HSP shall be modified. However, should conditions and or activities change, the application of the provisions

of SHSP should be evaluated and the relevant sections of this HSP shall be changed, as necessary.

D. ON-SITE ORGANIZATION AND COORDINATION

The following personnel are designated to carry out the stated job functions on site:

Health and Safety Officer:	Dale Lanier	(704) 246-2424
Project Team Leader:	Dale Lanier	(704) 246-2424
Field Team leader	Greg Bodnaruk	
	The designated Field Team Leader is directly responsible for safety recommendations on site.	
Field Team Members:	TBD	
Contractors:	ADT	
Federal Agency Representatives:	None	
State Agency Representatives:	None	
Municipal Representatives:	None	
Other Representatives:	None	

Personnel arriving at or departing from the site will log in and out with the Field Team Leader. All activities on site must be cleared through the Project Team Leader.

E. SITE CONTROL

Although potential chemical and physical hazards have been identified in this HSP, if unexpected conditions arise, the Field Team Leader will stop all work at the site and notify the Project Team Leader and Health and Safety Officer. Work will not resume until the HSP and working conditions have been reevaluated and the HSP revised accordingly.

F. HAZARD EVALUATION

The following substances are known or suspected to be on site. The primary hazards of each are identified as follow:

Substance		Concentration		Primary Hazard
Benzene, mercury and benzo(b)fluroanthene		Unknown		Dermal

G. AIR MONITORING

Air monitoring may be performed using a photo-ionization detector or equivalent, however is not required.

H. PERSONAL PROTECTIVE EQUIPMENT

Based on evaluation of potential hazards, the following levels of personal protection have been designated for the applicable work areas or tasks:

Location		Job Function		Level of Protection
Sample Areas		Field Engineer/Geologist		A ☐ B ☐ C ☐ D ☐
				A ☐
				A ☐

Specific protective equipment for each level of protection may be as follows:

Level A		**Level B**
N/A		N/A
Level C		**Level D**
N/A		Hard hat & safety glasses
		Ear plugs
		Disposable gloves
		Safety vest
		Steel toe boots

No changes to the specified levels of protection shall be made without the approval of the project team manager.

I. PHYSICAL HAZARDS

Accidents involving physical hazards can directly injure field personnel and can create additional hazards such as increased exposure to chemicals due to damaged protective equipment. One of the most common potential hazards is improper bending and lifting which may result in back injuries. Field personnel should maintain awareness of potential safety hazards at each specific site and should immediately inform the Field Team Leader so that corrective measures can be taken.

Slips, Trips and Falls

During field activities, work will occur in areas where hoses and other equipment at ground level present possible slip, trip and fall hazards. In addition, wet weather conditions may also pose such hazards. The work locations will be kept as tidy as possible and free of debris on the ground. Personnel will wear appropriate footwear for site conditions and walk carefully.

Noise

Noise is a potential hazard in areas where equipment including drill rigs, power tools, pumps or generators are operated. Equipment operation may produce noise levels that reach or exceed 85 decibels (dBA), the action level established by the Occupational Safety and Health Administration (OSHA). Exposure to elevated noise levels can lead to temporary or permanent hearing loss and can also cause muscle tension and irritability. The Field Team Leader will ensure hearing protection is utilized when noise levels are elevated. Elevated noise levels will be evaluated by the Field Team Leader when equipment is operated. Excess noise levels can be estimated using the following rule of thumb. When normal voice communication is not possible between field personnel who are no more than three feet apart, hearing protection will

be utilized. Hearing protection typically involves the use of disposable ear plugs for the duration of the excessive noise level and will be used during drilling operations and other operations that present a noise hazard.

Utility Lines and Buried Objects
All field vehicles and equipment will be maintained at a minimum distance of 10 feet, in vertical and horizontal directions from all electrical power lines (energized lines) and/or electrical equipment with a voltage less than or equal to 50 kilovolts (kv). If the voltage exceeds 50 kv, the clearance will be increased by 4 inches for every 10 kv over that voltage. The location and marking of such lines and equipment will be coordinated with Underground Utility Alert prior to the start of field activities.

Excavations
Excavations deeper than five feet will either have shoring with ladder ingress/egress benched or sloped walls as per current OSHA regulations.

Sunburn
Working outdoors on sunny days for extended periods of time can cause sunburn. Excessive exposure to sunlight is associated with the development of skin cancer. Field staff will take precautions to prevent sunburn by using sun-screen lotion and/or wearing hats and long-sleeved garments.

Heat Stress
The potential for heat stress is a concern when field activities are performed on warm, sunny days and is accentuated when chemical protective clothing is worn. Indications of heat stress are: profuse sweating, ashen color, and weakness. When these symptoms appear, the individual should cease working, go to a cool place, and drink as much cool water as possible. If the individual collapses, faints, or begins to vomit, emergency personnel should be contacted and he/she should be given immediate medial attention.

Hypothermia/Frost Bite
Working in the winter can create exposure problems associated with hypothermia and frost bite. Personnel that are excessively shivering or with white patches on exposed areas should immediately cease working and proceed indoors or to a warm area.

J. COMMUNICATION PROCEDURES

If due to the close proximity of field crew members, the necessity for radio communication may be alleviated.

The following standard hand signals may be used if deemed appropriate by the Field Team Leader:

Hand drawn across throat	Cease operation immediately
Hand gripping throat.....	Out of air, can't breath
Hand on top of head.....	Need assistance
Thumbs up.....	Ok, I am all right, understood
Thumbs down	No, negative

K. DECONTAMINATION PROCEDURES

Personnel shall be trained in the route of entry of vapor (respiratory and ingestion) so that they can avoid any unnecessary exposure to contaminated soil. Personnel shall be instructed to wash their hands and face after contact with soils prior to eating, drinking, other activities involving hand to face contact, and at the end of the work day. Personnel shall not be permitted to engage in practices that permit soils coming in direct contact with their skin, including the use of soiled clothing from day to day that directly contacts their skin.

L. EMERGENCY INFORMATION

Emergency Medical Care:

Name:	St. Elizabeth Medical Center
Address:	2209 Genesse Street
	Utica, NY
Phone:	315-801-8100
Comments:	

The route to the emergency facility is shown on the attached map.

List of emergency phone numbers:

Agency Facility	Emergency Phone No.
Fire Department	911
Ambulance	911
Medical	911
Spill Team	911

Emergency Procedures:

The following standard emergency procedures may be used by on-site personnel. The Field Team Leader shall be notified of any on-site emergencies and is responsible for seeing that the appropriate procedures are followed.

Personal Injury
Upon notification of an injury the Field Team Leader should evaluate the nature of the injury, and the person affected should be decontaminated to the extent possible prior to movement. The Field Team Leader should initiate the appropriate first aid, and contact should be made with an ambulance or the designated medical facility if required.

Fire/Explosion
The fire department shall be alerted and all personnel moved to a safe distance from the involved area.

Other Equipment Failure
If any equipment on site fails to operate properly, the Project Team Leader shall be notified and shall evaluate the effect of this failure on continuing operations on site. If the failure affects the safety of personnel or precludes completion of the Work Plan tasks, work will cease until the situation is evaluated and appropriate actions taken.

Excavation Sampling
There will be no excavating during this investigation.

All site personnel are required to read the above HSP and, by signing below, acknowledge that they are 40-hour OSHA HAZWOPER trained with current annual refresher updates and that they are familiar with the HSP provisions. Alternatives or exceptions to the foregoing training should only be conducted with the approval of a CIH.

	Print Name and Company	Signature and Date
Project Team Leader:	Dale Lanier	
Field Team Leader:	Greg Bodnaruk	
Others:		

EFI Global
Engineering, Fire & Environmental Services

ATTACHMENT 1

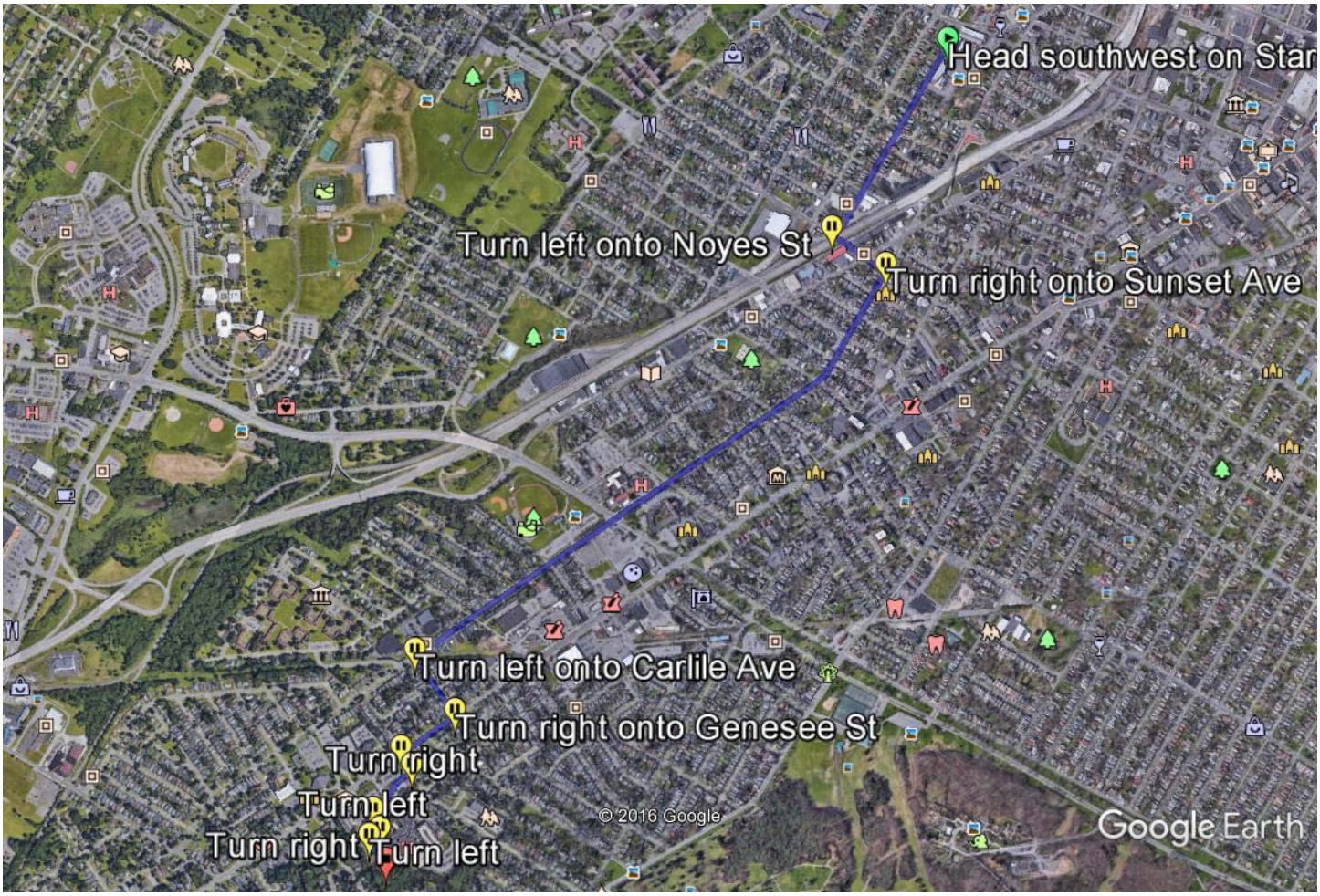
SITE LOCATION MAP

N W E S	**Site Location Map** **Lofts at Globe Mill** **Utica, New York**	**Scale:**	1'' = 165'	EFI Global Engineering, Fire & Environmental Services
		Created By:	C. Dare	
		Revision:	1.0.0	
		Date:	11/08/2017	
		Source:	Google Earth	**Figure 1**

EFI Global
Engineering, Fire & Environmental Services

ATTACHMENT 2

ROUTE TO HOSPITAL



Google Earth

miles 1
km 1

Figure 2

A 925 Stark St
Utica, NY 13502

B 2209 Genesee St
Utica, NY 13501

Suggested routes

Sunset Ave	2.1 miles,10 min
Genesee St	2.3 miles,11 min
NY-12 S/NY-5 W/NY-8 S	2.9 miles,10 min

A 925 Stark St

1. Head **southwest** on **Stark St** toward **Warren St**
   0.4 mi
2. Turn **left** onto **Noyes St**
   0.1 mi
3. Turn **right** onto **Sunset Ave**
   1.1 mi
4. Turn **left** onto **Carlile Ave**
   0.1 mi
5. Turn **right** onto **Genesee St**
   0.1 mi
6. Turn **left** onto **Ballantyne Brae**
   197 ft
7. Turn **right**
   0.1 mi
8. Turn **left**
   210 ft
9. Turn **right**
   121 ft
10. Turn **left**
    141 ft

B 2209 Genesee St

Appendix B

Generic Community Air Monitoring Plan (CAMP)

Appendix B – New York State Department of Health
Generic Community Air Monitoring Plan (CAMP)

1. Overview

A CAMP requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical- specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

2. Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for VOCs and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate DEC/NYSDOH staff.

Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting, trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. “Periodic” monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

3. VOC Monitoring, Response Levels, and Actions

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

VOCs must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions, particularly if wind direction changes. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

1. If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

2. If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors

identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

3. If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

4. All 15-minute readings must be recorded and be available for State (NYCDEC and NYSDOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

4. Particulate Monitoring, Response Levels, and Actions

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m3 above the upwind level and provided that no visible dust is migrating from the work area.

2. If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m3 of the upwind level and in preventing visible dust migration.

3. All readings must be recorded and be available for State (NYCDEC and NYSDOH) and County Health personnel to review.

Appendix C

Field Forms

Boring Location:

Elevation: Datum:

Obs. Well Install. Yes No

Boring _____ Date _____ Sheet _____ of _____

Job _____ Job No. _____

Logged By _____ Weather _____

Drilled By _____

Drill Type/ Method _____

Sampling Method

Bottom of Boring _____ ATD Water Level Depth _____

SIZE (%)			PID or other	DEPTH		SAMPLE		SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES: Odor, staining, sheen, scrag, slag, etc.	REMARKS: Drill action, drill and sample procedures, water conditions, heave, etc.	SUMMARY LOG (Water & Date)
G	S	F										
Max.	Range	Att. Limits		From	To	Type	Number					
								0				
								1				
								2				
								3				
								4				
								5				
								6				
								7				
								8				
								9				
								0				

Daily Log

PROJECT NAME: _____ **DATE:** _____

SITE ADDRESS: _____ **PERSONNEL:** _____

WEATHER: **WIND FROM:** N | NE | E | SE | S | SW | W | NW

SUNNY | CLOUDY | RAIN | ?

LIGHT | MEDIUM | HEAVY

TEMPERATURE: ° F . ° C

[Circle appropriate units]

TIME	COMMENTS

Signature: _____

LOG OF EXPLORATORY BORING

CLIENT/PROJECT NAME_____ BORING #_____

PROJECT NUMBER_____ DATE BEGAN_____

GEOLOGIST/ENGINEER_____ DATE COMPLETED_____

DRILLING CONTRACTOR_____ TOTAL DEPTH_____

DRILLING METHOD_____ SHEET_____ OF_____

HOLE DIAMETER_____

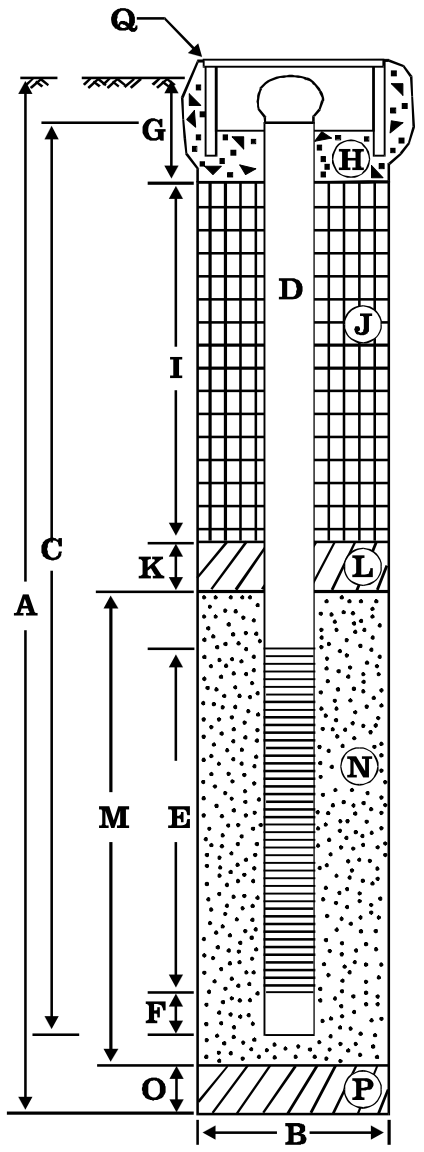
OTHER*	WELL OR PIEZOMETER DETAILS	SAMPLING DATA						DEPTH IN FEET	SOIL GROUP SYMBOL (USCS)	Field location of boring / LITHOLOGIC DESCRIPTION
		SAMPLING METHOD	SAMPLE NUMBER	FID / PID (ppm)	RECOVERY (feet)	BLOWS / 6 INCHES	DEPTH SAMPLED			
								1		
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		
								0		
								1		
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		
								0		

Remarks:

WELL DETAILS

Project Number: _____
Client Name: _____
Project Name: _____
Location: _____
Driller: _____

Boring/Well No.: _____
Top of Casing Elev.: _____
Ground Surface Elev.: _____
Installation Date: _____
Permit/Start Card No.: _____



	Depth (ft, bgs)	Elev. (ft, msl)

EXPLORATORY BORING

A. Total depth: _____ **ft.**
B. Diameter _____ **in.**
Drilling method: _____

WELL CONSTRUCTION

C. Well casing length: _____ **ft.**
Well casing material: _____
D. Well casing diameter: _____ **in.**
E. Well screen length: _____ **ft.**
Well screen type: _____
Well screen slot size: _____ **in.**
F. Well sump/end cap length: _____ **ft.**
G. Surface seal thickness: _____ **ft.**
H. Surface seal material: _____
I. Annular seal thickness: _____ **ft.**
J. Annular seal material: _____
K. Filter pack seal thickness: _____ **ft.**
L. Filter pack seal material: _____
M. Sand pack thickness: _____ **ft.**
N. Sand pack material: _____
O. Bottom material thickness: _____ **ft.**
P. Bottom material: _____
Q. Vault box type: _____
Well centralizer depths: _____ **ft.**

NOTES:

Installed by: _____
Reviewed by: _____
Date: _____

WELL DEVELOPMENT FORM

Project No.	Date:	Well:	
Site Location:	Initial DTB:		Final DTB:
Name:	Initial DTW:		Final DTW:
Development Method:	Casing Volume:		
Total Water Removed:	Casing Diameter:		
Water Contained ?	Meter #:		
Estimate of specific capacity or recharge to well:			

Time	Cum. Vol. Removed	Sand/Silt (ml/1000ml)	Temp.	EC	pH	DTW (TOC)	Appearance/Comments

Appendix D

Laboratory Quality Manual

Please refer to the link provided in the email dated March 7, 2018 from EFI Global, Inc.

Appendix E

Field SOPs

SAMPLE DOCUMENTATION

CONTENTS

* These sections affected by Revision 0.0.

SUPERCEDES: SOP #2002; Revision 2.0; 05/17/93; U.S. EPA Contract 68-03-3482.

1.0 OBJECTIVE

The objective of this Standard Operating Procedure (SOP) is to define the procedures for preparing and maintaining documentation which provides the details of field sampling activities. The sample documentation discussed in this procedure includes: site and personal logbooks, Field Data Sheets and labels, and Chain of Custody records and Custody seals.

2.0 APPLICABILITY

This SOP is applicable to all REAC field activities which involve the generation of environmental measurements.

3.0 DESCRIPTION

3.1 General

Accurate sample documentation is essential for proper site evaluation. A clear traceable paper trail must follow each sample from its point of origin to the Final Report (or other appropriate report). It is important that specific procedures be adopted so that the desired degree of accuracy is achieved.

All sample documents must be completed legibly and in ink. Any corrections or revisions must be made by lining through the incorrect entry and initialing the error.

3.2 Site Logbook

The site logbook is used to record data and observations so that an accurate account of field operations can be reconstructed in the writer's absence. There is the potential, especially on Superfund sites, for site logs to be used as legal evidence sometime in the future. The site logbook is essentially a descriptive notebook detailing site activities and observations. All entries should be dated and signed by the individual(s) making the entries. Site logbooks should contain at a minimum, the following information:

- Site name and location on inside cover
- Date and location of field work
- Times (military times preferred, or reference a.m. or p.m.)
- Names and addresses of field contacts
- Site sketches and photographic references
- Weather conditions (Optional if provided on Field Data Sheets. See Section 3.1.)
- Sample descriptions, locations, times taken, identification numbers (Optional if provided on Field Data Sheets. See Section 3.4.1.)
- Chain of Custody information, shipping paper identification number, recipient address, and phone number, etc.
- Field observations and discussion (Optional if provided on Field Data Sheets. See Section 3.4.1.)
- Field measurements (i.e., pH, temperature, surface water flow rates, etc.) (Optional if provided on Field Data Sheets. See Section 3.4.1.)
- Instructions issued by the Work Assignment Manager
- Field activities by all REAC personnel on site

Entries may be made in site logbooks by any ERT or REAC personnel on site and should detail the activities of all personnel involved in the field operations. Each entry should be signed by the person making the entry and should relate to previous entries or have sufficient background detail. The sequence of site activities should be clear to a reader who was not at the site.

When a site logbook is completed, no longer needed for site documentation, or after a project is finished, the site logbook must be transmitted to the appropriate Work Assignment folder of the Central File. If the site logbook is transmitted to the ERT, documentation of the transmittal must be prepared and maintained in the Central File.

3.3 Personal Logbooks

When involved in field operations, all REAC personnel will maintain a personal logbook. The personal logbook will be a chronological compilation of the individual's daily field activities. Personal logbooks are to be maintained, even if a REAC member is entering information in a site log. The personal logbook may reference the site logbook, but must also identify what, if any, work was performed when not on site. In the absence of a dedicated site logbook, the personal logbook must detail all site related activities that would typically be entered in a site logbook.

If personal logbooks are used for site-related information in lieu of a dedicated site logbook, the REAC Task Leader must obtain copies of the site notes from each individual field member and transmit the notes under a standard cover memo (Figure 1, Appendix A) to the Central File. This must be done within 10 working days of completion of field activities.

Personal logbooks may be maintained for the individual's daily office activities at the discretion of the individual. When a REAC member is in the office, the personal logbook should contain, at a minimum, meetings attended and meeting notes, telephone conversations, and detail of any work performed that relates to a particular site. Any task related entries should include the Work Assignment number. Entries should include, but are not limited to, the following:

- Field and project-related activities performed
- Directives from Work Assignment Manager
- Verbal instructions from U.S. EPA personnel
- Personal injuries or potential exposures
- Phone conversations relevant to Work Assignments

When a personal logbook is completed or the person to whom it is assigned leaves REAC, the personal logbook shall be returned to the Quality Assurance (QA) Office. People who must access information in a personal logbook may obtain photocopies from the person to whom the logbook is assigned.

3.4 Field Data Sheets and Sample Labels

Field Data Sheets and corresponding sample labels are used to identify samples and document field sampling conditions and activities. There are several different Field Data Sheets and sample labels used within the REAC project.

Field Data Sheets will be maintained by the Task Leader or designee. Task Leaders are responsible for conveying original Field Data Sheets to the corresponding Central File folder upon completion of the Trip or Final Report. Field Data Sheets may be transmitted to the Central File as an attachment to these reports or as a stand alone document.

3.4.1 Field Data Sheets and Sample Labels

Prenumbered Field Data Sheets and corresponding, prenumbered sample labels (Figures 2 and 3, Appendix A) are used for all types of samples except soil gas and air samples (see Sections 3.4.2 and 3.4.3).

Upon sample collection at a particular sampling location, Field Data Sheet(s) shall be completed with the following information:

1. Site name, sampling location, date and time of sampling, name(s) of sampler(s), Chain of Custody record number, REAC Task Leader's name, U.S. EPA Work Assignment Manager's name, and the Work Assignment number.

2. Site description and, as applicable, soil type, surface water, stream, and bottom information.

3. Sample type, sampling device, sample information (e.g., color, odor, temperature, pH, etc.) and weather parameters.

4. Analyses to be performed and sample preparation information.

Also upon sample collection, the corresponding prenumbered sample labels must be completed and securely affixed to the sample container(s).

Because samples are often collected from the same location in more than one container (for more than one analysis), the sample label consists of several parts (Figure 3, Appendix A). The largest part of the sample label consists of the project name and U.S. EPA contract number, the unique sample identification number consisting of the prefix "A" followed by a five-digit number (A01001), and spaces for inserting the following information: site name, work order number, date and time of collection, the analysis requested, and the preservative. Other parts of the sample label include additional sample labels numbered with the same sample identification number and consecutive letter prefixes (B01001 to L01001).

When a sample is collected in only one container, the largest part of the sample label is completed and affixed to the sample container. When the sample is collected in multiple containers, the largest part of the sample label is completed and affixed to one of the sample containers, and the additional labels, beginning with letter prefix "B," are affixed to the additional containers in a consecutive order. If more than 12 containers are included in a sample set, then the sampler may use blank labels and insert the sample identification number beginning with letter prefix "M" (M01001).

If duplicates or blanks are collected at a sampling location, the sample sets must be treated as being unique from the original sample and labeled with different sample identification numbers. When collecting samples for parameters which require extra

volume for matrix spike/matrix spike duplicate (MS/MSD) analysis, the original sample container(s) and the MS/MSD containers are labeled with the same sample identification number and consecutive letter prefixes. For example, a water sample for BNA analysis that also requires MS/MSD analysis would be collected in four sample containers which would be labeled A01003 through D01003. Required volumes for MS/MSD analysis for typical parameters are specified in ERT/REAC SOP #4005, Chain of Custody.

3.4.2 Soil Gas Sampling Data Sheets and Sample Labels

Soil Gas Sampling Data Sheets and prenumbered sample labels (Figure 4 and 5, Appendix A) are used for all soil gas sampling activities.

The heading of the data sheets shall be completed with the following information: site name, samplers, date, REAC Task Leader, U.S. EPA Work Assignment Manager, the project number, and the weather parameters.

After the soil gas well is screened with field instrument(s), the location identification, pertinent remarks, time, depth, and the instrument reading(s) are recorded in the first available column on the Soil Gas Sampling Data Sheet. A total of five (5) columns are available to record data from five sampling points on each Data Sheet.

If a soil gas sample was collected at that particular location, "Y" is circled to indicate this. The soil gas sample label is completed with the site name, sample location, date, time, remarks, and instrument readings; then the label is affixed to the sample container. A corresponding sample label (with sample identification number only) is inserted on the sample number line in the appropriate column on the soil gas sampling data sheet. If a soil gas sample was not collected at that particular location, "N" is circled to indicate this.

If necessary, the additional sample label (with the sample identification number only) can be inserted in the logbook used for documenting sampling activities, or it can be used for additional sample containers if the sample is collected in multiple containers. Blank sample labels are also provided so that sample numbers can be written in, when needed. Trip standards, field blanks, and samples containing spikes must be assigned unique sample identification numbers. Soil Gas Sampling Data Sheets and sample labels will be prepared and maintained for these types of samples in the same manner as other sample matrices.

3.4.3 Air Sampling Work Sheets and Sample Labels

Air Sampling Work Sheets and prenumbered sample labels (Figures 6 and 7, Appendix A, respectively) are used for all air sampling activities.

The heading of the Air Sampling Worksheet is completed with the following information: site name, samplers, date, Work Assignment number, the name of the U.S. EPA Work Assignment Manager, and the REAC Task Leader.

When air sampling is initiated, the following information is recorded in the first available column on the Air Sampling Worksheet: sample number, location, pump number media, analysis/method and time/counter start. At the end of the sampling period the following information is recorded: time/counter stop, total time, pumpfault (indicate by using "Y"

or "N"), flow rate start, flow rate stop, flow rate average, and volume, are recorded. A total of five columns are available to record data from five sampling locations on each air sampling worksheet.

The total sampling time is calculated by subtracting the start time/counter value from the stop time/counter value. The flow rate average is calculated from the start and stop flow rates. The volume sampled is calculated by multiplying the total sampling time by the average flow rate. All calculated values, along with the analysis requested, are recorded in the appropriate location on the air sampling worksheets.

If real-time air monitoring instruments are used at a particular sample location, the instrument readings are recorded on an Air Monitoring Work Sheet (Figure 8, Appendix A). If air samples are collected outdoors, then the appropriate weather parameters are also recorded on the Air Monitoring Work Sheet.

The prenumbered air sample label (Figure 7, Appendix A) consists of several parts. The largest part includes the project name, the contract number, the sample identification number, and space for the following information: the site name, volume of air, date, time, requested analysis, and remarks. Other parts include two additional sample labels with only the sample identification number.

When a sample is collected, the largest part of the sample label is completed and affixed to the sample container in the manner described by the appropriate ERT/REAC air sampling SOP. If samples are collected from a single sampling location in more than one sample media, separate sample numbers are used for each different sample medium used. The blank space at the end of the sample identification number is used to indicate the media. The small sample labels are affixed to the additional sample containers. If available, the small sample labels may be inserted in the sample number space in the appropriate column on the Air Sampling Work Sheet. Blank sample labels are provided for use as necessary.

Alternatively, at the Task Leader's discretion, separate sample numbers may be used for each media in which samples are collected at a single sampling location. In this case, the largest part of the sample label will be completed and affixed to the sample container in the manner described by the appropriate ERT/REAC air sampling SOP. The small sample labels (with sample identification number only) will be affixed to the Air Sampling Worksheet and the logbook.

Quality Control (QC) samples must be assigned unique sample identification numbers. Air Sampling Work Sheets and prenumbered sample labels will be prepared and maintained in the same manner as for other sample matrices.

3.4.4 Specialized Field Data Sheets

Task Leaders, with the approval of the Group Leader, the Work Assignment Manager, and the QA Officer, may develop specialized Field Data Sheets if none of the three types described above meet the specific needs of the project. At a minimum, the Field Data Sheet must include space for recording the name(s) of the sampler(s), the sample number(s), the location of the sample, the date and time that the sample was taken, and any pertinent field conditions. The following information will be included in the header

of the data sheet: (Matrix) Data Sheet, Roy F. Weston, Inc., REAC, Edison, NJ, U.S. EPA Contract: 68-C4-0022.

3.5 Chain of Custody

A Chain of Custody record (Figure 9, Appendix A) must be maintained from the time a sample is collected to its final deposition. The Chain of Custody record shall contain, at a minimum, the following information: project name, project number, the REAC contact, and the contact telephone number. For each sample collected, the Chain of Custody record shall include the sample number, sampling location, sample matrix, date collected, number of bottles, container/preservative, the analysis requested, and special instructions, if any are applicable.

Chain of Custody records must be completed legibly, with all required information, so that miscommunication with, or misunderstanding by, the receiving laboratory is prevented.

If samples collected during a sampling event are being forwarded to more than one laboratory, then a separate Chain of Custody record, indicating which samples are being sent to that particular laboratory, must be completed.

The Chain of Custody provides a means by which the entire path and life of a sample can be traced. Every transfer of custody must be noted and signed for on the Chain of Custody record. If a sample or group of samples is not under direct control or observation of the individual responsible for the samples, then they must be stored in a locked container that has been sealed with a Custody Seal (Section 3.6). A copy of the Chain of Custody record should be kept by each individual who has signed it. The final copy should be included with the Analytical Report.

3.6 Custody Seals

Custody Seals (Figure 10, Appendix A) demonstrate that a sample container has not been opened or tampered with during transport or storage. Two seals should be affixed in such a manner that the shipping container cannot be opened without breaking the seal. The person in direct possession of the samples shall sign and date the seal. The name of the individual signing the seal and a description of the packaging shall be noted in the site logbook.

4.0 RESPONSIBILITIES

4.1 Task Leaders and Field Staff

Task Leaders and field staff are responsible for preparing and maintaining sample documentation in accordance with this SOP.

4.2 Group Leaders and Section Leaders

Group Leaders and Section Leaders are responsible for ensuring implementation of the procedures outlined in this SOP.

4.3 QA Office

The QA Office is responsible for ensuring compliance with this SOP by auditing reports prepared by REAC personnel.

APPENDIX A
Figures
SOP #2002
September 1994

FIGURE 1. Cover Memo - Transmittal of Site Notes

DATE:

TO: Central File #

FROM: _____; Task Leader

SUBJECT: LOGBOOK NOTES
SITE NAME, DATE(s)

Attached please find copies of field-related personal logbook records for activities performed at the above-referenced site. Individuals involved included:

NAME	LOGBOOK NUMBER

w/Attachments

FIGURE 2. Field Data Sheet

FIELD DATA SHEET

26880

Roy F. Weston, Inc.
REAC, Edison, N.J.
EPA Contract 68-C4-0022

Chain of Custody No. _____

Samplers: _____ REAC Task Leader: _____

Date: _____ Site Name: _____ EPA WAM _____

Time: _____ Sample Location: _____ Work Assignment No.: _____

SITE DESCRIPTION			SOIL TYPE		SURFACE WATER	STREAM	BOTTOM	
landfill	old field	upland palustrine	rock	clay	color _____	width _____	rock	silt
industrial	wooded	lowland riverine	gravel	muck	odor _____	depth _____	rubble	clay
commercial	farmland	lacustrine	sand	loam	flow _____	velocity _____ cm/s	gravel	organic
residential	gully		silt	peat	direction _____	pools _____ %	shell	other _____
hedgegrows	floodplain		color _____			riffles _____ %	sand	

SAMPLE TYPE		DEVICE		SAMPLE INFORMATION		WEATHER PARAMETERS
surface water	effluent	kemmerer	ponar	color_____	pH _____	ambient temp _____
groundwater	sludge	trowel	other _____	odor _____	ORP _____	barometric pressure _____
potable water	leachate	bucket		temp _____	salinity _____	relative humidity _____
sediment	waste	auger		DO _____	sample depth _____	weather conditions _____
soil	other _____	ekman		cond _____	tide stage _____	_____

ANALYSES TO BE PERFORMED

ORGANICS
- A. halogenated & aromatic volatiles
- B. volatiles
- C. trihalomethanes
- D. pesticides/PCB
- E. PCB
- F. base neutral/acid extractables
- G. pesticides, drinking water
- H. herbicides, drinking water
- I. other _____

INORGANICS
- A. metals, priority pollutant
- B. metals, TAL
- C. metals scan (ICP)
- D. metals, other _____

RCRA
- A. TCLP
- B. Ignitability
- C. corrosivity _____ pH _____
- D. reactivity
- E. other _____

ORGANICS
- A. total cyanide
- B. total phenol
- C. petroleum hydrocarbons
- D. pH
- E. alkalinity
- F. hardness
- G. total dissolved solids
- H. total suspended solids
- I. sulfate
- J. TOC
- K. grain size
- L. other _____
- M. other _____

SAMPLE PREPARATION

CONTAINER	PRESERVATIVES
glass jar	HNO_3
plastic jar	NaOH
acetate core	Zn Acetate
plastic bag	HCl
plastic bucket	Na_2SO_4
other _____	other _____

STORAGE
- wet ice
- dry ice
- ambient

COMMENTS:

FIGURE 3. Sample Labels

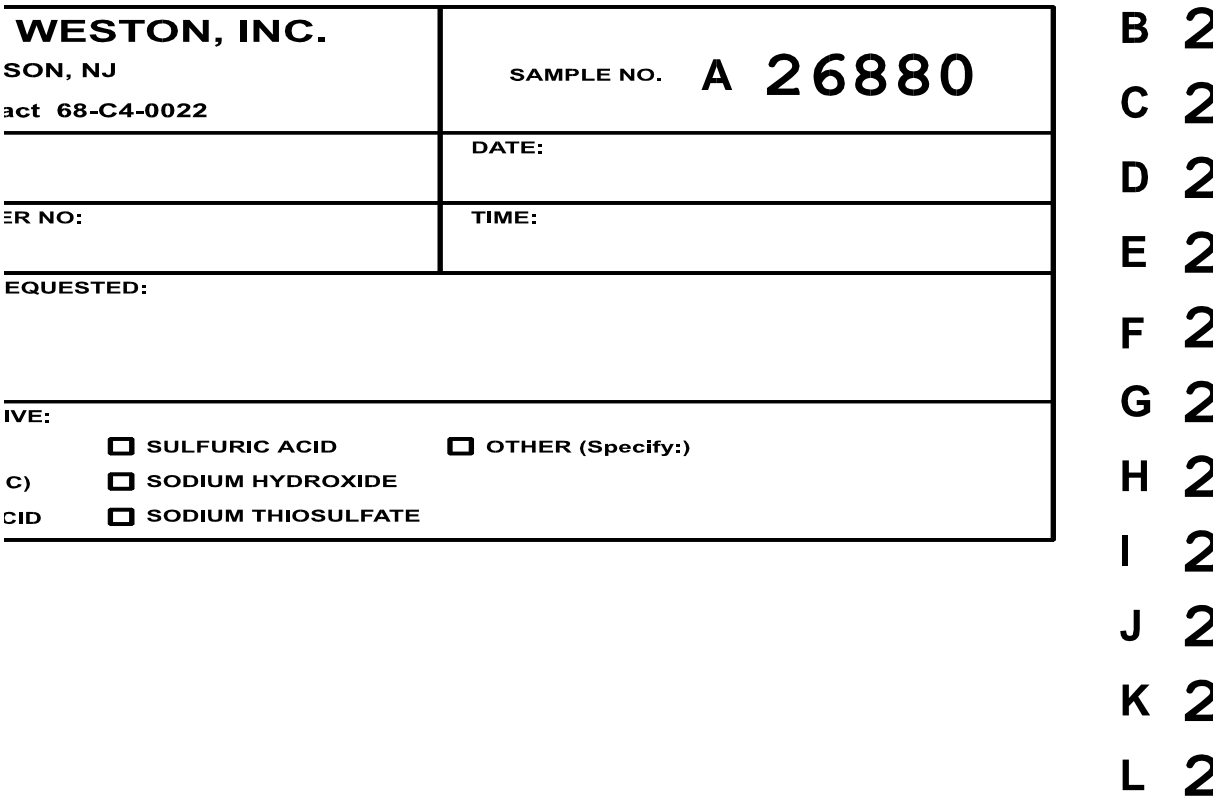


FIGURE 4. Soil Gas Sampling Data Sheet

SOIL GAS SAMPLING SHEET

Roy F. Weston, Inc.
REAC Project, Edison, NJ
EPA Contract No. 68-C4-0022

Site Name: _____ REAC Task Leader: _____

Samplers: _____ EPA Work Assignment Manager: _____

Date: _____ Work Assignment No.: _____

Weather Parameters: ambient temp. _____ relative humidity _____
barometric pressure _____ weather conditions _____

Sample No.:					
Location ID.:					
Remarks:					
Time:					
Sample Depth:					
Sample Taken:	Y/N	Y/N	Y/N	Y/N	Y/N
Instrument Readings:					
HNU					
OVA					
LEL					
% O_2					
Soil Temp.					

FIGURE 5. Soil Gas Sample Labels

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. SG 02951
EPA CONTRACT 68-C4- 22
SITE NAME: DATE: TIME:
SAMPLE LOCATION: REMARKS:
HNu _____ % O_2 _____
OVA _____ SOIL TEMP. _____
LEL _____ OTHER _____

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. SG 02952
EPA CONTRACT 68-C4- 22
SITE NAME: DATE: TIME:
SAMPLE LOCATION: REMARKS:
HNu _____ % O_2 _____
OVA _____ SOIL TEMP. _____
LEL _____ OTHER _____

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. SG 02953
EPA CONTRACT 68-C4-0022
SITE NAME: DATE: TIME:
SAMPLE LOCATION: REMARKS:
HNu _____ % O_2 _____
OVA _____ SOIL TEMP. _____
LEL _____ OTHER _____

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. SG 02954
EPA CONTRACT 68-C4-0022
SITE NAME: DATE: TIME:
SAMPLE LOCATION: REMARKS:
HNu _____ % O_2 _____
OVA _____ SOIL TEMP. _____
LEL _____ OTHER _____

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. SG 02955
EPA CONTRACT 68-C4- 22
SITE NAME: DATE: TIME:
SAMPLE LOCATION: REMARKS:
HNu _____ % O_2 _____
OVA _____ SOIL TEMP. _____
LEL _____ OTHER _____

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. SG 02956
EPA CONTRACT 68-C4- 22
SITE NAME: DATE: TIME:
SAMPLE LOCATION: REMARKS:
HNu _____ % O_2 _____
OVA _____ SOIL TEMP. _____
LEL _____ OTHER _____

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. SG 02957
EPA CONTRACT 68-C4- 22
SITE NAME: DATE: TIME:
SAMPLE LOCATION: REMARKS:
HNu _____ % O_2 _____
OVA _____ SOIL TEMP. _____
LEL _____ OTHER _____

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. SG 02958
EPA CONTRACT 68-C4- 22
SITE NAME: DATE: TIME:
SAMPLE LOCATION: REMARKS:
HNu _____ % O_2 _____
OVA _____ SOIL TEMP. _____
LEL _____ OTHER _____

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. SG 02959
EPA CONTRACT 68-C4- 22

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. SG 02960
EPA CONTRACT 68-C4- 22

FIGURE 6. Air Sampling Work Sheet

ENVIRONMENTAL RESPONSE TEAM
AIR SAMPLING WORK SHEET

Page ____ of

Roy F. Weston, Inc.
REAC Project, Edison, NJ
EPA Contract No. 68-C4-0022

Site: _____ WA#: _____

Samplers: _____ EPA/ERT WAM: _____

Date: _____ REAC Task Leader:: _____

Sample #					
Location					
Pump #					
Media					
Analysis/Method					
Time/Counter (Start)					
Time/Counter (Stop)					
Total Time					
Pump Fault	Y / N	Y / N	Y / N	Y / N	Y / N
Flow Rate (Start)					
Flow Rate (Stop)					
Flow Rate (Average)					
Volume					

MET Station On-site? Y / N

General Comments:

FIGURE 7. Air Sample Labels

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. 07091_
EPA CONTRACT 68-C4- 22

SITE NAME:	DATE:
VOL. OF AIR:	TIME:
ANALYSIS REQUEST:	REMARKS:

0 7 0 9 1
0 7 0 9 1
0

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. 07092_
EPA CONTRACT 68-C4- 22

SITE NAME:	DATE:
VOL. OF AIR:	TIME:
ANALYSIS REQUEST:	REMARKS:

0 7 0 9 2
0 7 0 9 2
0

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. 07093_
EPA CONTRACT 68-C4- 22

SITE NAME:	DATE:
VOL. OF AIR:	TIME:
ANALYSIS REQUEST:	REMARKS:

0 7 0 9 3
0 7 0 9 3
0

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. 07094_
EPA CONTRACT 68-C4- 22

SITE NAME:	DATE:
VOL. OF AIR:	TIME:
ANALYSIS REQUEST:	REMARKS:

0 7 0 9 4
0 7 0 9 4
0

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. 07095_
EPA CONTRACT 68-C4- 22

SITE NAME:	DATE:
VOL. OF AIR:	TIME:
ANALYSIS REQUEST:	REMARKS:

0 7 0 9 5
0 7 0 9 5
0

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. 07096_
EPA CONTRACT 68-C4- 22

SITE NAME:	DATE:
VOL. OF AIR:	TIME:
ANALYSIS REQUEST:	REMARKS:

0 7 0 9 6
0 7 0 9 6
0

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. 07097_
EPA CONTRACT 68-C4- 22

SITE NAME:	DATE:
VOL. OF AIR:	TIME:
ANALYSIS REQUEST:	REMARKS:

0 7 0 9 7
0 7 0 9 7
0

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. 07098_
EPA CONTRACT 68-C4- 22

SITE NAME:	DATE:
VOL. OF AIR:	TIME:
ANALYSIS REQUEST:	REMARKS:

0 7 0 9 8
0 7 0 9 8
0

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. 07099_
EPA CONTRACT 68-C4- 22

SITE NAME:	DATE:
VOL. OF AIR:	TIME:
ANALYSIS REQUEST:	REMARKS:

0 7 0 9 9
0 7 0 9 9
0

Roy F. Weston, Inc.
REAC, EDISON, NJ SAMPLE NO. 07100_
EPA CONTRACT 68-C4- 22

SITE NAME:	DATE:
VOL. OF AIR:	TIME:
ANALYSIS REQUEST:	REMARKS:

0 7 1 0 0
0 7 1 0 0
0

FIGURE 8. Air Monitoring Work Sheet

FIGURE 9. Chain of Custody Record/Lab Work Request

ENVIRONMENTAL RESPONSE TEAM
AIR SAMPLING WORK SHEET

Roy F. Weston, Inc.
REAC Project, Edison, NJ
EPA Contract No. 68-C4-0022

Site: _____ WA#: _____

Prepared By: _____ EPA/ERT WAM: _____

Date: _____ REAC Task Leader:: _____

Instrument	EPA #	Location/Description	Reading	

General Comments:

FIGURE 10. Custody Seals

n, Ir
n, N
: 68-

No.

PW
GW
SW
SL

Date

Signature

CUSTODY SEAL

Dat

Sig

SAMPLE STORAGE, PRESERVATION AND HANDLING

CONTENTS

*These sections affected by Revision 0.0.

SUPERCEDES: SOP #2003; Revision 2.0; 01/09/92; U.S. EPA Contract EP-W-09-0031.

SAMPLE STORAGE, PRESERVATION AND HANDLING

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide general guidelines for the storage and preservation of water and soil/sediment samples. Requirements for sample volume, matrix spike/matrix spike duplicate (MS/MSD) sample volume, container type, and preservation techniques are presented for both individual parameters and groups of parameters. Specific requirements for sample storage, preservation and handling must be established in the Quality Assurance (QA) Work Plan prior to sample collection.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U. S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

This SOP is applicable to all water or soil/sediment samples collected by ERT/SERAS personnel. For handling, storage and preservation requirements for waste and air samples refer to the specific SOPs for waste and air sampling techniques.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

3.1 Sample Storage and Preservation

Samples should be collected using equipment and procedures appropriate to the matrix, parameters and sampling objective. The volume of the sample collected must be sufficient to perform the analysis requested. Sample containers must not be pre-rinsed with the sample prior to sample collection.

Table 1 (Appendix A) contains a list of parameters which are typically of interest in ERT/SERAS activations. Table 1 also indicates sample volumes to be collected by matrix and parameter. Samples must be stored in the proper types of containers and preserved in a manner appropriate to the analysis to be performed. This information is also provided in Table 1. To prevent leakage during shipping, sample containers should be no more than 90% full. If air space would affect sample integrity (i.e., samples for VOA analysis), fill the sample container completely and place the container in a second container to meet the 90% requirement.

All samples must be cooled to 4^{o}C from the time of collection until analysis. When a preservative other than cooling is used, the preservative is generally added after the sample is collected, unless the sample container has been pre-preserved by the laboratory. If necessary, the pH must be adjusted to the appropriate level and checked with pH paper in a manner which will not contaminate the sample.

Depending on the arrangements for sample analysis and the amount of sample required for the analysis, it is possible that aliquots for several analyses may be taken from the same sample container. This should be verified with the laboratory performing the analyses prior to sample collection.

All sample containers must be labeled appropriately. The exterior of the sample containers must be wiped clean and dry prior to sample packaging. All samples must be packaged according to the requirements of U.S. Department of Transportation (U.S. DOT) or International Air Transportation Association (IATA).

3.2 Special Analytical Requests

If a parameter or group of parameters is not included in Table 1 (Appendix A), the laboratory performing the analysis should be contacted to determine the appropriate sample containers, volumes and preservatives. This information shall be documented in the QA Work Plan.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The following are interferences or potential problems associated with sample storage, preservation and handling:

1. Samples should be protected from sunlight which may initiate photodegradation of sample components.

2. Delaying sample preservation may cause chemical reactions to occur, altering original sample composition.

3. Improper sample preservation may adversely affect sample results.

4. Inadequate sample volume may prohibit the appropriate analyses from being performed.

5.0 EQUIPMENT/APPARATUS

The equipment/apparatus required to collect samples must be determined on a site specific basis. Due to the wide variety of sampling equipment available, refer to the specific SOPs for sampling techniques which include lists of the equipment/apparatus required for sampling.

The following specific equipment/apparatus may be required for proper sample preservation:

-pipettes (various sizes)
-bulb
-pH paper
-safety equipment

6.0 REAGENTS

Reagents required for preservation of samples are specified in Table 1 (Appendix A). The preservatives required are specified by the analyses to be performed. Decontamination solutions are specified in ERT/SERAS SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURES

Once aqueous samples are collected, add the appropriate preservative to reach the desired pH. For non-aqueous samples, cool samples to 4°C immediately after collection. For handling, storage and preservation requirements for waste and air samples refer to the specific SOPs.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

Refer to the specific SOPs for the type and frequency of QA/Quality Control (QC) samples to be analyzed, the acceptance criteria for the QA/QC samples, and any other QC activities which are associated with sampling techniques. All data associated with sampling must be documented on Field Data Sheets or within site logbooks.

10.0 DATA VALIDATION

Refer to the specific SOPs for data validation activities that are associated with sampling techniques.

11.0 HEALTH AND SAFETY

When working with potential hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

12.0 REFERENCES

This section is not applicable to this SOP.

APPENDIX A
Table
SOP #2003
August, 1994

TABLE 1. Sample Containers, Volumes to be Collected and Preservatives by Parameter and Matrix[1]

Parameter	Matrix[2]	Container[3]	Volume to be Collected	Preservative
Acidity/Alkalinity	W	P or G	1 liter	Cool (4°C)
Acidity/Alkalinity	S	P or G	8 oz	Cool (4°C)
BNA[4]	W	G (amber)	2 x 1 liter	Cool (4°C)
BNA	S	G	8 oz	Cool (4°C)
BOD	W	G	1 liter	Cool (4°C)
COD	W	P or G	1 liter	Cool (4°C) H_2SO_4,pH<2
Cr^{+6}	W	P	200 ml	Cool (4°C)
Creosotes[4]	W	G	2 x 1 liter	Cool (4°C)
Creosotes	S	G	8 oz	Cool (4°C)
Cyanide[4]	W	P	1 liter	Cool (4°C), NaOH, pH>12
Cyanide	S	G	8 oz	Cool (4°C))
Dioxin/Furans	W	G	2 x 1 liter	Cool (4°C)
Dioxin/Furans	S	G	16 oz	Cool (4°C))
Herbicides[4]	W	G	2 x 1 liter	Cool (4°C)
Herbicides	S	G	8 oz	Cool (4°C)
Metals	W	P or G	1 liter	Cool (4°C), HNO_3, pH<2
Metals	S	G	8 oz	Cool (4°C)
Oil & Grease[4]	W	G	2 x 1 liter	Cool (4°C), H_2SO_4 pH<2
Oil & Grease	S	G	8 oz	Cool (4°C)
Petroleum Hydrocarbons[4]	W	G	2 x 1 liter	Cool (4°C), H_2SO_4, pH<2
Petroleum Hydrocarbons	S	G	8 oz	Cool 4°C)
Pesticides/PCBs[4]	W	G (amber)	2 x 1 liter	Cool (4°C)
Pesticides/PCBs	S	G	8 oz	Cool (4°C)
Phenols	W	G	1 liter	Cool (4°C), H_2SO_4, pH<2
Phenols	S	G	8 oz	Cool (4°C)
Polynuclear Aromatic Hydrocarbons[4]	W	G	2 x 1 liter	Cool (4°C)
Polynuclear Aromatic Hydrocarbons	S	G	8 oz	Cool (4°C)
Reactivity (RCRA) (Cyanide)	W	P	1 liter	Cool (4°C), NaOH, pH>12
Reactivity (RCRA) (Sulfide)	W	P	1 liter	Cool (4°C), 4.0 ml zinc acetate solution
Reactivity (RCRA) (Cyanide/Sulfide)	S	G (amber)	8 oz	Cool (4°C)
Corrosivity (RCRA)	W	P	500 ml	Cool (4°C)

TABLE 1. (continued) Sample Containers, Volumes to be Collected and Preservatives by Parameter and Matrix[1]

Parameter	Matrix[2]	Container[3]	Volume to be Collected	Preservative
Ignitibility (RCRA)	W	G (amber)	500 ml	Cool (4°C)
Ignitibility (RCRA)	S	G (amber)	8 oz	Cool (4°C)
TCLP-VOAs[6]	W	G	3 x 40 ml vial	Cool (4°C)
TCLP-BNAs	W	G (amber)	2 x 1 liter	Cool (4°C)
TCLP-Pesticides/Herbicides	W	G (amber)	2 x 1 liter	Cool (4°C)
TCLP-Inorganics	W	P	1 liter	Cool (4°C),HNO_3, pH<2
TCLP-Non-Volatile Extraction[5]	S	G	16 oz	Cool (4°C)
TCLP-Volatile Extraction[5]	S	G	16 oz	Cool (4°C)
TOC	W	P or G	500 ml	Cool (4°C), H_2SO_4, pH<2
TOC	S	G	8 oz	Cool (4°C)
TOX	W	G	300 ml	Cool (4°C)
TOX	S	G	8 oz	Cool (4°C)
VOAs[6]	W	G	3 x 40 ml vial	Cool (4°C)[7]
VOAs	S	G	40 ml vial	Cool (4°C)

1. ERT/SERAS requirements. Subcontract laboratory requirements may vary. Verify prior to sample collection.
2. W - water, S - soil/sediment
3. P - polyethylene, G - glass
4. For 1 sample of every batch of 10 (or less) samples, collect 2 additional 1 liter volumes for MS/MSD analysis.
5. For 1 sample of every batch of 10 (or less) samples, collect 2 additional 16 oz volumes for MS/MSD analysis.
6. Avoid excessive turbulence when filling the sample container. The container must be sealed so that no air bubbles are entrapped. No headspace allowed.
7. For drinking water samples, if residual chlorine is present, the sample should be preserved with 0.008% sodium thiosulfate. EPA Methods 330.4 and 330.5 may be used for measurement of residual chlorine. Field test kits are commercially available for this purpose.

SAMPLE PACKING AND SHIPMENT

CONTENTS

*These sections affected by Revision 0.0.

SUPERCEDES: SOP #2004; Revision 0.0; 08/11/94; U.S. EPA Contract 68-C4-0022.

SAMPLE PACKING AND SHIPMENT

1.0 OBJECTIVE

The objective of this Standard Operating Procedure (SOP) is to summarize requirements for the packaging, marking/labeling, and shipping of environmental and hazardous materials samples.

2.0 APPLICABILITY

This SOP is applicable to all Response, Engineering, and Analytical Contract (REAC) personnel when packaging, marking/labeling, and shipping environmental and hazardous material samples.

3.0 DESCRIPTION

3.1 General

Samples collected by REAC personnel are typically shipped to the REAC laboratory or a subcontract laboratory for analysis. Samples must be transported in a manner that will ensure their integrity, guard the samples from the detrimental effects of sample leakage or breakage and protect the health and safety of shipping/receiving personnel. Regulations for packaging, marking/labeling, and shipping of hazardous materials and wastes are promulgated by the U.S. Department of Transportation (U.S. DOT). Air carriers which transport hazardous materials, in particular Federal Express, require compliance with the current edition of the International Air Transport Association (IATA) *Dangerous Goods Regulations*, which applies to shipment and transportation of hazardous materials samples by air carrier. Following current IATA regulations will ensure compliance with U.S. DOT.

Employees should be aware that regulatory agencies with jurisdiction have the authority to levy substantial fines and penalties to violators. Failure on the part of any employee to comply with the requirements of these procedures may be cause for disciplinary action, including discharge.

3.2 Environmental Samples versus Hazardous Material Samples

Samples collected by REAC personnel are classified as either environmental or hazardous material samples. In general, environmental samples (soils, sediments, surface and ground waters) are those collected from off-site areas and are not expected to contain high concentrations of contaminants considered to be hazardous. Soils, sediments, surface and ground waters collected from on-site areas may be classified as hazardous material samples if they contain hazardous levels of contaminants. On-site materials collected from drums, bulk storage tanks, obviously contaminated ponds, impoundments, lagoons, pools, and leachates from hazardous waste sites are generally considered hazardous material samples. It should be noted that the sample collection location (on-site versus off-site) is not the dominant factor in determining whether the sample is an environmental or hazardous waste sample, but rather the concentration of the contaminants and the nature of the matrix. The following are examples of the types of information that the Task Leader may use to determine if a matrix should be considered either an environmental or hazardous material samples:

- proximity of the sampling location to the suspected source of contamination
- field screening results (HNu, OVA, XRF, etc.)

- environmental indicators such as living biota (vegetation, fish, etc.), staining, matrix characteristics (i.e., does the soil or water appear "normal"?)
- historic sampling and analytical results
- type of site and activities conducted on the site

Distinctions must be made between environmental and hazardous material samples:

- To determine the IATA requirements for the transportation of samples. If there is any doubt, a sample should be considered hazardous and shipped accordingly.
- To protect the health and safety of sample receiving personnel. Special precautions may be necessary when samples other than those of an environmental nature are received.

3.3 Environmental Samples

3.3.1 Packaging

Environmental samples must be packaged as follows:

1. The sample jars should be properly labeled in accordance with ERT/REAC SOP #2002, *Sample Documentation*, and the exteriors of the sample jars should be wiped clean and dried, if necessary. The sealed sample jars should be placed in a polyethylene bag (one sample per bag), and the bag should be sealed.

2. The sample jars may be placed in a U.S. DOT-approved fiberboard box or cooler (shipping container) which has been lined with a large polyethylene bag or plastic sheeting.

3. The shipping container must be packed with enough noncombustible, absorbent, cushioning material to minimize the possibility of sample jar breakage, and to absorb any material that may have leaked. If there are multiple sample jars, there must be sufficient cushioning material between them to prevent breakage if the shipping container is dropped or severely shocked.

4. If maintenance of the sample jars at 4^{o}C is necessary, wet or blue ice must be placed into two sealable polyethylene bags which must be sealed and placed in the shipping container. Additional absorbent material may be added, if necessary.

   NOTE: If dry ice is used, it should be limited to 4 pounds or less per shipping container. Use of more than 4 pounds of dry ice will require the completion of the Federal Express Air bill for Dangerous Goods Shipments. In addition, the shipping container must be vented to allow for escape of carbon dioxide gas. It is recommended to use a dry ice shipping container.

5. The Chain of Custody Record, completed in accordance with ERT/REAC SOP #4005, *Chain of Custody Procedures*, must be placed in a polyethylene bag which must be sealed and taped to the inside of the shipping container lid.

6. The shipping container must be closed and sealed with duct or strapping tape.

3.3.2 Marking/Labeling of Shipping Containers and Shipping Papers

1. Sample jars must have completed sample labels, and the shipping container must be marked "Environmental Samples" (Appendix A, Figure 1). When liquid samples are included in the shipping container, two sides of the shipping container must be marked "This End Up" or arrow labels (Appendix A, Figure 2) should be affixed. No IATA marking or labeling are required. However, the shipping container must be labeled with the names and addresses of both the sender and the receiver. At least two custody seals must be placed across the shipping container openings as per ERT/REAC SOP #4005, *Chain of Custody Procedures*.

2. No IATA shipping papers are required.

3.3.3 Transportation

1. There are no IATA restrictions on the mode of transportation.

2. In general, Federal Express is used for all overnight sample shipment. Due to holding time restrictions, this is highly recommended unless the samples personally can be transported to the appropriate laboratory for analysis.

3. When environmental samples are shipped by Federal Express, a Federal Express Airbill (Appendix A, Figure 3) must be completed. If Federal Express service is not available for a particular location, the REAC Shipping/Receiving Department must be contacted to determine the appropriate overnight carrier and make arrangements for shipment.

3.4 Hazardous Material Samples

3.4.1 Determination of Hazard Class

Prior to mobilization in the field and any sampling activities, the following steps must be taken to determine the Hazard Class(es) of the materials to be shipped.

1. The Task Leader or designee shall identify the material for which samples are being collected and analyzed. If it is a class of materials (i.e., BNAs, VOAs, etc.), the specific compound/analyte considered to be the most hazardous should be identified.

2. The Task Leader or designee shall provide the REAC Shipping/Receiving Department with the proper shipping name (usually the chemical name or a

synonym) of the material to be shipped. If the material is not included in the IATA List of Dangerous Goods, the Task Leader, or designee, shall assist the Shipping/Receiving personnel in determining the appropriate Hazard Class and Packing Group, if applicable. This is usually dependent on the physical properties of the hazardous material.

The appropriate Hazard Class and Packing Group for hazardous material samples can be determined through professional judgment and logical elimination of inappropriate classes for the material being shipped. Definitions of the nine Hazard Classes specified by the IATA *Dangerous Goods Regulations*(1) are included in Appendix B.

3. The Shipping/Receiving personnel will consult the IATA *Dangerous Goods Regulations* (current edition) for packing, marking and labeling, and documentation instructions. REAC personnel will implement the "Limited Quantities" regulations unless they are not applicable.

4. Instructions provided by the Shipping/Receiving Department must be documented in the site specific Work Plan.

3.4.2 Packaging

Unless otherwise directed by the IATA *Dangerous Goods Regulations*, samples must be packaged as described in Section 3.3.1 of this SOP.

3.4.3 Marking/Labeling of Shipping Containers and Shipping Papers

Shipping containers must be marked, labeled and shipping documentation completed as described in the IATA *Dangerous Goods Regulations*. Shipping containers must be labeled with the names and addresses of both the sender and the receiver, and at least two custody seals must be placed across the shipping container openings.

3.4.4 Transportation

1. Generally, Federal Express is used for all overnight shipment of samples. Due to holding time constraints, this is highly recommended unless the samples can be personally transported to the appropriate laboratory for analysis.

2. When hazardous material samples are shipped by Federal Express, a Federal Express Airbill (Appendix A, Figure 3) in conjunction with a Shipper's Declaration for Dangerous Goods (Appendix A, Figure 4) must be completed. If Federal Express service is not available for a particular location, the REAC Shipping/Receiving Department must be contacted to determine the appropriate overnight carrier and to make arrangements for shipment.

3.5 Training Requirements

All personnel responsible for packing and shipping samples shall be trained as required by 40 CFR 171-177, as follows:

3.5.1 Initial Training Requirements

- C Training for employees employed after November 15, 1992, shall be completed within 90 days of their employment.
- C Employees who change job functions shall complete training within 90 days after the change if packing and shipping samples are to be part of the employee's new responsibilities.
- C Employees employed after November 15, 1992, or have changed job functions may perform sample packing and shipping functions prior to the completion of training provided they are supervised by properly trained and knowledgeable employees.

3.5.2 Recurrent Training Requirements

- C Employees shall receive training in packing and shipping samples as required by 40 CFR 171-177 at least once every three years.

4.0 RESPONSIBILITIES

4.1 Field Personnel

Field personnel are responsible for packaging and shipping samples in accordance with this SOP and the IATA *Dangerous Goods Regulations*. Field personnel must attend initial and recurrent training as described above.

4.2 Task Leaders

Task Leaders are responsible for assuring samples are packaged and shipped in accordance with this SOP and the IATA *Dangerous Goods Regulations*, for obtaining packaging and shipping information, when required, from the REAC Shipping/Receiving Department and assuring that all field personnel have the required training.

4.3 Shipping/Receiving Department

The REAC Shipping/Receiving Department is responsible for providing appropriate packaging and shipping information when requested by Task Leaders or field personnel. The REAC Shipping/Receiving Department in conjunction with Health and Safety are responsible for providing initial and recurrent training as described above.

4.4 Section Leaders and the QA Office

The Section Leaders and the QA Office are responsible for assuring this SOP is implemented.

5.0 APPENDICES

A - Figures
B - IATA Hazard Class Definitions

6.0 REFERENCES

(1) International Air Transport Association (IATA). 2000. *Dangerous Goods Regulations*. Montreal, Quebec, Canada.

APPENDIX A
Figures
SOP #2004
November 2000

FIGURE 1. Environmental Samples Label

FIGURE 2 Arrow Label

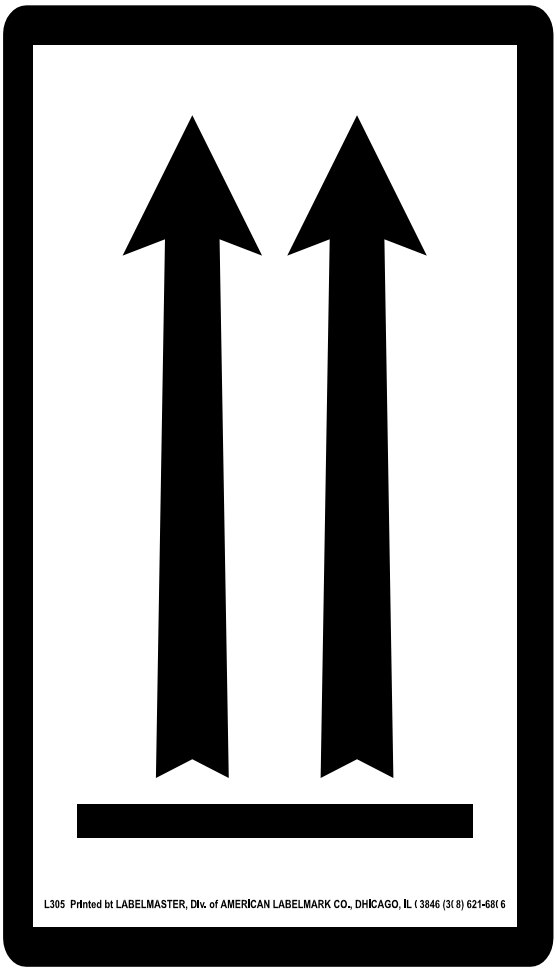


FIGURE 3 Federal Express AirBill

FIGURE 4. Shipper's Declaration for Dangerous Goods

204/250 14119410

SHIPPER'S DECLARATION FOR DANGEROUS GOODS (Provide at least two copies to the airline)

Shipper

Page 1 of 1 Pages

Shipper's Reference Number:

Consignee

LOCKHEED PARTIN GOVT REAC
2890 WOODBRIDGE AVE
EDISON NJ US 08837

FedEx. Federal Express

Two completed and signed copies of this Declaration must be handed to the operator.

WARNING

Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder, or an IATA cargo agent.

TRANSPORT DETAILS

This shipment is within the limitations prescribed for: (delete non-applicable)

PASSENGER AND CARGO AIRCRAFT / CARGO AIRCRAFT ONLY

Airport of Departure:

Airport of Destination:

Shipment type: (delete non-applicable)

NON-RADIOACTIVE / RADIOACTIVE

NATURE AND QUANTITY OF DANGEROUS GOODS

Dangerous Goods Identification							
Proper Shipping Name	Class or Division	UN or ID No.	Packing Group	Subsidiary Risk	Quantity and type of packaging	Packing Inst.	Authorization

Additional Handling Information

Emergency telephone number

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labelled/placarded, and are in all respects in proper condition for transport according to applicable international and National Governmental Regulations.

Name/Title of Signatory

Place and Date

Signature
(see warning above)

IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT.

APPENDIX B
IATA Hazard Class Definitions
SOP #2004
November 2000

SAMPLE PACKING AND SHIPMENT

IATA Hazard Class Definitions

Class 1 - Explosives

This class includes:

(a) Explosive substances, except those whose predominant hazard should be in another class.

(b) Explosive articles, except devices containing explosive substances in such a limited quantity or of such a character that their inadvertent or accidental ignition or initiation, during transport, will not cause any manifestation of projection, fire, smoke, heat, or loud noise external to the device.

(c) Articles and substances not mentioned above which are manufactured with a view to producing a practical explosion or pyrotechnic effect.

Class 2 - Gases

This class comprises compressed gases, liquefied gases, gases in solution, refrigerated liquefied gases, mixtures of gases, mixtures of one or more gases with one or more vapors of substances of other classes, articles charged with a gas, tellurium hexafluoride, and aerosols.

Class 3 - Flammable Liquids

This class comprises liquids or mixtures of liquids or liquids containing solids in solution or in suspension which give off a flammable vapor at temperatures of not more than 60.5^{o}C (141^{o}F) closed-cup test or not more than 65.6^{o}C (150^{o}F) open-cup test.

Class 4 - Flammable Solids

Class 4 is divided into three divisions as follows:

Division 4.1 - Flammable Solids

Flammable solids are readily combustible solids and those which may cause fire through friction. Readily combustible solids are powdered, granular, or pasty substances which are dangerous if they can be easily ignited by brief contact with an ignition source, such as a burning match, and if the flame spreads rapidly. The danger may not only come from the fire but also from the toxic combustion products. Metal powders are especially dangerous because of the difficulty of extinguishing a fire since normal extinguishing agents such as carbon dioxide or water can increase the hazard.

Division 4.2 - Substances Liable to Spontaneous Combustion

Substances which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up in contact with air, and being then liable to catch fire.
Division 4.3 - Substances Which, on Contact With Water, Emit Flammable Gases (Dangerous When Wet)

Substances which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

Class 5 - Oxidizing Substances and Organic Peroxides

Oxidizing substances are substances which, in themselves are not necessarily combustible, but may generally cause or contribute to the combustion of other material by yielding oxygen.

Organic peroxides are organic substances which contain the bivalent structure -O-O- and may be considered derivatives of hydrogen peroxide in which one or both of the hydrogen atoms have been replaced by organic radicals. Organic peroxides are thermally unstable substances which may undergo exothermic, self-accelerating decomposition. In addition, they may have one or more of the following properties:

- Be liable to explosive decomposition
- Burn rapidly
- Be sensitive to impact or friction
- React dangerously with other substances
- Cause damage to the eyes

Class 6 - Poisonous (Toxic) and Infectious Substances

Poisonous (toxic) substances are substances which are liable to cause death or injury or harm to human health if swallowed, inhaled, or contacted by the skin.

Infectious substances are substances containing viable micro-organisms including a bacterium, virus, rickettsia, parasite, fungus, or a recombinant, hybrid, or mutant, that are known or reasonably believed to cause disease in humans or animals.

Genetically modified organisms or micro-organisms

Biological products

Diagnostic specimens

Class 7 - Radioactive Material

For the purpose of these regulations, a radioactive material is any article or substance with a specific activity greater than 70 kBq/kg (0.002 uCi/g).

Class 8 - Corrosives

Substances which, in the event of leakage, can cause severe damage by chemical action when in contact with living tissue or can materially damage other freight or the means of transport.

Class 9 - Miscellaneous Dangerous Goods

SAMPLE PACKING AND SHIPMENT

Substances and articles which during air transport present a danger not covered by other classes. Included in this class are: other regulated substances, magnetized material, and miscellaneous articles and substances.

Other regulated substances are liquids or solids which have anesthetic, noxious, or other similar properties which could cause extreme annoyance or discomfort to passengers and/or flight crew members.

Magnetized material is any material, which, when packed for air transport, has a magnetic field strength of 0.159 A/m (0.002 gauss) or more at a distance of 2.1 m (7 ft) from any point on the surface of the assembled package.

Examples of miscellaneous articles and substances are as follows:

- Asbestos
- Dry ice
- Environmentally hazardous substances
- Polymeric beads
- Zinc dithionite

CONTENTS

CONTENTS (cont)

SUPERCEDES: SOP #2005; Revision 1.1; 04/19/93; U.S. EPA Contract 68-03-3482.

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to describe typical Quality Assurance/Quality Control (QA/QC) samples that are collected in the field, or prepared for or by the laboratory. The QA/QC samples identified in this SOP are representative for soil, water and air matrices.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

QA samples are used as an assessment tool to determine if environmental data meet the quality criteria established for a specific application. QC samples are 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. The goal of including QA/QC samples with any sampling or analytical event is to be able to identify, measure and control the sources of error that may be introduced from the time of sample bottle preparation through analysis.

Analytical results for these samples can be used to assess accuracy as well as cross contamination. Accuracy refers to the correctness of the concentration value and the qualitative certainty that the analyte is present. It is a combination of both bias (systematic error) and precision (random error). Bias is defined as the deviation of a measured value from a reference value or known spiked amount, and is determined by calculating percent recovery. Precision is a measure of the closeness of agreement among individual measurements. Precision is determined by coefficient of variation calculations.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

The amount of sample to be collected, and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest, and are discussed in ERT/REAC SOP #2003, Sample Storage, Preservation, and Handling, for the soil and water matrices. Sample preservation, containers, handling, and storage for air and waste samples are discussed in the specific SOPs for air and waste sampling techniques.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

QA/QC samples are collected and analyzed in addition to environmental samples to assist in identifying the origin of both field and laboratory contamination. In order to provide useful information, QA/QC samples must be prepared and analyzed appropriately.

5.0 EQUIPMENT/APPARATUS

With the exception of some types of blank and performance evaluation samples, the equipment/apparatus required to collect QA/QC samples is the same as the equipment/apparatus required to collect the environmental samples. This is determined on a site specific basis. Due to the wide variety of sampling

equipment available, refer to the specific SOPs for sampling techniques which include lists of the equipment/apparatus required for sampling. Sampling equipment/apparatus are generally not required for field, trip, or lot blanks or performance evaluation samples.

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed and are summarized in ERT/REAC SOP #2003, Sample Storage, Preservation, and Handling. Decontamination solutions are specified in ERT/REAC SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

QA/QC samples for soil, water and air matrices and the laboratory are discussed below. Each type of sample is defined and a preparation procedure is outlined. In addition, the suggested minimum frequency of collection of these QA/QC samples is discussed.

7.1 Soil QA/QC Samples

7.1.1 Field Replicates

Field replicates are field samples obtained from one location, homogenized, and divided into separate containers. They are treated as separate samples throughout the remaining sample handling and analytical processes. These samples are used to assess error (precision) associated with sample heterogeneity, sampling methodology and analytical procedures. Field replicates may be collected on a site-specific basis and may not be collected at all sites investigated.

Field replicates may be used when determining total error (precision) for critical samples with contamination concentrations at or near the action level. This procedure is useful in determining total (sampling and analytical) error because it evaluates sample collection, sample preparation, and analytical procedures. If error is to be determined, a minimum of eight replicate samples from a single sample location is required in order for a valid statistical analysis to be performed.

NOTE: The terms "field duplicate" or "duplicate sample" have been replaced by the term "field replicate".

7.1.2 Collocated Samples

Collocated samples are collected adjacent to the routine field sample to determine variability of the soil and contaminant(s) at the site within a small area. Typically, collocated samples are collected about one-half to three feet away from the routine field sample location. Analytical results from collocated samples can be used to assess site variation, but only in the immediate sampling area. Due to the non-homogenous nature of soil at sites, collocated samples should not be used to assess variability across a site and are not recommended for assessing error. Applicability and frequency of collocated samples should be determined on a site-specific basis.

7.1.3 Background Samples

Background samples are collected from area(s) either on or off site where there are little or no contaminants. Background samples are collected in an attempt to determine the natural composition of the soil (especially important in areas with high concentrations of naturally-occurring metals) and are considered "clean" samples. They provide a basis for comparison of contaminant concentration levels with samples collected on site. At least one background soil sample should be collected; however, more may be warranted when site-specific factors such as natural variability of local soil, multiple on-site contaminant source areas, or off-site facilities potentially contributing to soil contamination exist. Background samples may be collected for all QA objectives, in order to evaluate potential error associated with sampling design, sampling methodology, and analytical procedures.

Background samples may be used to determine bias and precision if at least eight replicates are spike with the analyte of interest at a concentration equal to the action level and then analyzed.

7.1.4 Rinsate Blanks

For the soil matrix, rinsate blanks are not required because the aqueous rinse does not simulate the cross-contamination mechanism that would occur.

7.1.5 Field Blanks

Field blanks are prepared in the field by filling the appropriate sample container with certified clean sand or soil and are then submitted to the laboratory for analysis. A field blank is primarily used to evaluate contamination error associated with field operations and shipping but may also be used to evaluate contamination error associated with laboratory procedures. Submit field blanks at a rate of one per day to meet QA2 and QA3 objectives.

7.1.6 Trip Blanks

Trip blanks are only required for volatile organics analysis and are prepared prior to going into the field. Trip blanks consist of certified clean sand or soil and are handled, transported, and analyzed in the same manner as the other volatile organic samples collected that day. Trip blanks are used to evaluate contamination error associated with sample handling and shipment, or laboratory handling and analysis. Utilize trip blanks to meet QA2 and QA3 objectives for volatile organic analyses only. The minimum frequency of trip blanks is one per container used to transport volatile organic samples.

7.1.7 Performance Evaluation Samples

Performance evaluation (PE) samples evaluate the overall accuracy of the analytical laboratory and detect any bias in the analytical method used. These samples are usually prepared by a third party, using a quantity of analyte(s) which is known to the preparer

but unknown to the laboratory. These samples always undergo some type of certification analysis. The analyte(s) used to prepare the PE sample is the same as the analyte(s) of concern. Laboratory accuracy is evaluated by comparing the percentage of analyte identified in the PE sample (percent recovery) with the analytical results of the site samples. Even though they are not available for all analytes, PE samples are required to achieve QA3 objectives. Where PE samples are unavailable for an analyte of interest, QA2 is the highest QA objective achievable. When analyzed, the minimum frequency of PE samples is one per analyte of interest per matrix.

7.1.8 Matrix Spike Samples

Matrix spike and matrix spike duplicate samples (MS/MSDs) are environmental samples that are spiked in the laboratory with a known concentration of a target analyte(s) to verify percent recoveries. MS/MSDs are primarily used to check sample matrix interferences. They can also be used to monitor laboratory performance. However, a dataset of at least three or more results is necessary to distinguish between laboratory performance and matrix interference. For ERT/REAC sampling events, the minimum frequency of MS/MSDs is 10% of the total number of samples being analyzed for the target analyte(s).

MS/MSDs are also used to evaluate error due to laboratory bias and precision. One MS/MSD pair should be analyzed and the average percent recovery should be calculated to assess bias. To assess precision, at least eight matrix spike replicates from the same sample should be analyzed and the standard deviation and coefficient of variation should be determined. Bias and precision calculations are optional for QA2 objectives and required to meet QA3 objectives.

7.2 Aqueous QA/QC Samples

7.2.1 Field Replicates

Field replicates are field samples obtained from one location and divided into separate containers. They are treated as separate samples throughout the remaining sample handling and analytical processes. These samples are used to assess error (precision) associated with sample heterogeneity, sampling methodology and analytical procedures. Field replicates may be collected on a site-specific basis and may not be collected at all sites investigated.

Field replicates may be used when determining total error (precision) for critical samples with contamination concentrations at or near the action level. This procedure is useful in determining total (sampling and analytical) error because it evaluates sample collection, sample preparation, and analytical procedures. If error is to be determined, a minimum of eight replicate samples from a single sample location is required in order for a valid statistical analysis to be performed.

NOTE: The terms "field duplicate" or "duplicate samples" have been replaced by the term "field replicate".

7.2.2 Background Samples

Background samples are collected from area(s) either on or off site where there are little or no contaminants. Background samples determine the natural composition of the aqueous matrix and are considered "clean" samples. They provide a basis for comparison of contaminant concentration levels with samples collected on site. At least one background sample should be collected; however, more may be warranted when site-specific factors such as multiple on-site contaminant source areas, or off-site facilities potentially contributing to contamination exist. Background samples may be collected for all QA objectives, in order to evaluate potential error associated with sampling design, sampling methodology, and analytical procedures.

Background samples may be used to determine bias and precision if at least eight replicates are spiked with the analyte of interest at a concentration equal to the action level and then analyzed.

7.2.3 Rinsate Blanks

Rinsate blanks are samples obtained by running distilled/deionized water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated in the same manner as the samples collected that day. A rinsate blank is used to assess cross-contamination brought about by improper decontamination procedures. Where non-dedicated sampling equipment is utilized, collect one rinsate blank per type of sampling device per day to meet QA2 and QA3 objectives.

7.2.4 Field Blanks

Field blanks are prepared in the field by filling the appropriate sample container with distilled/deionized water and are then submitted to the laboratory for analysis. A field blank is primarily used to evaluate contamination error associated with field operations and shipping but may also be used to evaluate contamination error associated with laboratory procedures. Submit field blanks at a rate of one per day to meet QA2 and QA3 objectives.

7.2.5 Trip Blanks

Trip blanks are only required for volatile organics analysis and are prepared prior to going into the field. Trip blanks consist of distilled/deionized water and are handled, transported, and analyzed in the same manner as the other volatile organic samples collected that day. Trip blanks are used to evaluate contamination error associated with sample handling and transport, or laboratory handling and analysis. Utilize trip blanks to meet QA2 and QA3 objectives for volatile organic analyses only. The minimum frequency of trip blanks is one per container used to transport volatile organic samples.

7.2.6 Performance Evaluation Samples

Performance evaluation (PE) samples evaluate the overall accuracy of the analytical laboratory and detect any bias in the analytical method used. These samples are usually prepared by a third party, using a quantity of analyte(s) which is known to the preparer but unknown to the laboratory. These samples always undergo some type of certification analysis. The analyte(s) used to prepare the PE sample is the same as the analyte(s) of concern. Laboratory accuracy is evaluated by comparing the percentage of analyte identified in the PE sample (percent recovery) with the analytical results of the site samples. Even though they are not available for all analytes, PE samples are required to achieve QA3 objectives. Where PE samples are unavailable for an analyte of interest, QA2 is the highest QA objective achievable. When analyzed, the minimum frequency of PE samples is one per analyte of interest per matrix.

7.2.7 Matrix Spike Samples

MS/MSDs are environmental samples that are spiked in the laboratory with a known concentration of a target analyte(s) to verify percent recoveries. MS/MSDs are primarily used to check sample matrix interferences. They can also be used to monitor laboratory performance. However, a dataset of at least three or more results is necessary to distinguish between laboratory performance and matrix interference. For ERT/REAC sampling events, the minimum frequency of MS/MSDs is 10% of the total number of samples being analyzed for the target analyte(s).

MS/MSDs are also used to evaluate error due to laboratory bias and precision. One MS/MSD pair should be analyzed and the average percent recovery should be calculated to assess bias. To asses precision, at least eight matrix spike replicates from the same sample should be analyzed and the standard deviation and coefficient of variation should be determined. Bias and precision calculations are optional for QA2 objectives and required to meet QA3 objectives.

7.3 Air QA/QC Samples

7.3.1 Collocated Samples

Collocated samples are collected by placing two identical samplers next to each other and, either: (1) air is drawn from one source and split with a manifold; or (2) two pumps are set adjacent to each other and each collect a sample at the same flow rate. Depending upon the methods used to collect and analyze the samples, collocated samples can determine the variation due to both sampling error and precision in the analyses (e.g., using thermally desorbed adsorbent tubes), or to isolate the variation due to sampling error only (e.g., using solvent-extracted tubes and Summa canisters). The minimum frequency of collocated samples is 5% or one per sampling event for all QA objectives.

7.3.2 Field Blanks

Field blanks are samples that undergo the full handling and shipping process of an actual sample. Field blanks are designed to detect potential sample contamination that may occur during field operations or during shipment. The field blank is opened with the other sampling media, resealed and carried through the sampling process. The field blank must be associated with an actual sampling period. Submit field blanks at a rate of

5% of the total samples or a minimum of one per sampling event to meet QA2 and QA3 objectives.

7.3.3 Trip Blanks

Trip blanks detect whether samples are contaminated during shipping. It is typically used in conjunction with field blanks to isolate sources of sample contamination already noted in previous field blanks. The trip blank is prepared and added to the site samples after sampling has been completed, just prior to shipping samples for analysis. If the absorbent tubes were sealed from the manufacturer, their seals should be broken at this point. For absorbent tubes that have been recycled and resealed by the laboratory, there is no need to break these temporary seals prior to shipping. Canister trip blanks are evacuated containers that are shipped to and from the site with the canisters used for air sampling. A trip blank for an impinger-based sampling method consists of an aliquot of impinger reagent that is shipped back to the laboratory with the samples. Submit trip blanks at a rate of 5% of the total samples or a minimum of one per sampling event to meet QA2 and QA3 objectives.

7.3.4 Lot Blanks

A lot blank detects contamination producing false positive results strictly due to the sampling medium itself. It consists of a sample collector from the same lot as the sample collectors used during a particular day or time period. It comes from the manufacturer or laboratory with the seal intact. The lot blank is included with the samples when they are delivered to the laboratory. Whenever a set of canisters is cleaned by the laboratory for reuse, the previously most contaminated canister should be re-analyzed as a lot blank at least 24 hours later, in order to check the cleanliness of that lot of "cleaned" canisters. Whenever a new sampler system (e.g., Anderson stainless steel bellows pump) is initially received from the manufacturer or from a laboratory, a lot blank should be pulled off the system using humidified zero air or humidified nitrogen. In a similar manner, whenever a sampler system is cleaned, at a minimum, the sampler(s) that had generated the most contaminated canister sample(s) in the previous batch should be checked with humidified zero air. Submit lot blanks at a rate of 10% of the total samples or a minimum of one per sampling event per lot to meet QA1, QA2, and QA3 objectives.

7.3.5 Breakthrough Sample

Breakthrough samples detect false negative results and significant negative biases in the data. These problems can arise when compounds elute from the sampling media before the sampling run is completed. The two types of breakthrough samples are serial media samples and spiked media samples. To collect a serial media sample, a sampling train is set up with a primary sampling device and backed by a secondary sampling device. A spiked media breakthrough sample is obtained by pulling air through a sampling train that was either spiked in the field with a standard solution or was spiked in the laboratory prior to being shipped into the field. The spiked media breakthrough sample is always collected next to and concurrent with an upwind/background sample.

The breakthrough sample typically is used to determine whether the first sampling device has retained all of the compounds of concern. It should be collected in the first batch of samples. When mixed-bed adsorbent tubes are being used, serial media samples are not recommended. Instead, spike medium samples or distributed volume samples should be collected. Breakthrough samples are recommended to be collected to meet QA2 and QA3 objectives; however, the rate of collection is method dependent.

7.3.6 Performance Evaluation Sample

A PE sample evaluates the overall accuracy of the analytical laboratory and detects any bias in the analytical method being used. The PE sample contains a quantity of analyte(s) which is known to the sampling team but unknown to the laboratory. It is usually prepared by a third party and always undergoes some type of certification analysis. The analyte(s) used to prepare the PE sample is the same as the analyte(s) of concern. The laboratory's accuracy is evaluated by comparing the percentage of analyte identified in the PE sample with the analytical results of the site samples. PE samples are required to achieve QA3 objectives. Where they are unavailable for the analyte(s) of interest, QA2 is the highest QA objective achievable. When analyzed, the minimum frequency of PE samples is one per analyte of interest per matrix.

7.3.7 Blind Spike

A blind spike is a rarely used proficiency sample that is prepared and sent "blind" to a laboratory for the same analyses as the other samples. A blind spike is used when: (1) the desired frequency of check samples for the laboratory exceeds the number of available PE samples; (2) the background matrix of the PE does not truly reflect the background matrix of the samples (e.g., high summer-time humidity or the exhaust from soil vapor extraction or methane gas collection systems); or (3) many or all of the compounds of concern are not readily available in a PE sample. In the latter case, because of uncertainties in the stability and half-lives of "new" compounds in or on the sample media, the preparing laboratory must both certify the blind spikes which will be shipped to the field, and archive a few spike samples for re-certification analyses in the same time period as the actual sample analyses. A blind spike should be prepared by an individual who is proficient in its preparation. If used instead of PE samples, blind spikes are required to achieve QA3 objectives, and are optional for QA2 objectives. When analyzed, the minimum frequency of blind spikes is one per parameter.

Caution: Due to the large potential for errors, the difficulty of calculating the amount of spike needed, and the distribution of the spike compound throughout the sample, it is not recommended that blind spikes be used to evaluate labs. If used, the preparing laboratory must take all precautions to ensure accuracy and to reanalyze samples should there be any discrepancies.

7.4 Laboratory QA/QC Samples

7.4.1 Reagent/Method Blank

A reagent/method blank is a sample of the reagent used in sample analyses. Unlike field and trip blanks, a reagent/method blank is prepared in the laboratory and is designed to detect contamination that could arise from the reagents and laboratory equipment used in the analysis. This would include the reagents used in preparing impinger solutions and the reagents used in the extraction and cleanup of solvent extracted adsorbent media. Reagent/method blanks should be analyzed at a rate of one per sample batch per matrix.

7.4.2 Surrogate Spike

A surrogate spike is designed to detect potential quantitative errors in the actual analyses of each sample. The surrogate compounds, which are usually non-target compounds that elute throughout the analyses, are typically spiked into each sample prior to sample preparation. Surrogate spikes are also used to evaluate the method efficiency.

7.4.3 Matrix Spike (Air Matrix Only)

A matrix spike is designed to test the ability of the method to detect known concentrations of the target compounds. As a laboratory-prepared sample, it contains known concentrations of the target compounds which are spiked into a sample prior to analysis. The matrix spike results are used to verify retention times and percent recoveries in the extraction procedure and to determine the degree to which matrix interferences will affect the overall identification and quantification of the target compounds.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general QA procedures apply when preparing QC samples:

1. All data must be documented on Field Data Sheets or within site logbooks and on Chain of Custody forms.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

Results of the QA/QC samples will be evaluated for contamination. This information will be utilized to qualify the environmental samples results accordingly with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

12.0 REFERENCES

U.S. EPA Office of Emergency and Remedial Response. April, 1990. Quality Assurance/Quality Control Guidance for Removal Activities: Sampling QA/QC Plan and Data Validation Procedures. Interim Final. EPA/540/G-90/004.

U.S. EPA. Office of Emergency and Remedial Response. June, 1991. Removal Program Representative Sampling Guidance. Volume 1 - Soil. Interim Final. OWSER Directive 9360.4-10.

U.S. EPA Quality Assurance Management Staff. Quality Assurance Glossary and Acronyms. Draft. February 8, 1991.

SAMPLING EQUIPMENT DECONTAMINATION

CONTENTS

CONTENTS (cont)

SUPERCEDES: SOP #2006; Revision 3.0; 1/23/92; U.S. EPA Contract EP-W-09-031.

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which

includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest. For the soil and water matrices, these are discussed in ERT/SERAS SOP #2003, Sample Storage, Preservation and Handling. For air and waste samples, sample preservation, containers, handling, and storage are discussed in the specific SOPs for the technique selected.

More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has

been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).

- The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.

- If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.

- Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

5.0 EQUIPMENT/APPARATUS

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft-bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.1 Decontamination Solutions

Non-phosphate detergent
Selected solvents (acetone, hexane, nitric acid, etc.)
Tap water
Distilled or deionized water

5.2 Decontamination Tools/Supplies

Long and short handled brushes
Bottle brushes
Drop cloth/plastic sheeting

Paper towels
Plastic or galvanized tubs or buckets
Pressurized sprayers (H_2O)
Solvent sprayers
Aluminum foil

5.3 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.4 Waste Disposal

Trash bags
Trash containers
55-gallon drums
Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. In general, the following solvents are typically utilized for decontamination purposes:

- 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern.
- Acetone (pesticide grade)[(1)]
- Hexane (pesticide grade)[(1)]
- Methanol[(1)]

[(1)] - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment

enters the areas of potential exposure. The equipment decontamination plan should include:

- The number, location, and layout of decontamination stations.
- Decontamination equipment needed.
- Appropriate decontamination methods.
- Methods for disposal of contaminated clothing, equipment, and solutions.
- Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

<u>Mechanical</u>

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3) feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 (Appendix B) shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1 Segregate Equipment Drop

Place plastic sheeting on the ground (Figure 2, Appendix B). Size will depend on amount of equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2 Physical Removal With A High-Pressure Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove by washing with brushes. The

elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may consist of an approximately 1 1/2 foot-deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3 Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.

Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station . Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4 Water Basin

Fill a wash basin, a large bucket, or child's swimming pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5 Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process.

Approximately 10-20 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6 Nitric Acid Sprayers

Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7 Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8 Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9 Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10 Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

Station 1 Segregate Equipment Drop

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2 Physical Removal With A High-Pressure Washer (Optional)

Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

Station 3 Physical Removal With Brushes And A Wash Basin

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4 Equipment Rinse

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5 Low-Pressure Rinse

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 6 Nitric Acid Sprayers (required only if metals are a contaminant of concern)

Using spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the

acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

Station 7 Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 8 Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

Station 9 Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10 Clean Equipment Drop

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.

2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

3. Empty soap and water liquid wastes from basins and buckets and store in appropriate drum or container. Refer to the DOT

requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.

5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.

6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.

7. Empty low-pressure sprayer water onto the ground.

8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field. Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day, per type of sampling device for samples, to meet QA2

and QA3 objectives. For further information, refer to ERT/SERAS SOP #2005, Quality Control Samples.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February, 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

APPENDIX A
Table
SOP #2006
August, 1994

TABLE 1
Soluble Contaminants and Recommended Solvent Rinse

SOLVENT[1]	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water Tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute Bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents [2]	Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent[2]	Hexane	PCBs

[1] - Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

[2] - WARNING: Some organic solvents can permeate and/or degrade the protective clothing

APPENDIX B
Figures
SOP #2006
August, 1994

FIGURE 1. Contamination Reduction Zone Layout

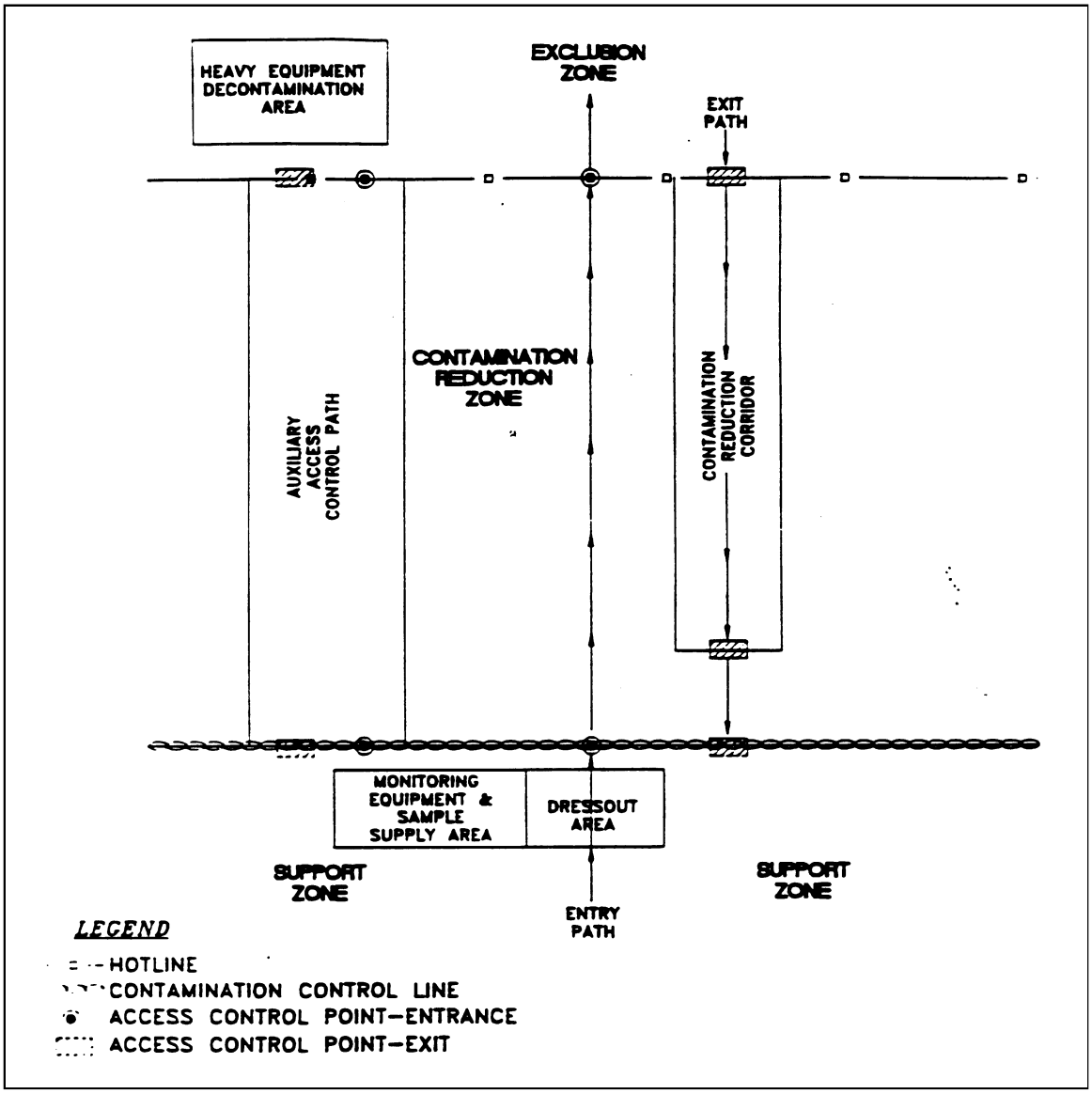
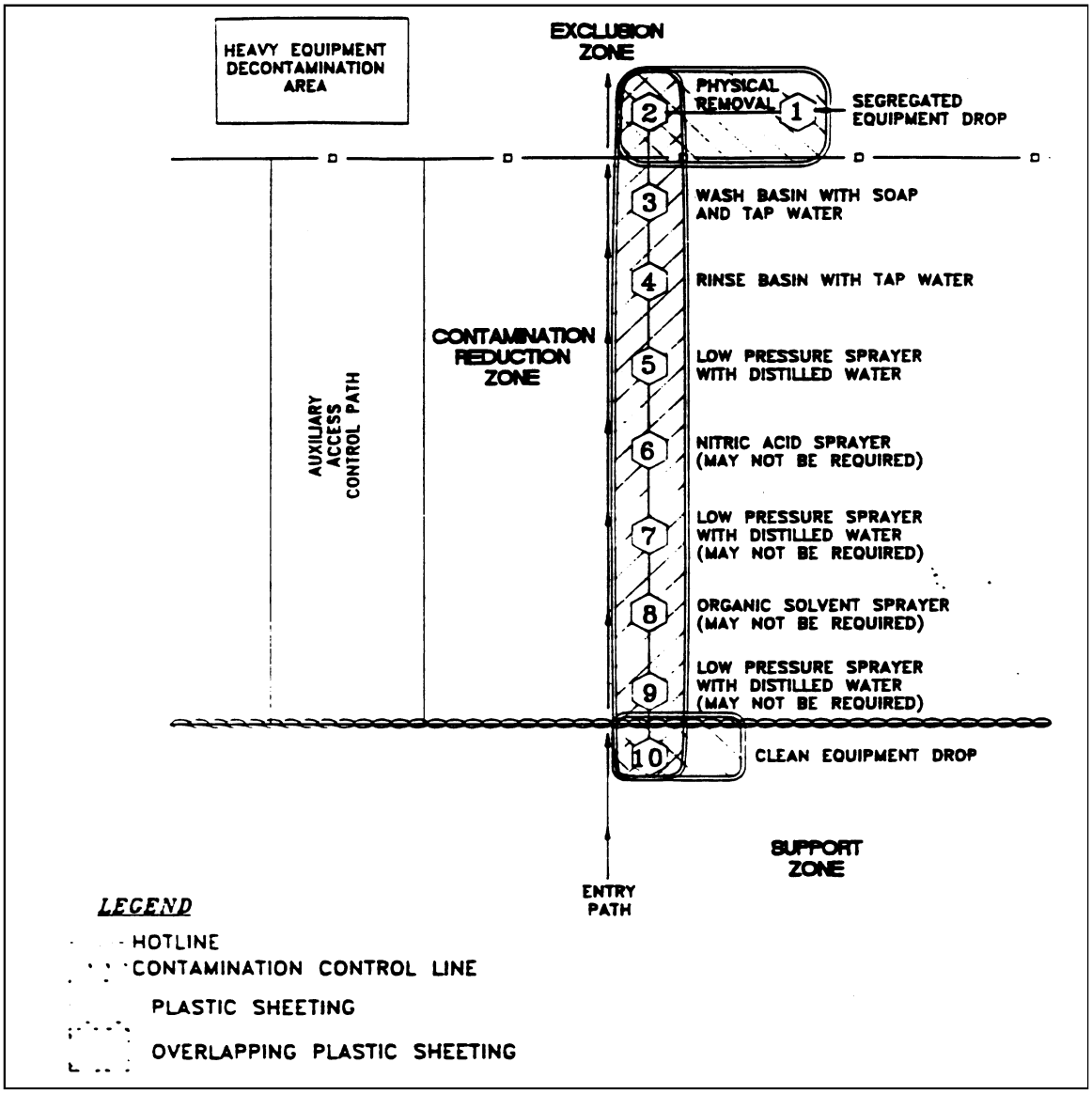


FIGURE 2. Decontamination Layout



STANDARD OPERATING PROCEDURES

GROUNDWATER WELL SAMPLING

CONTENTS

CONTENTS (cont)

* These sections affected by Revision 0.0.

SUPERSEDES: SOP #2007; Revision: 0.0; 1/26/95; U.S. EPA Contract EP-W-09-031.

GROUNDWATER WELL SAMPLING

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) provides general information on sampling groundwater wells and ensures that the sample is representative of the particular groundwater zone being sampled. The growing concern over the past several years with respect to low levels of volatile organic compounds (VOCs) in water supplies has led to the development of highly sophisticated analytical methods that can provide detection limits at part per trillion levels. While the laboratory methods are extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed and quality assured as the analytical procedures.

The procedures are designed for sampling the most common types of groundwater contaminants (e.g., volatile and semivolatile organic compounds, pesticides, herbicides, polychlorinated biphenyls (PCBs), metals, and biological parameters).

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, or equipment limitations and limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute United States Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

In order to obtain a representative groundwater sample for chemical analysis (es), it is important to remove stagnant water from the well casing and the water immediately adjacent to the well before collection of the sample. This may be achieved with one of a number of sampling devices. The most common of these devices are the bailer, submersible pump, non-contact gas bladder pump, inertia pump and suction pump. At a minimum, three well volumes should be purged, if possible. Equipment must be decontaminated prior to use and between wells. Once purging is completed and the proper sample containers have been prepared, sampling may proceed. Samples should be collected from the depth interval where contaminants are expected but need not be collected with the same device used for well purging. However, some sampling methods will affect sample integrity and care should be taken when choosing the sampling device. If possible, sampling should occur progressively from the least to the most contaminated well.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The sample analysis determines the type of bottle, preservative, holding time, and filtering requirements. Samples should be collected directly from the sampling device into appropriate sample containers. Check that a Teflon liner is present in the cap of the sample container, if required. Attach a sample identification label. Complete a field data sheet, a chain of custody form, and record all pertinent data in the site logbook.

Samples should be placed in a cooler and maintained at 4°C and ideally should be shipped within 24 hours of sample collection. If large numbers of samples are being collected, shipments may occur on a regular

basis after consultation with the analytical laboratory. In all cases, samples should be shipped well before the holding time expires.

Due to the trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Treatment of the sample with sodium thiosulfate preservative is required only if there is residual chlorine in the water that could cause free radical chlorination and change the identity of the original contaminants. This preservative should not be used if there is no chlorine in the water. Quality assurance/quality control (QA/QC) samples are incorporated into the shipment package to provide a check against cross contamination. Samples for the analysis of volatiles, semivolatiles, pesticides, herbicides and PCBs do not normally require preservation. Groundwater samples for metal analyses should be adjusted with nitric acid to a pH of less than 2. Refer to SERAS SOP# 2003, *Sample Storage, Preservation and Handling*.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The primary goal of well sampling is to obtain a representative sample of the groundwater. Analysis can be compromised by: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. To avoid introducing foreign contaminants into a sample, strict sampling procedures should be followed.

4.1 Well Purging

In a non-pumping well, there will be little or no vertical mixing of the water and stratification will occur. The well water above the screened section will remain isolated and may lack the contaminants representative of the ground water. To avoid collecting unrepresentative water, all monitor wells should be purged of three to five volumes of water prior to sampling. When purging with a submersible pump, the pump intake may be set within the screened interval if evaluation of the well construction, pumping rate, and aquifer characteristics ensures that formation material will not be drawn into the well. Otherwise, the pump should be set just above the top of the screen. Bailers, peristaltic pumps, and miniature submersible pumps can also be used for purging, depending on well depth, groundwater level, and well yield. During purging, the temperature, pH, turbidity, and specific conductivity of the groundwater should be monitored at regular intervals and recorded in the site field logbook. The frequency of monitoring will depend on the purge rate but measurements are generally collected every 5 to 15 minutes. Purging is generally considered complete when these parameters stabilize. Depending on the formation characteristics and the degree of previous development, turbidity may also be a problem. Purging may have to be continued until the turbidity reaches an acceptable level, generally less than 50 nephelometric turbidity units (NTUs).

4.2 Sampling Equipment

The tendency of organics to adsorb or desorb onto or out of many materials makes the selection of sampling materials critical for trace organics analyses. Construction materials for samplers and purging equipment (bladders, pump, bailers, and tubing) should be limited to stainless steel, polytetrafluoroethylene (Teflon), and glass in areas where concentrations are expected to be at or near the detection limit. The use of plastics, such as polyvinyl chloride (PVC) or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation

equipment as it will not normally come into contact with the sample. Rinsate blanks may be required to check the effectiveness of decontamination procedures when using non-dedicated equipment. In highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

4.3 Light Non-Aqueous Phase Liquids (LNAPL)

The presence of floating organic layers in a well may require reevaluation of the sampling plan. There is generally little point in sampling the groundwater directly beneath an organic layer and the presence of both phases complicates the sampling procedure. The organic phase is usually sampled by skimming the top of the liquid column in the well with a bailer or small pump, depending on the viscosity of the liquid.

5.0 EQUIPMENT/APPARATUS

5.1 Bailers

Advantages

- No power source needed
- Portable
- Inexpensive, so it can be dedicated and hung in a well, thereby reducing the chances of cross contamination
- Minimal outgassing of volatile organics while sample is in bailer
- Readily available
- Removes stagnant water first
- Rapid, simple method for removing small volumes of purge water

Disadvantages

- Time-consuming to flush a large well
- Transfer of sample may cause aeration
- The valve at the bottom of the bailer often leaks thus losing some of the sample

5.2 Submersible Pumps

Advantages

- Smaller diameter pumps are usually portable and can be transported from well to well
- Relatively high pumping rates are possible
- Generally very reliable and does not require priming

Disadvantages

- Potential for effects on analysis of trace organics

- Deep wells may require pumps that are heavy and cumbersome to use
- Expensive
- Power source needed
- Sediment in water may clog intake screen or impellers
- Must be decontaminated between wells

5.3 Non-Contact Gas Bladder Pumps

Advantages

- Maintains integrity of sample
- Easy to use
- Can sample from discrete locations within the monitor well

Disadvantages

- Difficulty in cleaning, although dedicated tubing and bladder may be used
- Only useful to a depth of about 100 feet
- Requires a supply of gas or an air compressor for operation, gas bottles or compressors are often difficult to obtain and are cumbersome
- Relatively low pumping rates

5.4 Suction Pumps (including peristaltic pumps)

Advantages

- Portable, inexpensive, and readily available
- Operates from either 110 VAC or 12 VDC
- Variable flow rate, easily controlled

Disadvantages

- Restricted to wells where water levels are within 20 to 25 feet of the ground surface
- Vacuum can cause loss of dissolved gasses and volatile organics
- Some types must be primed and vacuum is often difficult to maintain during initial stages of pumping
- Generally suitable for only small diameter shallow wells; maximum flow rate of some types (e.g. peristaltic pumps) limited to approximately one gallon per minute (gpm)

5.5 Inertia Pumps

Advantages

- Portable, inexpensive, and readily available
- Offers a rapid method for purging relatively shallow wells

Disadvantages

- Restricted to areas with water levels within 70 feet of the ground surface
- May be time consuming to purge wells with these manual pumps
- Labor intensive
- WaTerra pumps (for example) are only effective in 2-inch diameter wells

5.6 Field Equipment Checklist

5.6.1 General

- Water level indicator
- electric sounder
- steel tape
- transducer
- reflection sounder
- airline
- Depth sounder
- Appropriate keys for well cap locks
- Steel brush
- HNU or OVA (whichever is most appropriate)
- Logbook (bound)
- Calculator
- Field data sheets and samples labels
- Chain of custody records and seals
- Sample containers
- Engineer's rule
- Sharp knife (locking blade)
- Tool box (to include at least: screwdrivers, pliers, hacksaw, hammer, flashlight
- Leather work gloves
- Surgical gloves (for sampling)
- Appropriate Health & Safety gear
- Five-gallon pail
- Plastic sheeting
- Shipping containers
- Packing materials
- Bolt cutters
- Ziploc plastic bags
- Containers for evacuation liquids
- Decontamination solutions
- Tap water
- Non phosphate soap
- Pails or tubs

- Aluminum foil
- Garden sprayer
- Preservatives
- Distilled or deionized water
- Fire extinguisher (if using a generator as a power source)
- In-line filters, 0.45 microns (µm)
- pH meter, temperature meter specific conductivity meter, turbidity meter
- Indelible markers
- Duct tape
- Paper towel
- First aid kit

5.6.2 Bailers

- Clean, decontaminated bailers of appropriate size and construction material
- Unused nylon line, enough to dedicate to each well
- Teflon coated bailer wire
- Sharp knife
- Aluminum foil (to wrap clean bailers)
- Five gallon bucket

5.6.3 Submersible Pumps

- Pump(s)
- Generator (120, or 240 volts) or 12 volt power source, depending on pump
- Extension cords
- PVC coil tubing, diameter suitable for flow requirements
- Hose clamps
- Safety cable
- Tool box
- pipe wrenches
- wire strippers
- electrical tape
- heat shrink wrap or tubing
- hose connectors
- Teflon tape
- Winch, pulley or hoist for large submersible pumps (4-inch diameter or greater)
- Gasoline container, gasoline
- Flow meter and gate valve
- Plumbing components (nipples, reducers, plastic pipe connectors)
- Control box (if necessary)

5.6.4 Non-Contact Gas Bladder Pumps

- Non-contact gas bladder pump
- Compressor or nitrogen gas tank
- Batteries and charger
- Teflon tubing - enough to dedicate to each well
- Swagelock fitting
- Toolbox supplements - same as submersible pump
- Control box (if necessary)

5.6.5 Suction Pumps

- Pump
- Black PVC coil tubing - enough to dedicate to each well
- Gasoline - if required
- Toolbox
- Plumbing fittings
- Flow meter with gate valve

5.6.6 Inertia Pumps

- Pump assembly (WaTerra pump, piston pump)
- Five gallon bucket

5.6.7 Peristaltic Pumps

- Small diameter "Geotubing"
- Roll of Masterflex tubing
- 110 VAC generator or 12 VDC power source
- Knife, screwdriver

6.0 REAGENTS

Reagents may be used for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed and are summarized in Environmental Response Team/Scientific, Engineering, Response and Analytical Services (ERT/SERAS) SOP #2003, *Sample Storage, Preservation, and Handling*. Decontamination solutions are specified in ERT/SERAS SOP #2006, *Sampling Equipment Decontamination*.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed (i.e., diameter and depth of wells to be sampled).

2. Obtain necessary sampling and monitoring equipment, appropriate to the type of contaminant being investigated. For collection of volatile organic samples, refer to the work plan to ensure that sufficient 40 milliliter (mL) glass sample vials with Teflon lined septa are available. Check availability of preservatives, packing material, sample labels, and coolers. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

3. Decontaminate or pre-clean equipment and ensure that it is in working order.

4. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

5. Identify all sampling locations.

7.2 Field Preparation

1. Start at the least contaminated well, if known.

2. Lay plastic sheeting around the well to minimize likelihood of equipment contamination from the soil adjacent to the well.

3. Remove locking well cap, note location, time of day, and date in field notebook or appropriate log form.

4. Remove well casing cap.

5. Immediately screen headspace of well with an appropriate air monitoring instrument to determine the presence of volatile organic compounds and record flame ionization detector (FID) or photoionization detector (PID) readings in site logbook.

6. Measure distance from water surface to a reference measuring point and record in site logbook. A reference point may be the top of outer protective casing, the top of riser pipe, the ground surface, or the top of a concrete pad. If floating organics are present, the water level and depth to floating product can be measured with an oil/water interface probe. However, the presence of floating organics will indicate the need to reevaluate the validity of groundwater sampling.

7. Measure total depth of well and record in site logbook or on field data sheet.

8. Calculate the volume of water in the well and the volume to be purged using the calculations in Section 8.0.

9. Select the appropriate purging and sampling equipment.

7.3 Purging

The amount of purging required before sampling depends on the intent of the monitoring program as well as the hydrogeologic conditions. General assessment of groundwater quality may require long pumping periods to obtain a sample representative of a large volume of the aquifer. The purge volume is determined prior to sampling and the sample is collected after a known volume of the water is pumped from the well, or the well can be pumped until parameters such as temperature, specific conductivity, pH, or turbidity have stabilized. Groundwater quality in the well is considered stabilized after three sets of consecutive readings indicate no change. The time between readings is based on the purge rate and cumulative volume but generally is between 5 to 15 minutes.

Sampling to define a contaminant plume requires a representative sample from a small volume of the aquifer. This requires that the well be purged enough to remove the stagnant water but not enough to induce flow from other areas. Generally, three well volumes are considered sufficient. The total volume purged, purge method, purge rate, and the start and end times of purging are recorded in the field log book.

The following purging devices are most commonly used. Other evacuation devices are available, but have been omitted in this discussion due to their limited use.

7.3.1 Bailers

Bailers are the simplest purging device and generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A nylon line is used to tie and lower the bailer into the well and retrieve a volume of water. The three most common types of bailers are made of PVC, Teflon, and stainless steel. Purging with bailers is best suited to shallow or small diameter wells. For deep, larger diameter wells that require removal of large volumes of water, pumps may be more appropriate.

Equipment needed will, include a clean decontaminated bailer, Teflon or nylon line, a sharp knife, and plastic sheeting.

1. Determine the volume of water to be purged as described in Section 8.0, *Calculations*.

2. Lay plastic sheeting around the well to prevent contamination of the bailer line with soil or other foreign materials. Do not let the bailer line touch the ground.

3. Attach the line to the bailer and lower into the well until the bailer is completely submerged.

4. Pull bailer out ensuring that the line either falls onto a clean area of plastic sheeting or never touches the ground.

5. Empty the bailer into a container of known volume to determine when the purge volume is reached.

6. Dispose of purge waters as specified in the work plan.

7.3.2 Submersible Pumps

The use of submersible pumps for purging is permissible provided they are constructed of no contaminating materials. The chief drawback, however, is the difficulty in avoiding cross-contamination between wells. Some pumps can be easily disassembled for cleaning, but field decontamination may be difficult and require solvents that can affect sample analysis. The use of submersible pumps in multiple well-sampling programs, therefore, should be carefully considered against other sampling mechanisms (bailers, bladder pumps). In most cases, a sample can be collected by bailer after purging with a submersible pump; however, submersible pumps may be the only practical sampling device for extremely deep wells (greater than 300 feet of hydraulic head). Under those conditions, dedicated pump systems should be considered to eliminate the potential for cross-contamination of well samples.

Submersible pumps generally use either electric or compressed gas for power. Electric powered pumps can run off a 12 volt direct current (DC) rechargeable battery, or a 110 or 220 volt alternating current (AC) power supply. Gasoline used to power electrical generators is a potential source of contamination and should be kept well away from purging and sampling equipment. Those units powered by compressed air normally use a small electric or gas-powered air compressor. They may also use compressed gas (i.e., nitrogen) from bottles. Pumps are available for monitor wells of various depths and diameters.

The following steps describe the use of submersible pumps in purging a well:

1. Determine the volume of water to be purged as described in Section 8.0, *Calculations* .

2. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with soil or other foreign materials.

3. Assemble pump, hoses and safety cable, and lower the pump into the well. Make sure the pump is deep enough so as not to dewater the pump.

4. Attach flow meter to the outlet hose to measure the volume of water purged or measure with a container of known volume.

5. Use a ground fault circuit interrupter (GFCI) or ground the generator to avoid possible electric shock.

6. Attach power supply, and purge the well until the specified volume of water has been removed (or until field parameters, such as temperature, pH, conductivity, etc, have stabilized). Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, reduce the pumping rate.

7. Collect and dispose of purge waters as specified in the work plan.

7.3.3 Non-Contact Gas Bladder Pumps

Pumps in this category may be dedicated to a well and include stainless steel and Teflon Middleburg-squeeze bladder pumps such as IEA, TIMCO, Well Wizard or Geolog.

1. Assemble Teflon tubing, pump and charged control box.

2. Procedure for purging with a bladder pump is the same as for a submersible pump (Section 7.3.2).

3. Adjust flow rate to prevent violent movement of the hose as water is drawn in.

7.3.4 Suction Pumps

Suction pumps include centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for relatively rapid purging and can be adjusted to a slower rate for sampling. The peristaltic pump is a low volume pump that uses rollers to squeeze the flexible tubing thereby creating suction. The tubing can be dedicated to a well to prevent cross-contamination. Peristaltic pumps, however, require a power source.

1. Assemble the pump, tubing, and power source if necessary.

2. Procedure for purging with a suction pump is exactly the same as for a submersible pump (Section 7.3.2).

7.3.5 Inertia Pumps

Inertia pumps such as the WaTerra pump and piston pump, are manually operated. These pumps are most appropriate to use when wells are too deep to bail by hand, too shallow or too small in diameter to warrant the use of a submersible pump. The pumps are made of plastic and may either be decontaminated or discarded after use.

1. Determine the volume of water to be purged as described in Section 8.0, *Calculations.*

2. Assemble pump and lower to the appropriate depth in the well.

3. Begin pumping manually, discharging water into a five-gallon bucket (or other graduated vessel). Purge until a specified volume of water has been evacuated (or until field parameters such as temperature, pH, and conductivity, have stabilized).

4. Collect and dispose of purge waters as specified in the work plan.

7.4 Sampling

Before choosing a sampling device, the advantages or disadvantages of any one device, as outlined in Section 5, should be reviewed. It may be appropriate to use a different device to sample than that which was used to purge. The most common example of this is the use of a submersible pump to purge and a bailer to sample. Samples for volatile organics are collected first when sampling for more than one set of parameters, followed in order by samples for semivolatile organic and inorganic analyses.

7.4.1 Bailers

The positive-displacement sampling bailer is perhaps the most appropriate for collection of water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by well conditions and desired sample depth. A sample is obtained with a bailer using the following steps:

1. Surround the monitor well with clean plastic sheeting.

2. Attach a line to a clean decontaminated bailer. Do not let the line touch the ground.

3. Lower the bailer slowly into the well. Stop lowering when adjacent to the screen or at the desired sample depth

4. Allow bailer to fill and then slowly retrieve the bailer from the well.

5. Remove the cap from the sample container and place it on the plastic sheet or in a location where it will not become contaminated. For VOC sampling precautions, see Section 7.6.

6. Slowly pour the sample from the bailer into the sample container. Any necessary preservative should be added to the sample container before sampling.

7. Repeat steps 3, 4, and 6 as necessary to fill the sample container(s).

8. Cap the sample container tightly and place the prelabeled sample container in a carrier.

9. Replace the well cap.

10. Log the collection time, sampling method, and analyses required for all samples in the site logbook and on field data sheets.

11. Package samples and complete necessary paperwork.

7.4.2 Submersible Pumps

Submersible pumps are not recommended for sampling but may be used in some situations. The generator and fuel (if needed) used to operate a submersible pump can be a source of contamination and should be kept separate from the sampling containers during transport and downwind during sampling.

1. Allow the monitor well to recharge after purging, keeping the pump just above the screened section.

2. Attach a clean gate valve to the discharge hose (if not already fitted), and reduce the flow of water to a manageable rate.

3. Assemble the appropriate bottles.

4. If a gate valve is not available, run the water down the side of a clean jar and fill the sample bottles from the jar.

5. Cap the sample container tightly and place the prelabeled sample container in a carrier.

6. Replace the well cap.

7. Log all samples in the site logbook and on the field data sheets and label all of the samples.

8. Package samples and complete the necessary paperwork.

9. Transport sample(s) to the decontamination zone for preparation for transport to the analytical laboratory.

10. Upon sampling completion, remove pump and assembly and fully decontaminate the equipment prior to setting it into the next sample well. When possible, dedicate the pump tubing to the well.

7.4.3 Non-Contact Gas Bladder Pumps

Non-contact gas positive displacement bladder pumps are often used when dedicated pumps are required. These pumps are also suitable for shallow (less than 100 feet) wells. They are somewhat difficult to clean, but may be used with dedicated sample tubing to avoid cleaning. These pumps require a power supply and a compressed gas supply (or compressor). They may be operated at variable flow and pressure rates making them ideal for both purging and sampling. Barcelona et al. (1984) and Nielsen and Yeates (1985) report that the non-contact gas positive displacement pumps cause the least amount of alteration in sample integrity as compared to other sample retrieval methods.

1. Allow the well to recharge after purging.

2. Assemble the appropriate bottles.

3. Turn the pump on, increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.

4. Non-filtered samples shall be collected directly from the outlet tubing into the sample bottle.

5. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should be minimized so that the pressure build up on the filter does not blow out the pump bladder or displace the filter. For the Geotech barrel filter, no actual connections are necessary.

6. Cap the sample container tightly and place the prelabeled sample container in a carrier.

7. Replace the well cap.

8. Log all samples in the site logbook and on the field data sheets, and label all samples.

9. Package samples and complete the necessary paperwork.

10. Transport sample(s) to the decontamination zone for preparation for transport to the analytical laboratory.

11. On completion, remove the tubing from the well and either replace the Teflon tubing and bladder with new dedicated tubing and bladder or rigorously decontaminate the existing materials.

7.4.4 Suction Pumps

Suction pumps are not recommended for sampling because it is operated by a vacuum and could remove volatile organics from the sample.

7.4.5 Inertia Pumps

Inertia pumps may be used to collect samples. It is more common, however, to purge with these pumps and sample with a bailer (Section 7.4.1).

1. Following well evacuation, allow the well to recharge.

2. Assemble the appropriate bottles.

3. Because these pumps are manually operated, the flow rate may be regulated by

the sampler. The sample may be discharged from the pump outlet directly into the sample container.

4. Cap the sample container tightly and place the prelabeled sample container in a carrier.

5. Replace the well cap.

6. Log all samples in the site logbook and on the field data sheets and label all samples.

7. Package samples and complete necessary paperwork.

8. Upon completion, remove pump and decontaminate or discard, as appropriate.

7.5 Filtering

Samples collected for dissolved metals analysis may require filtration. The filter must be changed or decontaminated between uses. Several types of filters are available. A barrel filter such as the "Geotech" works with a pneumatic (e.g. bicycle) pump, used to build up positive pressure in the chamber containing the sample, which is then forced through the filter paper (minimum size 0.45 µm) into a jar placed underneath. The barrel itself is filled manually from the bailer or directly via the hose of the sampling pump. The pressure must be maintained up to 30 pounds/square inch (lbs/in^2) by periodic pumping.

A vacuum type filter involves two chambers; the upper chamber contains the sample and a filter (minimum size 0.45 µm) divides the chambers. Using a hand pump or a Gillian type pump, air is withdrawn from the lower chamber, creating a vacuum and thus causing the sample to move through the filter into the lower chamber where it is drained into a sample jar. Repeated pumping may be required to drain the entire sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

An in-line filter may be used with a peristaltic pump to transfer the sample from the original sample jar, through the filter, and into a new sample jar. In-line filters are used specifically for the preparation of groundwater samples for dissolved metals analysis, and for filtering large volumes of turbid groundwater. Groundwater samples collected for VOCs are generally not filtered. The filtering of groundwater is performed primarily to allow for the collection of silty or particulate-laden samples that would otherwise interfere with the laboratory analysis. The filters used in groundwater sampling are either cartridge type filters inserted into a reusable housing, or are self-contained and disposable. Disposable filters are preferred and often used to reduce cross-contamination of groundwater samples. Disposable filter chambers are usually constructed of polypropylene material, with an inert filtering material within the housing. Both reusable and disposable filters have barb or national pipe thread (NPT) fittings on the inlet and outlet sides of the housing to connect to ⅜" or ⅝" tubing.

7.6 Special Considerations for VOC Sampling

The proper collection of a sample for VOC analysis requires minimal disturbance of the sample to limit volatilization. Sample retrieval systems suitable for collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona et al, 1984; Nielsen and Yeates, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The concern must be to collect a valid sample that has been subjected to the least amount of turbulence possible.

The following procedures should be used:

1. Open the vial, set cap in a clean place, and collect the sample. When collecting duplicates, collect both samples at the same time.

2. Fill the vial to just overflowing. Do not rinse the vial, or let it excessively overflow. There should be a convex meniscus on the top of the vial.

3. Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap.

4. Invert the vial and tap gently. Observe vial for at least ten (10) seconds. If an air bubble appears, discard the sample and resample. It is imperative that no air is trapped in the sample vial.

5. The holding time for samples to be analyzed for VOCs is seven days. Samples should be shipped or delivered to the laboratory in as short a time as practical in order to arrive before the holding time has expired. Ensure that the samples are stored at 4 °C during transport but do not allow them to freeze. The most readily available method of cooling is to use ice packed in double-sealed plastic bags (Ziploc® baggies).

8.0 CALCULATIONS

If it is necessary to calculate the volume of the well, use the following equation:

$$\textbf{Well Volume (gallons)} = \pi r^2 hk$$

where:

- π = 3.14
- **r** = radius of monitor well (feet)
- **h** = height of the water column (feet). This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.
- **k** = conversion factor, 7.48 gallons per cubic foot (gal/ft^3)

Monitor well diameters typically have a diameter of 2 to 4 inches. If the diameter of the monitor well is known, standard conversion factors can be used to simplify the equation above.

The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

$$V(gal/ft) = \pi r^2 k \quad \text{or} \quad V = 23.5r^2$$

where:

π = 3.14
r = radius of monitoring well (feet)
k = conversion factor (7.48 gal/ft^3)

For a 2-inch diameter well, the volume, in gallons per linear foot, can be calculated as follows:

$$V/\text{linear ft} = \pi r^2 k$$
$$= 3.14\ (1/12)^2\ (7.48\ gal/ft^3)$$
$$= 0.163\ gal/ft$$

The well radius must be in feet to be able to use the equation.

The conversion factors **(f)** for the most common diameter monitor wells are as follows:

Well diameter-inches	2	3	4	6
Volume (gal/ft.)	0.1631	0.3670	0.6528	1.4680

If you use the conversation factors above, Equation 1 should be modified as follows:

$$\text{Well } V = he$$

where:

h = height of water column (feet)
f = conversion factor

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance (QA) activities that apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All sample collection data, including purge methods and time, sample collection methods, times of collection, analyses required, and decontamination procedures (if any) must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration

must occur prior to purging or sampling and should be done according to the instruction manuals supplied by the manufacturer. All calibration procedures should be documented in the site logbook.

3. The collection of rinsate blanks is recommended to evaluate potential for cross contamination from the purging and/or sampling equipment.

4. Trip blanks are required if analytical parameters include VOCs.

10.0 DATA VALIDATION

This section does not apply to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health Administration (OSHA) or SERAS health and safety guidelines. More specifically, depending upon the site specific contaminants, various protective programs must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the well sampling tasks. Standard safe operating practices should be followed such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and disposable clothing.

When working around volatile organic contaminants:

1. Avoid breathing volatile constituents venting from the well.

2. Check the well head-space with a FID/PID prior to sampling.

3. If monitoring results indicate organic constituents, it may be necessary to conduct sampling activities in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

Physical hazards associated with well sampling:

1. Lifting injuries associated with pump and bailers retrieval; moving equipment.

2. Use of pocket knives for cutting discharge hose.

3. Heat/cold stress as a result of exposure to extreme temperatures in protective clothing.

4. Slip, trip, fall conditions as a result of pump discharge.

5. Restricted mobility due to the wearing of protective clothing.

6. Electrical shock associated with use of submersible pumps is possible. Use a GFCI or a copper

grounding stake to avoid this problem.

12.0 REFERENCES

Barcelona, M.J., J.A. Helfrich, E.E. Garske, J.P. Gibb. 1984. "A Laboratory Evaluation of Groundwater Sampling Mechanisms." *Groundwater Monitoring Review.* p. 32-41.

Barcelona, M.J., J.A. Helfrich, E.E. Garske. 1985. "Sampling Tubing Effects on Groundwater Samples." *Analytical Chemistry.* Vol. 57. p. 460-463.

Nielsen, David M. and Gillian L. Yeates. 1985. "A Comparison of Sampling Mechanisms Available for Small-Diameter Groundwater Monitoring Wells." *Groundwater Monitoring Review*. p. 83-99.

13.0 APPENDICES

This section does not apply to this SOP.

CHIP, WIPE, AND SWEEP SAMPLING

CONTENTS

SUPERCEDES: SOP #2011; Revision 2.0; 03/27/94; U.S. EPA Contract 68-03-3482.

CHIP, WIPE, AND SWEEP SAMPLING

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) outlines the recommended protocol and equipment for collection of representative chip, wipe, and sweep samples to monitor potential surficial contamination.

This method of sampling is appropriate for surfaces contaminated with non-volatile species of analytes (i.e., PCB, PCDD, PCDF, metals, cyanide, etc.) Detection limits are analyte specific. Sample size should be determined based upon the detection limit desired and the amount of sample requested by the analytical laboratory. Typical sample area is one square foot. However, based upon sampling location, the sample size may need modification due to area configuration.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Since surface situations vary widely, no universal sampling method can be recommended. Rather, the method and implements used must be tailored to suit a specific sampling site. The sampling location should be selected based upon the potential for contamination as a result of manufacturing processes or personnel practices.

Chip sampling is appropriate for porous surfaces and is generally accomplished with either a hammer and chisel, or an electric hammer. The sampling device should be laboratory cleaned and wrapped in clean, autoclaved aluminum foil until ready for use. To collect the sample, a measured and marked off area is chipped both horizontally and vertically to an even depth of 1/8 inch. The sample is then transferred to the proper sample container.

Wipe samples are collected from smooth surfaces to indicate surficial contamination; a sample location is measured and marked off. While wearing a new pair of surgical gloves, a sterile gauze pad is opened, and soaked with solvent. The solvent used is dependent on the surface being sampled. This pad is then stroked firmly over the sample surface, first vertically, then horizontally, to ensure complete coverage. The pad is then transferred to the sample container.

Sweep sampling is an effective method for the collection of dust or residue on porous or non-porous surfaces. To collect such a sample, an appropriate area is measured off. Then, while wearing a new pair of disposable surgical gloves, a dedicated brush is used to sweep material into a dedicated dust pan. The sample is then transferred to the proper sample container.

Samples collected by all three methods are then sent to the laboratory for analysis.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples should be stored out of direct sunlight to reduce photodegredation, cooled to 4^{o}C and shipped to

the laboratory performing the analysis. Appropriately sized laboratory cleaned, glass sample jars should be used for sample collection. The amount of sample required will be determined in concert with the analytical laboratory.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

This method has few significant interferences or problems. Typical problems result from rough porous surfaces which may be difficult to wipe, chip, or sweep.

5.0 EQUIPMENT

Equipment required for performing chip, wipe, or sweep sampling is as follows:

- Lab clean sample containers of proper size and composition
- Site logbook
- Sample analysis request forms
- Chain of Custody records
- Custody seals
- Field data sheets
- Sample labels
- Disposable surgical gloves
- Sterile wrapped gauze pad (3 in. x 3 in.)
- Appropriate pesticide (HPLC) grade solvent
- Medium sized laboratory cleaned paint brush
- Medium sized laboratory cleaned chisel
- Autoclaved aluminum foil
- Camera
- Hexane (pesticide/HPLC grade)
- Iso-octane
- Distilled/deionized water

6.0 REAGENTS

Reagents are not required for preservation of chip, wipe or sweep samples. However, reagents will be utilized for decontamination of sampling equipment. Decontamination solutions are specified in ERT/SERAS SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

6. Mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Chip Sample Collection

Sampling of porous surfaces is generally accomplished by using a chisel and hammer or electric hammer. The sampling device should be laboratory cleaned or field decontaminated as per ERT/SERAS SOP# 2006, Sampling Equipment Decontamination. It is then wrapped in cleaned, autoclaved aluminum foil. The sampler should remain in this wrapping until it is needed. Each sampling device should be used for only one sample.

Choose appropriate sampling points; measure off the designated area. Photo documentation is optional.

Record surface area to be chipped.

1. Don a new pair of disposable surgical gloves.

2. Open a laboratory-cleaned chisel or equivalent sampling device.

3. Chip the sample area horizontally, then vertically to an even depth of approximately 1/8 inch.

4. Place the sample in an appropriately prepared sample container with a Teflon lined cap.

5. Cap the sample container, attach the label and custody seal, and place in a plastic bag.

6. Record all pertinent data in the site logbook and on field data sheets. Complete the sampling analysis request form and chain of custody record before taking the next sample.

7. Store samples out of direct sunlight and cool to 4^{o}C.

8. Follow proper decontamination procedures then deliver sample(s) to the laboratory for analysis.

7.3 Wipe Sample Collection

Wipe sampling is accomplished by using a sterile gauze pad, adding a solvent in which the contaminant is most soluble, then wiping a pre-determined, pre-measured area. The sample is packaged in an amber jar to prevent photodegradation and packed in coolers for shipment to the lab. Each gauze pad is used for only one wipe sample.

1. Choose appropriate sampling points; measure off the designated area. Photo documentation is

optional.

2. Record surface area to be wiped.

3. Don a new pair of disposable surgical gloves.

4. Open new sterile package of gauze pad.

5. Soak the pad with solvent of choice.

6. Wipe the marked surface area using firm strokes. Wipe vertically, then horizontally to insure complete surface coverage.

7. Place the gauze pad in an appropriately prepared sample container with a Teflon-lined cap.

8. Cap the sample container, attach the label and custody seal, and place in a plastic bag. Record all pertinent data in the site logbook and on field data sheets. Complete the sampling analysis request form and chain of custody record before taking the next sample.

9. Store samples out of direct sunlight and cool to 4°C.

10. Follow proper decontamination procedures, and then deliver sample(s) to the laboratory for analysis.

7.4 Sweep Sample Collection

Sweep sampling is appropriate for bulk contamination. This procedure utilizes a dedicated, hand held sweeper brush to acquire a sample from a pre-measured area.

1. Choose appropriate sampling points; measure off the designated area. Photo documentation is optional.

2. Record the surface area to be swept.

3. Don new pair of disposable surgical gloves.

4. Sweep the measured area using a dedicated brush; collect the sample in a dedicated dust pan.

5. Transfer sample from dust pan to sample container.

6. Cap the sample container, attach the label and custody seal, and place in a plastic bag. Record all pertinent data in the site log book and on field data sheets. Complete the sampling analysis request form and chain of custody record before taking the next sample.

7. Store samples out of direct sunlight and cool to 4°C.

8. Leave contaminated sampling device in the sample material, unless decontamination is practical.

9. Follow proper decontamination procedures, and then deliver sample(s) to the laboratory for analysis.

8.0 CALCULATIONS

Results are usually provided in mg/g, µg/g, mass per unit area, or other appropriate measurement. Calculations are typically done by the laboratory.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on standard chain of custody forms, field data sheets or within the site logbook.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

The following specific quality assurance activities apply to wipe samples:

For wipe samples, a blank should be collected for each sampling event. This consists of a sterile gauze pad, wet with the appropriate solvent, and placed in a prepared sample container. The blank will help identify potential introduction of contaminants via the sampling methods, the pad, solvent or sample container. Spiked wipe samples can also be collected to better assess the data being generated. These are prepared by spiking a piece of foil of known area with a standard of the analyte of choice. The solvent containing the standard is allowed to evaporate, and the foil is wiped in a manner identical to the other wipe samples.

Specific quality assurance activities for chip and sweep samples should be determined on a site specific basis.

10.0 DATA VALIDATION

A review of the quality control samples will be conducted and the data utilized to qualify the environmental results.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow EPA, OSHA and corporate health and safety procedures.

12.0 REFERENCES

U.S. EPA, A Compendium of Superfund Field Operation Methods. EPA/540/5-87/001.

NJDEP Field Sampling Procedures Manual, February, 1988.

SOIL SAMPLING

CONTENTS

*These sections affected by Revision 1.0.

SUPERCEDES: SOP #2012; Revision 0.0; 2/18/00; U.S. EPA Contract 68-C99-223.

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to describe procedures for the collection of representative surface soil samples. Sampling depths are assumed to be those that can be reached without the use of a drill rig, direct-push technology, or other mechanized equipment (except for a back-hoe). Sample depths typically extend up to 1-foot below ground surface. Analysis of soil samples may define the extent of contamination, determine whether concentrations of specific contaminants exceed established action levels, or if the concentrations of contaminants present a risk to public health, welfare, or the environment.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with a final report.

Mention of trade names or commercial products does not constitute United States Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Surface soil samples can be used to investigate contaminants that are persistent in the near surface environment. Contaminants that are detected in the near surface environment may extend to considerable depths, may migrate to the groundwater, surface water, the atmosphere, or may enter biological systems.

Soil samples may be collected using a variety of methods and equipment depending on the depth of the desired sample, the type of sample required (discrete or composite), and the soil type. Near-surface soils may be easily sampled using a spade, trowel, and/or scoop. Sampling at greater depths may be performed using a hand auger, continuous-flight auger, trier, split-spoon sampler, or, if required, a backhoe.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples must be cooled and maintained at 4^{o}C and protected from sunlight immediately upon collection to minimize any potential reaction. The amount of sample to be collected, proper sample container type and handling requirements are discussed in the Scientific, Engineering, Response Analytical Services (SERAS) SOP #2003, *Sample Storage, Preservation and Handling.*

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary problems associated with soil sampling: 1) cross contamination of samples, and 2) improper sample collection. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, decontamination of sampling equipment is necessary. The guidelines for preventing, minimizing and limiting cross contamination of samples are discussed in the Environmental Response Team (ERT)/SERAS SOP #2006, *Sampling Equipment Decontamination*. Improper sample collection procedures can disturb the sample matrix, resulting in volatilization of contaminants, compaction of the sample, or inadequate homogenization of the samples (when required), resulting in variable, non-representative results.

5.0 EQUIPMENT/APPARATUS

Soil sampling equipment includes the following:

- Site maps/plot plan
- Safety equipment, as specified in the site-specific Health and Safety Plan (HASP)
- Traditional survey equipment or global positioning system (GPS)
- Tape measure
- Survey stakes or flags
- Camera and image collection media
- Stainless steel, plastic*, or other appropriate homogenization bucket, bowl or pan
- Appropriate size sample containers
- Ziplock plastic bags
- Site logbook
- Labels
- Chain of Custody records and custody seals
- Field data sheets and sample labels
- Cooler(s)
- Ice
- Vermiculite
- Decontamination supplies/equipment
- Plastic sheeting
- Spade or shovel
- Spatula(s)
- Scoop(s)
- Plastic* or stainless steel spoons
- Trowel(s)
- Continuous flight (screw) auger
- Bucket auger
- Post hole auger
- Extension rods
- T-handle
- Sampling trier
- Thin wall tube sampler
- Split spoon sampler
- Soil core sampler
  - Tubes, points, drive head, drop hammer, puller jack and grip
- Photoionization detector (PID), Flame ionization detector (FID) and/or Respirable Aerosol Monitor (RAM)

- Backhoe (as required)
- En Core® samplers

* Not used when sampling for semivolatile compounds.

6.0 REAGENTS

Decontamination solutions are specified in ERT/SERAS SOP #2006, *Sampling Equipment Decontamination*, and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the analytes to be determined, the sampling methods to be employed, and the types and amounts of equipment and supplies required to accomplish the assignment.

2. Obtain the necessary sampling and air monitoring equipment.

3. Prepare schedules and coordinate with staff, client, and regulatory agencies, as appropriate.

4. Perform a general site reconnaissance survey prior to site entry in accordance with the site specific HASP.

5. Use stakes or flags to identify and mark all sampling locations. Specific site factors, including extent and nature of contamination, should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations should be utility-cleared prior to soil sampling; utility clearances must be confirmed before beginning intrusive work.

6. Pre-clean and decontaminate equipment in accordance with the site specific work plan, and ensure that it is in working order.

7.2 Sample Collection

7.2.1 Surface Soil Samples

The collection of samples from near-surface soil can be accomplished with tools such as spades, shovels, trowels, and scoops. The over-burden or over-lying surface material is removed to the required depth and a stainless steel or plastic scoop is used to collect the sample. Plastic utensils are not to be used when sampling for semivolatile compounds.

This method can be used in most soil types but is limited to sampling at or near the ground surface. Accurate, representative samples can be collected by this procedure depending on the care and precision demonstrated by the sample team member. A flat, pointed mason trowel to cut a block of the desired soil is helpful when undisturbed profiles are required. Tools plated with chrome or other materials must not be used.

The following procedure is used to collect surface soil samples:

1. If volatile organic compound (VOC) contamination is suspected, use a PID to monitor the sampler's breathing zone during soil sampling activities.

2. Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard sticks, rocks, vegetation and other debris from the sampling area.

3. Accumulate an adequate volume of soil, based on the type(s) of analyses to be performed, in

a stainless, plastic or other appropriate container.

4. If volatile organic analysis is to be performed, immediately transfer the sample directly into an appropriate, labeled sample container with a stainless steel spoon, or equivalent, and secure the cap tightly to ensure that the volatile fraction is not compromised. Thoroughly mix the remainder of the soil to obtain a sample that is representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly, or, if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.2 Sampling at Depth with Augers and Thin Wall Tube Samplers

This system consists of an auger, head, a series of extensions, and a "T" handle (Figure 1, Appendix A). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the auger head. If additional sample volume is required, multiple grabs at the same depth are made. If a core sample is to be collected, the auger head is then replaced with a tube auger. The system is then lowered down the borehole, and driven into the soil to the completion depth. The system is withdrawn and the core is collected.

Several types of augers are available; these include bucket or tube type, and continuous flight (screw) or post-hole augers. Bucket or tube type augers are better for direct sample recovery because a large volume of sample can be collected from a discrete area in a short period of time. When continuous flight or post-hole augers are used, the sample can be collected directly from the flights or from the borehole cuttings. The continuous flight or post-hole augers are satisfactory when a composite of the complete soil column is desired, but have limited utility for sample collection as they cannot be used to sample a discrete depth.

The following procedure is used for collecting soil samples with an auger:

1. Attach the auger head to an extension rod and attach the "T" handle.

2. Clear the area to be sampled of surface debris (e.g., twigs, rocks, litter). It may be advisable to remove a thin layer of surface soil for an area approximately six inches in radius around the sampling location.

3. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents the accidental brushing of loose material back down the borehole when removing the auger or adding extension rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

4. After reaching the desired depth, slowly and carefully remove the auger from the hole. When sampling directly from the auger head, proceed to Step 10.

5. Remove auger tip from the extension rods and replace with a tube sampler. Install the

proper cutting tip.

6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the soil. Do not scrape the borehole sides. Avoid hammering the rods as the vibrations may cause the boring walls to collapse.

7. Remove the tube sampler and unscrew the extension rods.

8. Remove the cutting tip and the core from the device.

9. Discard the top of the core (approximately 1 inch), as this possibly represents material collected before penetration of the layer of concern. Place the core or a discrete portion of the core into the appropriate labeled sample container using a clean, decontaminated stainless steel spoon. If required, homogenize the sample as described in Step 10.

10. If VOC analysis is to be performed, transfer the sample directly from the auger head into an appropriate, labeled sample container with a stainless steel spoon, or equivalent and secure the cap tightly.

11. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger head to the drill assembly, and follow steps 3 through 11, making sure to decontaminate the auger head and tube sampler between samples.

12. Abandon the hole according to applicable state regulations.

7.2.3 Sampling at Depth with a Trier

The system consists of a trier and a "T" handle. The auger is driven into the soil to be sampled and used to extract a core sample from the appropriate depth.

The following procedure is used to collect soil samples with a sampling trier:

1. Insert the trier (Figure 2, Appendix A) into the material to be sampled at a zero degree to forty-five degree (0^o to 45^o) angle from the soil surface plane. This orientation minimizes the spillage of sample.

2. Rotate the trier once or twice to cut a core of material.

3. Slowly withdraw the trier, making sure that the slot is facing upward.

4. If VOC analyses are required, transfer the sample directly from the trier into an appropriate, labeled sample container with a stainless steel spoon, or equivalent device and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container and mix thoroughly to obtain a sample that is representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; if composite samples are to be collected, place a sample from another sampling interval into the

homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.4 Sampling at Depth with a Split Spoon (Barrel) Sampler

Split spoon sampling is generally used to collect undisturbed soil cores of 18- or 24- inches in length. A series of consecutive cores may be extracted with a split spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted.

When split spoon sampling is performed to gain geologic information, all work should be performed in accordance with American Society for Testing and Materials (ASTM) D1586-99, "*Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils".*

The following procedures are used for collecting soil samples with a split spoon:

1. Assemble the sampler by aligning both sides of the barrel and then screwing the drive shoe on the bottom and the head piece on top.

2. Place the sampler at a 90 degree (90^{o}) angle to the sample material.

3. Using a well ring, drive the sampler. Do not drive past the bottom of the head piece or compression of the sample will result.

4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain the sample.

5. Withdraw the sampler, and open it by unscrewing the bit and head, and then splitting the barrel. The amount of recovery and soil type should be recorded on the boring log. If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler is typically available in 2- and 3.5-inch diameter tubes. A larger barrel (diameter and/or length) may be necessary to obtain the required sample volume.

6. Without disturbing the core, transfer it to the appropriately labeled sample container(s) and seal tightly. Place the remainder of the sample into a stainless steel, plastic, or appropriate homogenization container, and mix thoroughly to obtain a sample that is representative of the entire sampling interval. Then, either place the sample into the appropriate, labeled containers and secure the caps tightly, or if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into the appropriate, labeled containers and secure the caps tightly.

7. Abandon the hole according to applicable state regulations.

7.2.5 Test Pit/Trench Excavation

A backhoe can be used to remove sections of soil when a detailed examination of stratigraphy and soil characteristics is required. The following procedures are used for collecting soil samples from test pits or trenches:

1. Prior to any excavation with a backhoe, it is imperative to ensure that all sampling locations are clear of overhead and buried utilities.

2. Review the site specific HASP and ensure that all safety precautions including appropriate monitoring equipment are installed as required.

3. Using the backhoe, excavate a trench approximately three feet wide and approximately one foot deep below the cleared sampling location. Place excavated soils on plastic sheets. Trenches greater than five feet deep must be sloped or protected by a shoring system, as required by Occupational Safety and Health Administration (OSHA) regulations.

4. A shovel is used to remove a one to two inch layer of soil from the vertical face of the pit where sampling is to be done.

5. Samples are taken using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose fresh soil for sampling. In many instances, samples can be collected directly from the backhoe bucket.

6. If VOC analyses are required, transfer the sample into an appropriate, labeled sample container with a stainless steel spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into the appropriate, labeled containers and secure the caps tightly.

7. Abandon the pit or excavation according to applicable state regulations.

7.2.6 Sampling for VOCs in Soil Using an En Core® Sampler

An En Core® sampler is a single-use device designed to collect and transport samples to the laboratory. The En Core® sampler is made of an inert composite polymer and reduces the open-air handling of soil samples in the field and in the laboratory; thereby, minimizing losses of VOCs.

1. Assemble the coring body, plunger rod and T-handle according to the instructions provided with the En Core® sampler.

2. Turn the T-handle with the T-up and the coring body down and push the sampler into the soil until the coring body is completely full. Remove the sampler from the soil. Wipe excess soil from the coring body exterior.

3. Cap the coring body while it is still on the T-handle. Push the cap over the flat area of the ridge. Be sure that the cap is seated properly to seal the sampler. Push and cap to lock arm in place.

4. Remove the capped sampler by depressing the locking lever on the T-handle while twisting and pulling the sampler from the T-handle.

5. Attach the label to the coring body cap, place in a plastic zippered bag, seal and put on ice.

Generally, three En Core® samplers are required for each sample location. These samplers are shipped to the laboratory where the cap is removed and the soil samples are preserved with methanol or sodium bisulfate.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance (QA) activities that apply to the implementation of these procedures. However, the following general QA procedures apply:

2. All data must be documented in site logbooks or on field data sheets. At a minimum, the following data is recorded:

Sampler's name and affiliation with project
Sample number
Sample location
Sample depth
Approximate volume of sample collected
Type of analyses to be performed
Sample description
Date and time of sample collection
Weather conditions at time of sampling
Method of sample collection
Sketch of sample location

2. All instrumentation must be operated in accordance with applicable SOPs and/or the manufacturer's operating instructions, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and must be documented.

3. The types of quality control (QC) samples to be collected in the field shall be documented in the site-specific Work Plan.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures, in addition to the procedures specified in the site specific HASP.

12.0 REFERENCES

Mason, B.J. 1983. *Preparation of Soil Sampling Protocol: Technique and Strategies*. EPA-600/4-83-020.

Barth, D.S. and B.J. Mason. 1989. *Soil Sampling Quality Assurance User's Guide*. EPA-600/8-89-046.

U.S. Environmental Protection Agency. 1984. *Characterization of Hazardous Waste Sites - A Methods Manual: Volume II.* Available Sampling Methods, Second Edition. EPA-600/4-84-076.

de Vera, ER, B.P. Simmons, R.D. Stephen, and D.L. Storm. 1980. *Samplers and Sampling Procedures for Hazardous Waste Streams*. EPA-600/2-80-018.

American Society for Testing and Materials. *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*. Method D 1586-99.

En Novative Technologies, Inc. 2001. *En Core® Sampler Sampling Procedures*. Web site access. March 13, 2001.

APPENDIX A
Figures
SOP #2012
July 2001

FIGURE 1. Sampling Augers

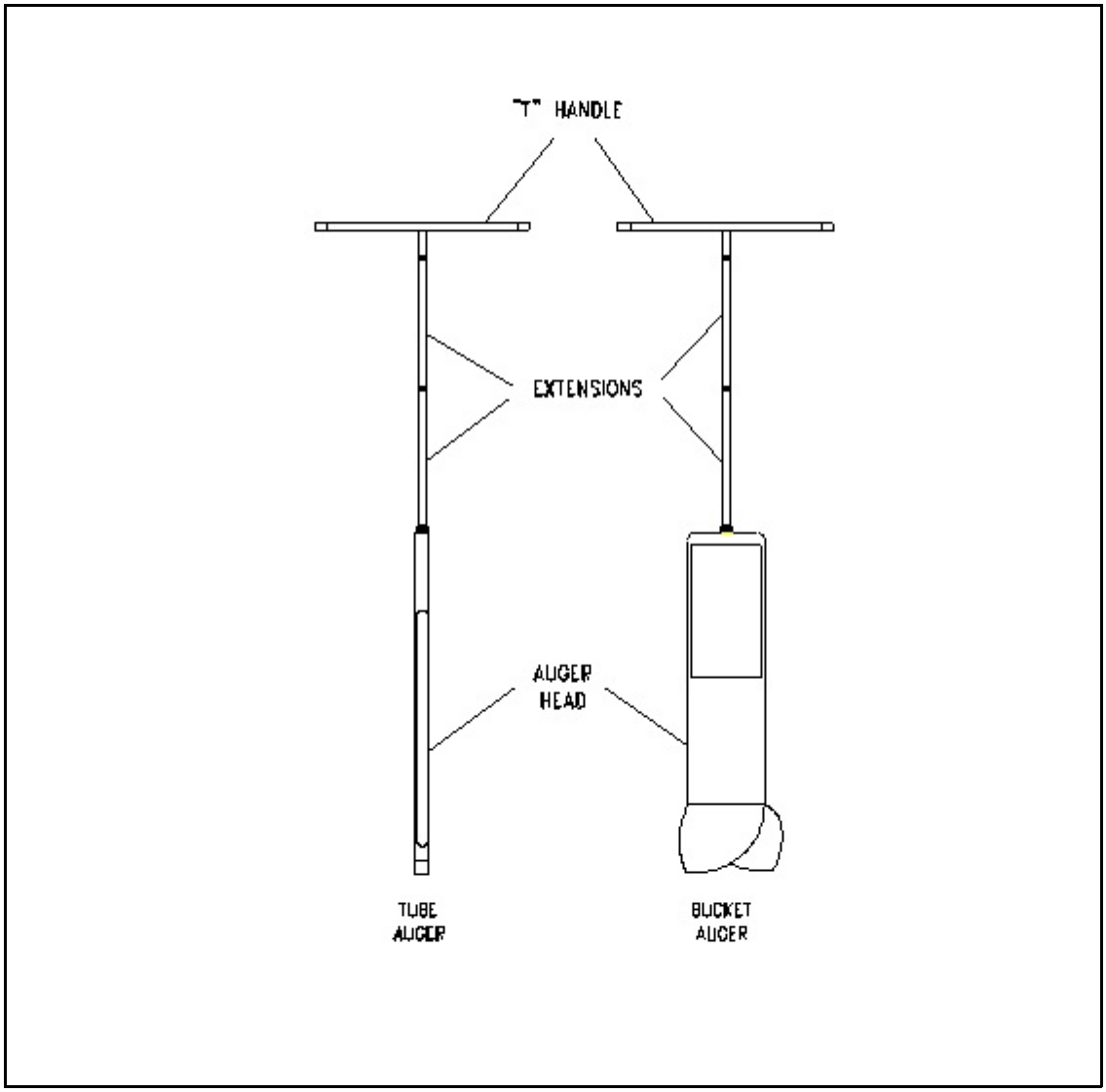
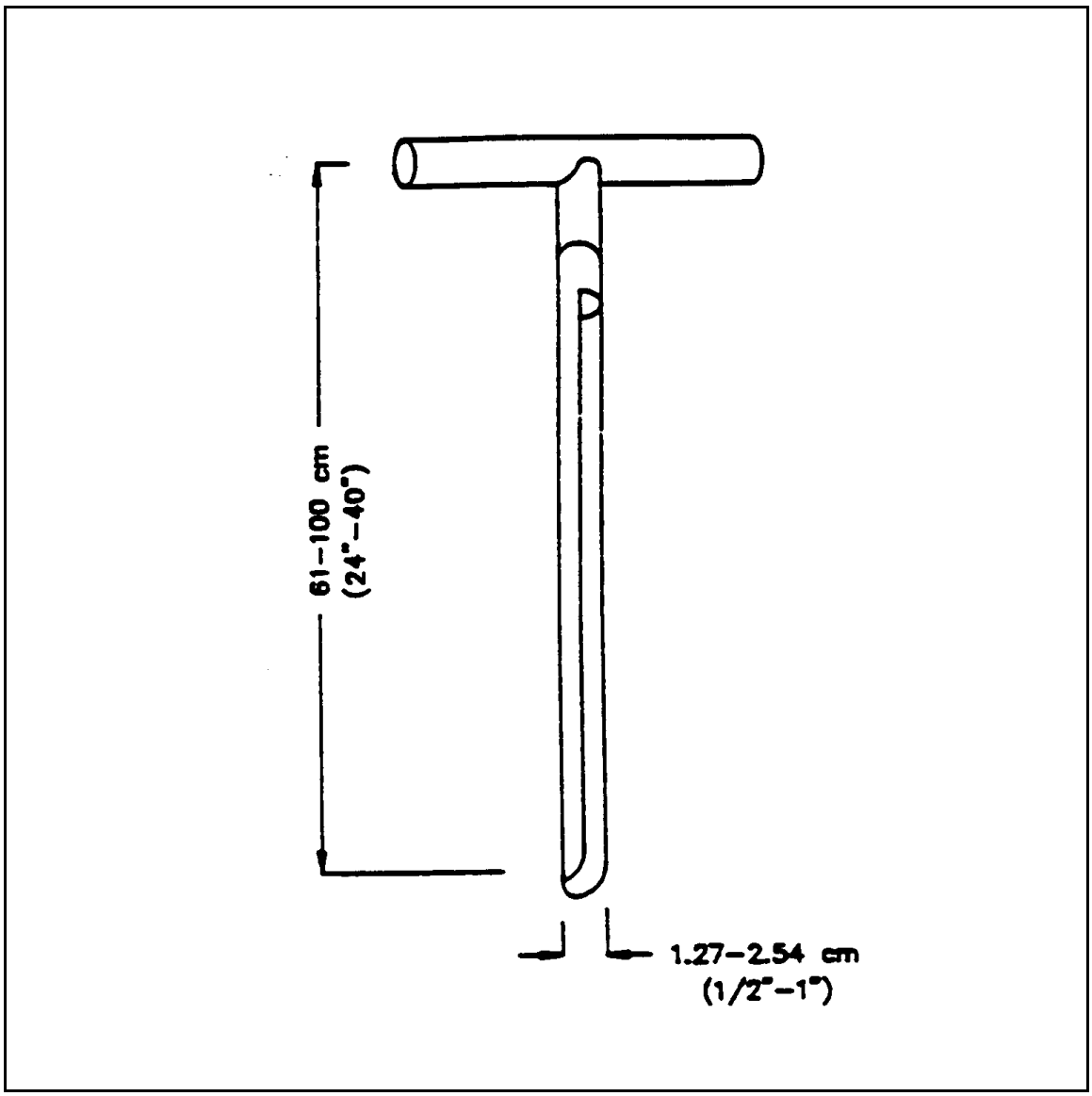


FIGURE 2. Sampling Trier


61-100 cm
(24"-40")
1.27-2.54 cm
(1/2"-1")

ASBESTOS SAMPLING

CONTENTS

CONTENTS (cont)

ASBESTOS SAMPLING

1.0 SCOPE AND APPLICATION

Asbestos has been used in many commercial products including building materials such as flooring tiles and sheet goods, paints and coatings, insulation, and roofing asphalts. These products and others may be found at hazardous waste sites hanging on overhead pipes, contained in drums, abandoned in piles, or as part of a structure. Asbestos tailing piles from mining operations can also be a source of ambient asbestos fibers. Asbestos is a known carcinogen and requires air sampling to assess airborne exposure to human health. This Standard Operating Procedure (SOP) provides procedures for asbestos air sampling by drawing a known volume of air through a mixed cellulose ester (MCE) filter. The filter is then sent to a laboratory for analysis. The U.S. Environmental Protection Agency/Environmental Response Team (U.S. EPA/ERT) uses one of four analytical methods for determining asbestos in air. These include: U.S. EPA's Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air for Transmission Electron Microscopy (TEM)[1]; U.S. EPA's Modified Yamate Method for TEM[2]; National Institute for Occupational Safety and Health (NIOSH) Method 7402 (direct method only) for TEM; and NIOSH Method 7400 for Phase Contrast Microscopy (PCM)[3]. Each method has specific sampling and analytical requirements (i.e., sample volume and flow rate) for determining asbestos in air.

The U.S. EPA/ERT typically follows procedures outlined in the TEM methods for determining mineralogical types of asbestos in air and for distinguishing asbestos from non-asbestos minerals. The Phase Contrast Microscopy (PCM) method is used by U.S. EPA/ERT as a screening tool since it is less costly than TEM. PCM cannot distinguish asbestos from non-asbestos fibers, therefore the TEM method may be necessary to confirm analytical results. For example, if an action level for the presence of fibers has been set and PCM analysis indicates that the action level has been exceeded, then TEM analysis can be used to quantify and identify asbestos structures through examination of their morphology crystal structures (through electron diffraction), and elemental composition (through energy dispersive X-ray analysis). In this instance samples should be collected for both analyses in side by side sampling trains (some laboratories are able to perform PCM and TEM analysis from the same filter). The Superfund method is designed specifically to provide results suitable for supporting risk assessments at Superfund sites, it is applicable to a wide range of ambient air situations at hazardous waste sites. U.S. EPA's Modified Yamate Method for TEM is also used for ambient air sampling due to high volume requirements. The PCM and TEM NIOSH analytical methods require lower sample volumes and are typically used indoors; however, ERT will increase the volume requirement for outdoor application.

Other Regulations pertaining to asbestos have been promulgated by U.S. EPA and OSHA. U.S. EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) regulates asbestos-containing waste materials. NESHAP establishes management practices and standards for the handling of asbestos and emissions from waste disposal operations (40 CFR Part 61, Subparts A and M). U.S. EPA's 40 CFR 763 (July 1, 1987)[4] and its addendum 40 CFR 763 (October 30, 1987)[4] provide comprehensive rules for the asbestos abatement industry. State and local regulations on these issues vary and may be more stringent than federal requirements. The OSHA regulations in 29 CFR 1910.1001 and 29 CFR 1926.58 specify work practices and safety equipment such as respiratory protection and protective clothing when handling asbestos. The OSHA standard for an 8-hour, time-weighted average (TWA) is 0.2 fibers/cubic centimeters of air. This standard pertains to fibers with a length-to-width ratio of 3 to 1 with a fiber length >5 µm[5,6]. An action level of 0.1 fiber/cc (one-half the OSHA standard) is the level U.S. EPA has established in which employers must initiate such activities as air monitoring, employee training, and medical surveillance[5,6].

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Prior to sampling, the site should be characterized by identifying on-site as well as off-site sources of airborne asbestos. The array of sampling locations and the schedule for sample collection is critical to the success of an investigation. Generally, sampling strategies to characterize a single point source are fairly straightforward, while multiple point sources and area sources increase the complexity of the sampling strategy. It is not within the scope of this SOP to provide a generic asbestos air sampling plan. Experience, objectives, and site characteristics will dictate the sampling strategy.

During a site investigation, sampling stations should be arranged to distinguish spatial trends in airborne asbestos concentrations. Sampling schedules should be fashioned to establish temporal trends. The sampling strategy typically requires that the concentration of asbestos at the source (worst case) or area of concern (downwind), crosswind, as well as background (upwind) contributions be quantified. See Table 1 (Appendix A) for U.S. EPA/ERT recommended sampling set up for ambient air. Indoor asbestos sampling requires a different type of strategy which is identified in Table 2 (Appendix A). It is important to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks can be utilized to determine other sources.

Much information can be derived from each analytical method previously mentioned. Each analytical method has specific sampling requirements and produce results which may or may not be applicable to a specific sampling effort. The site sampling objectives should be carefully identified so as to select the most appropriate analytical method. Additionally, some preparation (i.e., lot blanks results) prior to site sampling may be required, these requirements are specified in the analytical methods.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Sample Preservation

No preservation is required for asbestos samples.

3.2 Sample Handling, Container and Storage Procedures

1. Place a sample label on the cassette indicating a unique sampling number. Do not put sampling cassettes in shirt or coat pockets as the filter can pick up fibers. The original cassette box is used to hold the samples.

2. Wrap the cassette individually in a plastic sample bag. Each bag should be marked indicating sample identification number, total volume, and date.

3. The wrapped sampling cassettes should be placed upright in a rigid container so that the cassette cap is on top and cassette base is on bottom. Use enough packing material to prevent jostling or damage. Do not use vermiculite as packing material for samples. If possible, hand carry to lab.

4. Provide appropriate documentation with samples (i.e., chain of custody and requested analytical methodology).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Flow rates exceeding 16 liters/minute (L/min) which could result in filter destruction due to (a) failure of its physical support under force from the increased pressure drop; (b) leakage of air around the filter mount so that the filter is bypassed, or (c) damage to the asbestos structures due to increased impact velocities.

4.1 U.S. EPA's Superfund Method

4.1.1 Direct-transfer TEM Specimen Preparation Methods

Direct-Transfer TEM specimen preparation methods have the following significant interferences:

- The achievable detection limit is restricted by the particulate density on the filter, which in turn is controlled by the sampled air volume and the total suspended particulate concentration in the atmosphere being sampled.

- The precision of the result is dependent on the uniformity of the deposit of asbestos structures on the sample collection filter.

- Air samples must be collected so that they have particulate and fiber loadings within narrow ranges. If too high a particulate loading occurs on the filter, it is not possible to prepare satisfactory TEM specimens by a direct-transfer method. If too high a fiber loading occurs on the filter, even if satisfactory TEM specimens can be prepared, accurate fiber counting will not be possible.

4.1.2 Indirect TEM Specimen Preparation Methods

Indirect TEM specimen preparation methods have the following interferences:

- The size distribution of asbestos structures is modified.

- There is increased opportunity for fiber loss or introduction of extraneous contamination.

- When sample collection filters are ashed, any fiber contamination in the filter medium is concentrated on the TEM specimen grid.

It can be argued that direct methods yield an under-estimate of the asbestos structure concentration because many of the asbestos fibers present are concealed by other particulate material with which they are associated. Conversely, indirect methods can be considered to yield an over-estimate because some types of complex asbestos structures disintegrate during the preparation, resulting in an increase in the numbers of structures counted.

4.2 U.S. EPA's Modified Yamate Method for TEM

High concentrations of background dust interfere with fiber identification.

4.3 NIOSH Method for TEM

Other amphibole particles that have aspect ratios greater than 3:1 and elemental compositions similar to the asbestos minerals may interfere in the TEM analysis. Some non-amphibole minerals may give electron diffraction patterns similar to amphiboles. High concentrations of background dust interfere with fiber identification.

4.4 NIOSH Method for PCM

PCM cannot distinguish asbestos from non-asbestos fibers; therefore, all particles meeting the counting criteria are counted as total asbestos fibers. Fiber less than 0.25 um in length will not be detected by this method. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the detection limit.

5.0 EQUIPMENT/MATERIALS

5.1 Sampling Pump

The constant flow or critical orifice controlled sampling pump should be capable of a flow-rate and pumping time sufficient to achieve the desired volume of air sampled.

The lower flow personal sampling pumps generally provide a flow rate of 20 cubic centimeters/minute (cc/min) to 4 L/min. These pumps are usually battery powered. High flow pumps are utilized when flow rates between 2 L/min to 20 L/min are required. High flow pumps are used for short sampling periods so as to obtain the desired sample volume. High flow pumps usually run on AC power and can be plugged into a nearby outlet. If an outlet is not available then a generator should be obtained. The generator should be positioned downwind from the sampling pump. Additional voltage may be required if more than one pump is plugged into the same generator. Several electrical extension cords may be required if sampling locations are remote.

The recommended volume for the Superfund method (Phase I) requires approximately 20 hours to collect. Such pumps typically draw 6 amps at full power so that 2 lead/acid batteries should provide sufficient power to collect a full sample. The use of line voltage, where available, eliminates the difficulties associated with transporting stored electrical energy.

A stand should be used to hold the filter cassette at the desired height for sampling and the filter

cassette shall be isolated from the vibrations of the pump.

5.2 Filter Cassette

The cassettes are purchased with the required filters in position, or can be assembled in a laminar flow hood or clean area. When the filters are in position, a shrink cellulose band or adhesive tape should be applied to cassette joints to prevent air leakage.

5.2.1 TEM Cassette Requirements

Commercially available field monitors, comprising 25 mm diameter three-piece cassettes, with conductive extension cowls shall be used for sample collection. The cassette must be new and not previously used. The cassette shall be loaded with an MCE filter of pore size 0.45 µm, and supplied from a lot number which has been qualified as low background for asbestos determination. The cowls should be constructed of electrically conducting material to minimize electrostatic effects. The filter shall be backed by a 5 µm pore size MCE filter (Figure 1, Appendix B).

5.2.2 PCM Cassette Requirements

NIOSH Method 7400, PCM involves using a 0.8 to 1.2 µm mixed cellulose ester membrane, 25 mm diameter, 50 mm conductive cowl on cassette (Figure 2, Appendix B). Some labs are able to perform PCM and TEM analysis on the same filter; however, this should be discussed with the laboratory prior to sampling.

5.3 Other Equipment

- Inert tubing with glass cyclone and hose barb
- Whirlbags (plastic bags) for cassettes
- Tools - small screw drivers
- Container - to keep samples upright
- Generator or electrical outlet (may not be required)
- Extension cords (may not be required)
- Multiple plug outlet
- Sample labels
- Air data sheets
- Chain of Custody records

6.0 REAGENTS

Reagents are not required for the preservation of asbestos samples.

7.0 PROCEDURES

7.1 Air Volumes and Flow Rates

Sampling volumes are determined on the basis of how many fibers need to be collected for reliable

measurements. Therefore, one must estimate how many airborne fibers may be in the sampling location.

Since the concentration of airborne aerosol contaminants will have some effect on the sample, the following is a suggested criterion to assist in selecting a flow rate based on real-time aerosol monitor (RAM) readings in milligrams/cubic meter (mg/m^3).

	Concentration	Flow Rate
• Low RAM readings:	<6.0 mg/m^3	11-15 L/min
• Medium RAM readings	>6.0 mg/m^3	7.5 L/min
• High RAM readings:	>10. mg/m^3	2.5 L/min

In practice, pumps that are available for environmental sampling at remote locations operate under a maximum load of approximately 12 L/min.

7.1.1 U.S. EPA's Superfund Method

The Superfund Method incorporates an indirect preparation procedure to provide flexibility in the amount of deposit that be can be tolerated on the sample filter and to allow for the selective concentration of asbestos prior to analysis. To minimize contributions to background contamination from asbestos present in the plastic matrices of membrane filters while allowing for sufficient quantities of asbestos to be collected, this method also requires the collection of a larger volume of air per unit area of filter than has traditionally been collected for asbestos analysis. Due to the need to collect large volumes of air, higher sampling flow rates are recommended in this method than have generally been employed for asbestos sampling in the past. As an alternative, samples may be collected over longer time intervals. However, this restricts the flexibility required to allow samples to be collected while uniform meteorological conditions prevail.

The sampling rate and the period of sampling should be selected to yield as high a sampled volume as possible, which will minimize the influence of filter contamination. Wherever possible, a volume of 15 cubic meters (15,000 L) shall be sampled for those samples intended for analysis only by the indirect TEM preparation method (Phase 1 samples). For those samples to be prepared by both the indirect and the direct specimen preparation methods (Phase 2 samples), the volumes must be adjusted so as to provide a suitably-loaded filter for the direct TEM preparation method. One option is to collect filters at several loadings to bracket the estimated optimum loading for a particular site. Such filters can be screened in the laboratory so that only those filters closest to optimal loading are analyzed. It has been found that the volume cannot normally exceed 5 cubic meters (5000 L) in an urban or agricultural area, and 10 cubic meters (10,000 L) in a rural area for samples collected on a 25 mm filter and prepared by a direct-transfer technique.

An upper limit to the range of acceptable flow rates for this method is 15 L/min. At many locations, wind patterns exhibit strong diurnal variations. Therefore, intermittent sampling (sampling over a fixed time interval repeated over several days) may be

necessary to accumulate 20 hours of sampling time over constant wind conditions. Other sampling objectives also may necessitate intermittent sampling. The objective is to design a sampling schedule so that samples are collected under uniform conditions throughout the sampling interval. This method provides for such options. Air volumes collected on Phase I samples are maximized (<16 L/min). Air volumes collected on Phase 2 samples are limited to provide optimum loading for filters to be prepared by a direct-transfer procedure.

7.1.2 U.S. EPA's Modified Yamate Method for TEM

U.S. EPA's TEM method requires a minimum volume of 560 L and a maximum volume of 3,800 L in order to obtain an analytical sensitivity of 0.005 structures/cc. The optimal volume for TEM is 1200 L to 1800 L. These volumes are determined using a 200 mesh EM grid opening with a 25-mm filter cassette. Changes in volume would be necessary if a 37-mm filter cassette is used since the effective area of a 25 mm (385 sq mm) and 37 mm (855 sq m) differ.

7.1.3 NIOSH Method for TEM and PCM

The minimum recommended volume for TEM and PCM is 400 L at 0.1 fiber/cc. Sampling time is adjusted to obtain optimum fiber loading on the filter. A sampling rate of 1 to 4 L/min for eight hours (700 to 2800 L) is appropriate in non-dusty atmospheres containing 0.1 fiber/cc. Dusty atmospheres i.e., areas with high levels of asbestos, require smaller sample volumes (<400 L) to obtain countable samples.

In such cases, take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3,000 to 10,000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If > 50% of the filter surface is covered with particles, the filter may be too overloaded to count and will bias the measured fiber concentration. Do not exceed 0.5 mg total dust loading on the filter.

7.2 Calibration Procedures

In order to determine if a sampling pump is measuring the flow rate or volume of air correctly, it is necessary to calibrate the instrument. Sampling pumps should be calibrated immediately before and after each use. Preliminary calibration should be conducted using a primary calibrator such as a soap bubble type calibrator, (e.g., a Buck Calibrator, Gilibrator, or equivalent primary calibrator) with a representative filter cassette installed between the pump and the calibrator. The representative sampling cassette can be reused for calibrating other pumps that will be used for asbestos sampling. The same cassette lot used for sampling should also be used for the calibration. A sticker should be affixed to the outside of the extension cowl marked "Calibration Cassette."

A rotameter can be used provided it has been recently pre-calibrated with a primary calibrator.

Three separate constant flow calibration readings should be obtained both before sampling and after sampling. Should the flow rate change by more than 5% during the sampling period, the average of the pre- and post-calibration rates will be used to calculate the total sample volume. The sampling pump used shall provide a non-fluctuating air-flow through the filter, and shall maintain the initial volume flow-rate to within " 10% throughout the sampling period. The mean value of these flow-rate measurements shall be used to calculate the total air volume sampled. A constant flow or critical orifice controlled pump meets these requirements. If at any time the measurement indicates that the flow-rate has decreased by more than 30%, the sampling shall be terminated. Flexible tubing is used to connect the filter cassette to the sampling pump Sampling pumps can be calibrated prior to coming on-site so that time is saved when performing on-site calibration.

7.2.1 Calibrating a Personal Sampling Pump with an Electronic Calibrator

1. See manufacturer's manual for operational instructions.

2. Set up the calibration train as shown in (Figure 3, Appendix B) using a sampling pump, electronic calibrator, and a representative filter cassette. The same lot sampling cassette used for sampling should also be used for calibrating.

3. To set up the calibration train, attach one end of the PVC tubing (approx. 2 foot) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the electronic calibrator.

4. Turn the electronic calibrator and sampling pump on. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.

5. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.

6. Perform the calibration three times until the desired flow rate of " 5% is attained.

7.2.2 Calibrating a Rotameter with an Electronic Calibrator

1. See manufacturer's manual for operational instructions.

2. Set up the calibration train as shown in (Figure 4, Appendix B) using a sampling pump, rotameter, and electronic calibrator.

3. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6^{o} vertical.

4. Turn the electronic calibrator and sampling pump on.

5. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.

6. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.

7. Record the electronic calibrator flow rate reading and the corresponding rotameter reading. Indicate these values on the rotameter (sticker). The rotameter should be able to work within the desired flow range. Readings can also be calibrated for 10 cm^3 increments for Low Flow rotameters, 500 cm^3 increments for medium flow rotameters and 1 liter increments for high flow rotameters.

8. Perform the calibration three times until the desired flow rate of " 5% is attained. Once on site, a secondary calibrator, i.e., rotameter may be used to calibrate sampling pumps.

7.2.3 Calibrating a Personal Sampling Pump with a Rotameter

1. See manufacturer's manual for Rotameter's Operational Instructions.

2. Set up the calibration train as shown in (Figure 5, Appendix B) using a rotameter, sampling pump, and a representative sampling cassette.

3. To set up the calibration train, attach one end of the PVC tubing (approx. 2 ft) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the rotameter.

4. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6^o vertical.

5. Turn the sampling pump on.

6. Turn the flow adjust screw (or knob) on the personal sampling pump until the float ball on the rotameter is lined up with the pre-calibrated flow rate value. A sticker on the rotameter should indicate this value.

7. A verification of calibration is generally performed on-site in the clean zone immediately prior to the sampling.

7.3. Meteorology

It is recommended that a meteorological station be established. If possible, sample after two to three days of dry weather and when the wind conditions are at 10 mph or greater. Record wind speed, wind direction, temperature, and pressure in a field logbook. Wind direction is particularly

important when monitoring for asbestos downwind from a fixed source.

7.4 Ambient Sampling Procedures

7.4.1 Pre-site Sampling Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain necessary sampling equipment and ensure it is in working order and fully charged (if necessary).

3. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety plan.

4. Once on-site the calibration is performed in the clean zone. The calibration procedures are listed in Section 7.2.

5. After calibrating the sampling pump, mobilize to the sampling location.

7.4.2 Site Sampling

1. To set up the sampling train, attach the air intake hose to the cassette base. Remove the cassette cap (Figure 6 and 7, Appendix B). The cassette should be positioned downward, perpendicular to the wind

2. If AC or DC electricity is required then turn it on. If used, the generator should be placed 10 ft. downwind from the sampling pump.

3. Record the following in a field logbook: date, time, location, sample identification number, pump number, flow rate, and cumulative time.

4. Turn the pump on. Should intermittent sampling be required, sampling filters must be covered between active periods of sampling. To cover the sample filter: turn the cassette to face upward, place the cassette cap on the cassette, remove the inlet plug from the cassette cap, attach a rotameter to the inlet opening of the cassette cap to measure the flow rate, turn off the sampling pump, place the inlet plug into the inlet opening on the cassette cap. To resume sampling: remove the inlet plug, turn on the sampling pump, attach a rotameter to measure the flow rate, remove the cassette cap, replace the inlet plug in the cassette cap and invert the cassette, face downward and perpendicular to the wind.

5. Check the pump at sampling midpoint if sampling is longer than 4 hours. The generators may need to be regased depending on tank size. If a filter darkens in appearance or if loose dust is seen in the filter, a second sample should be started.

6. At the end of the sampling period, orient the cassette up, turn the pump off.

7. Check the flow rate as shown in Section 7.2.3. When sampling open-faced, the sampling cap should be replaced before post calibrating. Use the same cassette used for sampling for post calibration (increase dust/fiber loading may have altered the flow rate.

8. Record the post flow rate.

9. Record the cumulative time or run.

10. Remove the tubing from the sampling cassette. Still holding the cassette upright, replace the inlet plug on the cassette cap and the outlet plug on the cassette base.

7.4.3. Post Site Sampling

1. Follow handling procedures in Section 3.2 steps 1-4.

2. Obtain an electronic or hard copy of meteorological data which occurred during the sampling event. Record weather: wind speed, ambient temperature, wind direction, and precipitation. Obtaining weather data several days prior to the sampling event can also be useful.

7.5 Indoor Sampling Procedures

PCM analysis is used for indoor air samples. When analysis shows total fiber count above the OSHA action level 0.1 f/cc then TEM (U.S. EPA's Modified Yamate Method) is used to identify asbestos from non-asbestos fibers.

Sampling pumps should be placed four to five feet above ground level away from obstructions that may influence air flow. The pump can be placed on a table or counter. Refer to Table 2 (Appendix A) for a summary of indoor sampling locations and rationale for selection.

Indoor sampling utilizes high flow rates to increased sample volumes (2000 L for PCM and 2800 to 4200 L for TEM) in order to obtain lower detection limits below the standard, (i.e., 0.01 f/cc or lower [PCM] and 0.005 structures/cc or lower [TEM]).

7.5.1 Aggressive Sampling Procedures

Sampling equipment at fixed locations may fail to detect the presence of asbestos fibers. Due to limited air movement, many fibers may settle out of the air onto the floor and other surfaces and may not be captured on the filter. In the past, an 8-hour sampling period was recommended to cover various air circulation conditions. A quicker and more effective way to capture asbestos fibers is to circulate the air artificially so that the fibers remain airborne during sampling. The result from this sampling option typifies worst case condition. This is referred to as aggressive air sampling for asbestos. Refer to Table

2 for sample station locations.

1. Before starting the sampling pumps, direct forced air (such as a 1-horsepower leaf blower or large fan) against walls, ceilings, floors, ledges, and other surfaces in the room to initially dislodge fibers from surfaces. This should take at least 5 minutes per 1000 sq. ft. of floor.

2. Place a 20-inch fan in the center of the room. (Use one fan per 10,000 cubic feet of room space.) Place the fan on slow speed and point it toward the ceiling.

3. Follow procedures in Section 7.4.1 and 7.4.2 (Turn off the pump and then the fan(s) when sampling is complete.).

4. Follow handling procedures in Section 3.2 steps 1-4.

8.0 CALCULATIONS

The sample volume is calculated from the average flow rate of the pump multiplied by the number of minutes the pump was running (volume = flow rate X time in minutes). The sample volume should be submitted to the laboratory and identified on the chain of custody for each sample (zero for lot, field and trip blanks).

The concentration result is calculated using the sample volume and the numbers of asbestos structures reported after the application of the cluster and matrix counting criteria.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

Follow all QA/QC requirements from the laboratories as well as the analytical methods.

9.1 TEM Requirements

1. Examine lot blanks to determine the background asbestos structure concentration.

2. Examine field blanks to determine whether there is contamination by extraneous asbestos structures during specimen preparation.

3. Examine of laboratory blanks to determine if contamination is being introduced during critical phases of the laboratory program.

4. To determine if the laboratory can satisfactorily analyze samples of known asbestos structure concentrations, reference filters shall be examined. Reference filters should be maintained as part of the laboratory's Quality Assurance program.

5. To minimize subjective effects, some specimens should be recounted by a different microscopist.

6. Asbestos laboratories shall be accredited by the National Voluntary Laboratory

Accreditation Program.

7. At this time, performance evaluation samples for asbestos in air are not available for Removal Program Activities.

9.2 PCM Requirements

1. Examine reference slides of known concentration to determine the analyst's ability to satisfactorily count fibers. Reference slides should be maintained as part of the laboratory's quality assurance program.

2. Examine field blanks to determine if there is contamination by extraneous structures during sample handling.

3. Some samples should be relabeled then submitted for counting by the same analyst to determine possible bias by the analyst.

4. Participation in a proficiency testing program such as the AIHA-NIOSH proficiency analytical testing (PAT) program.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results accordingly with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures. More specifically, when entering an unknown situation involving asbestos, a powered air purifying respirator (PAPR) (full face-piece) is necessary in conjunction with HEPA filter cartridges. See applicable regulations for action level, PEL, TLV, etc. If previous sampling indicates asbestos concentrations are below personal health and safety levels, then Level D personal protection is adequate.

12.0 REFERENCES

1. Environmental Asbestos Assessment Manual, Superfund Method for the Determination of Asbestos in Ambient Air, Part 1: Method, EPA/540/2-90/005a, May 1990, and Part 2: Technical Background Document, EPA/540/2-90/005b, May 1990.

2. Methodology for the Measurement of Airborne Asbestos by Electron Microscopy, EPA's Report No. 68-02-3266, 1984, G. Yamate, S.C. Agarwal, and R. D. Gibbons.

3. National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Method. Third Edition. 1987.

4. U.S. Environmental Protection Agency. Code of Federal Regulations 40 CFR 763. July 1, 1987. Code of Federal Regulations 40 CFR 763 Addendum. October 30, 1987.

5. U.S. Environmental Protection Agency. Asbestos-Containing Materials in Schools; Final Rule and Notice. 52 FR 41826.

6. Occupational Safety and Health Administration. Code of Federal Regulations 29 CFR 1910.1001. Washington, D.C. 1987.

APPENDIX A
Tables
SOP #2015
November 1994

TABLE 1.

SAMPLE STATIONS FOR OUTDOOR SAMPLING

Sample Station Location	Sample Numbers	Rationale
Upwind/Background[(1)]	Collect a minimum of two simultaneous upwind/background samples 30^{o} apart from the prevailing windlines.	Establishes background fiber levels.
Downwind	Deploy a minimum of 3 sampling stations in a 180 degree arc downwind from the source.	Indicates if asbestos is leaving the site.
Site Representative and/or Worst Case	Obtain one site representative sample which shows average condition on-site or obtain worst case sample (optional).	Verify and continually confirm and document selection of proper levels of worker protection.

(1) More than one background station may be required if the asbestos originates from different sources.

TABLE 2

SAMPLE STATIONS FOR INDOOR SAMPLING

Sample Station Location	Sample Numbers	Rationale
Indoor Sampling	If a work site is a single room, disperse 5 samplers throughout the room. If the work site contains up to 5 rooms, place at least one sampler in each room. If the work site contains more than 5 rooms, select a representative sample of the rooms.	Establishes representative samples from a homogeneous area.
Upwind/Background	If outside sources are suspected, deploy a minimum of two simultaneous upwind/background samples 30^{o} apart from the prevailing windlines.	Establish whether indoor asbestos concentrations are coming from an outside source.
Worst Case	Obtain one worst case sample, i.e., aggressive sampling (optional).	Verify and continually confirm and document selection of proper levels of worker protection.

APPENDIX B
Figures
SOP #2015
November 1994

FIGURE 1. Transmission Electron Microscopy Filter Cassette

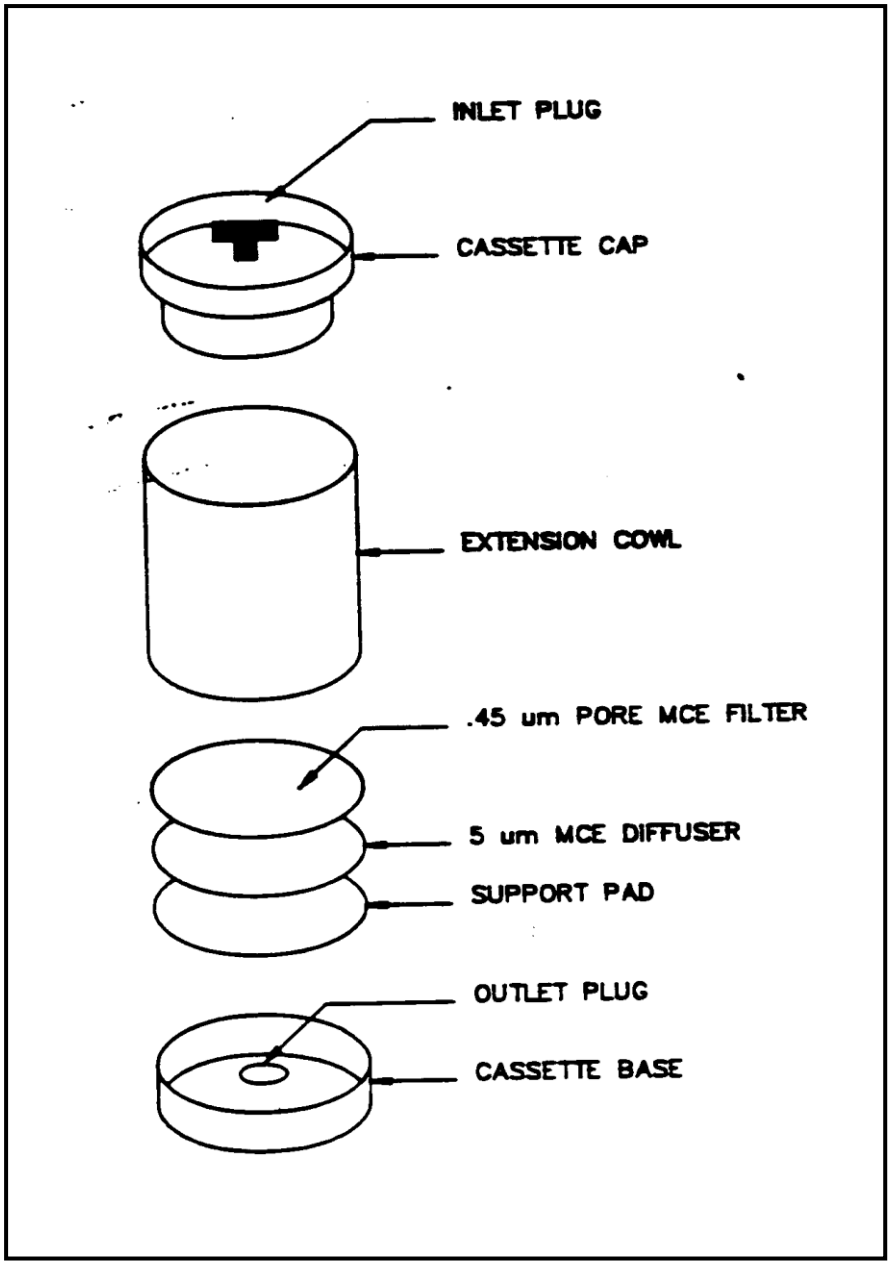


FIGURE 2. Phase Contrast Microscopy Filter Cassette

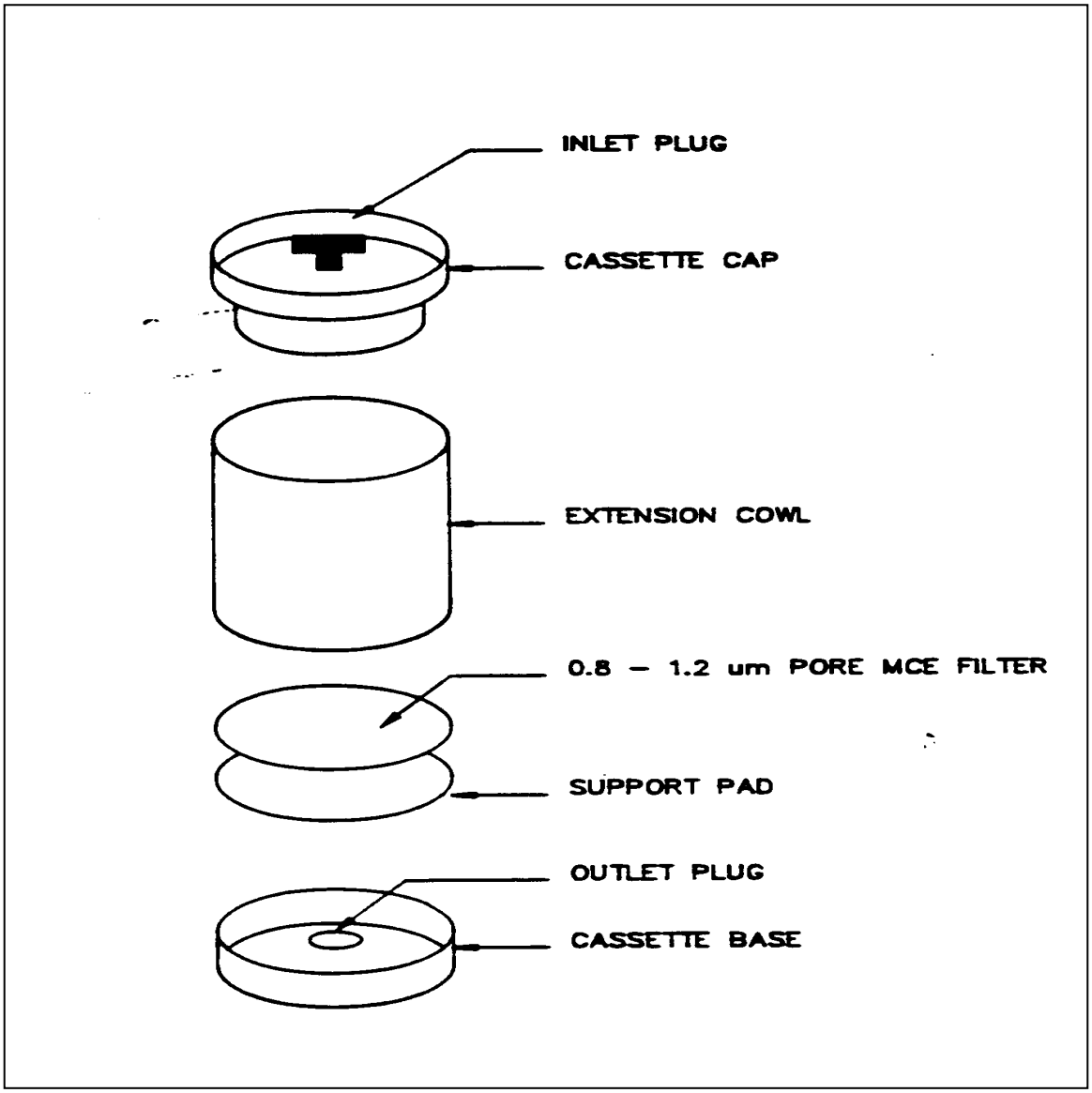


FIGURE 3. Calibrating a Personal Sampling Pump with a Bubble Meter

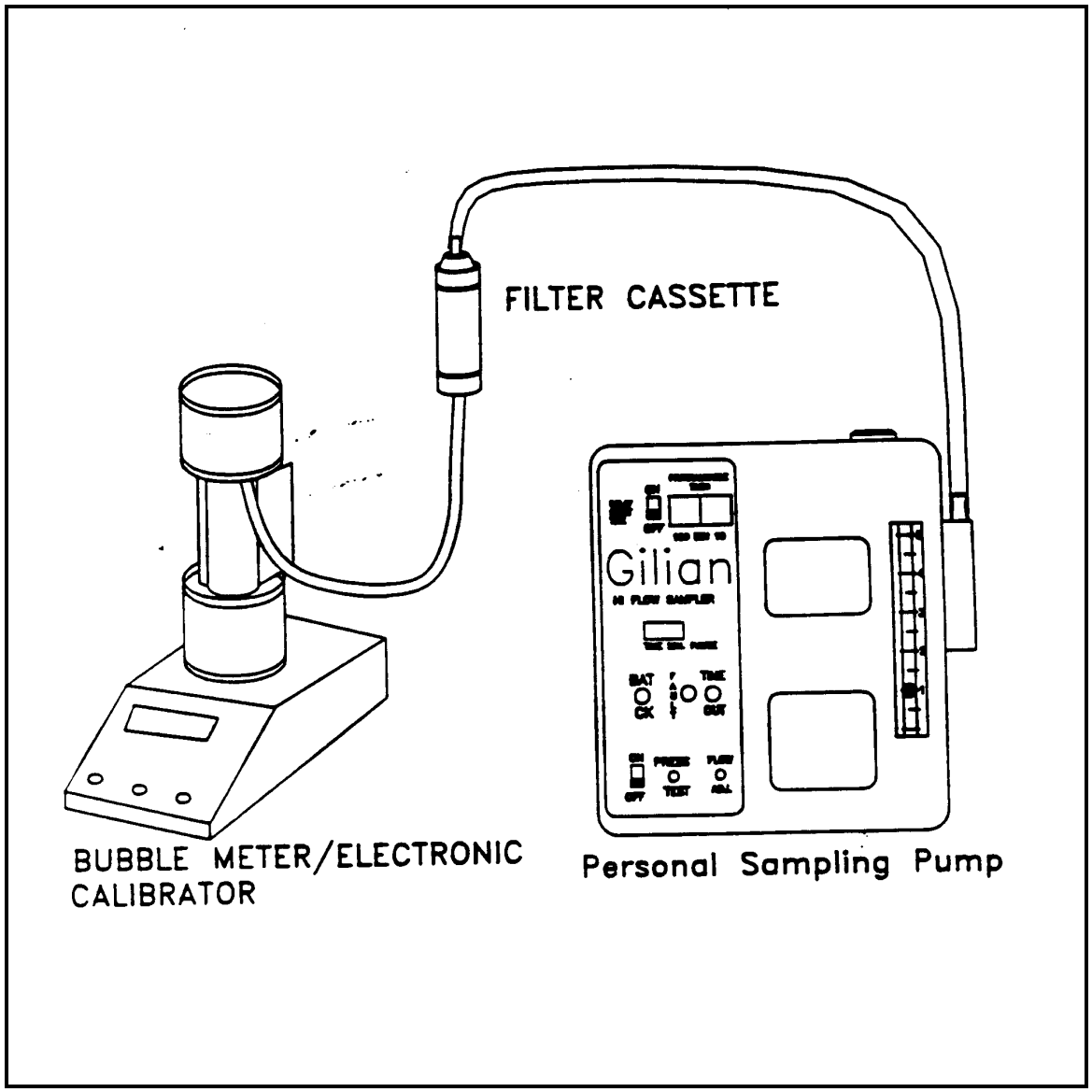


FIGURE 4. Calibrating a Rotameter with a Bubble Meter

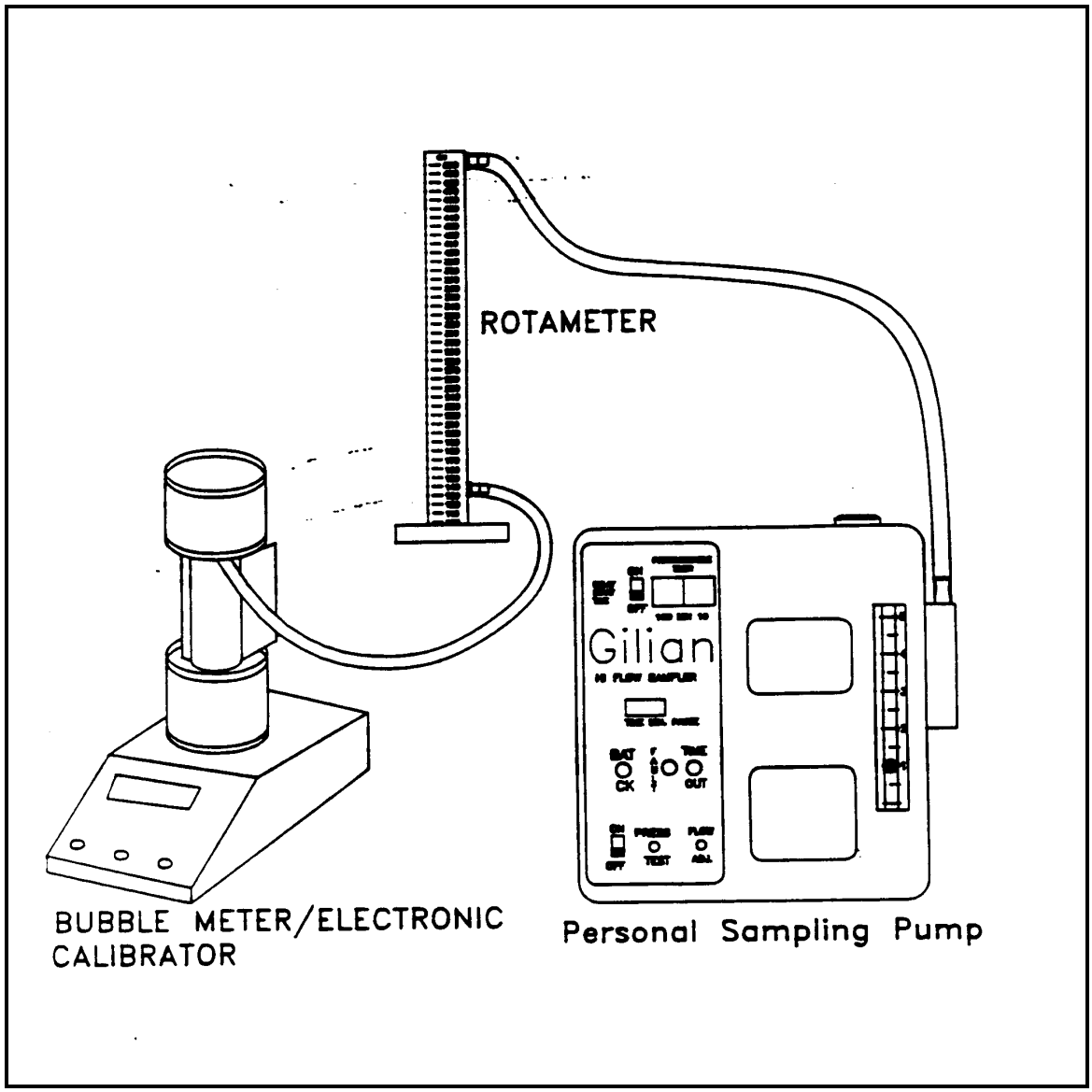


FIGURE 5. Calibrating a Sampling Pump with a Rotameter

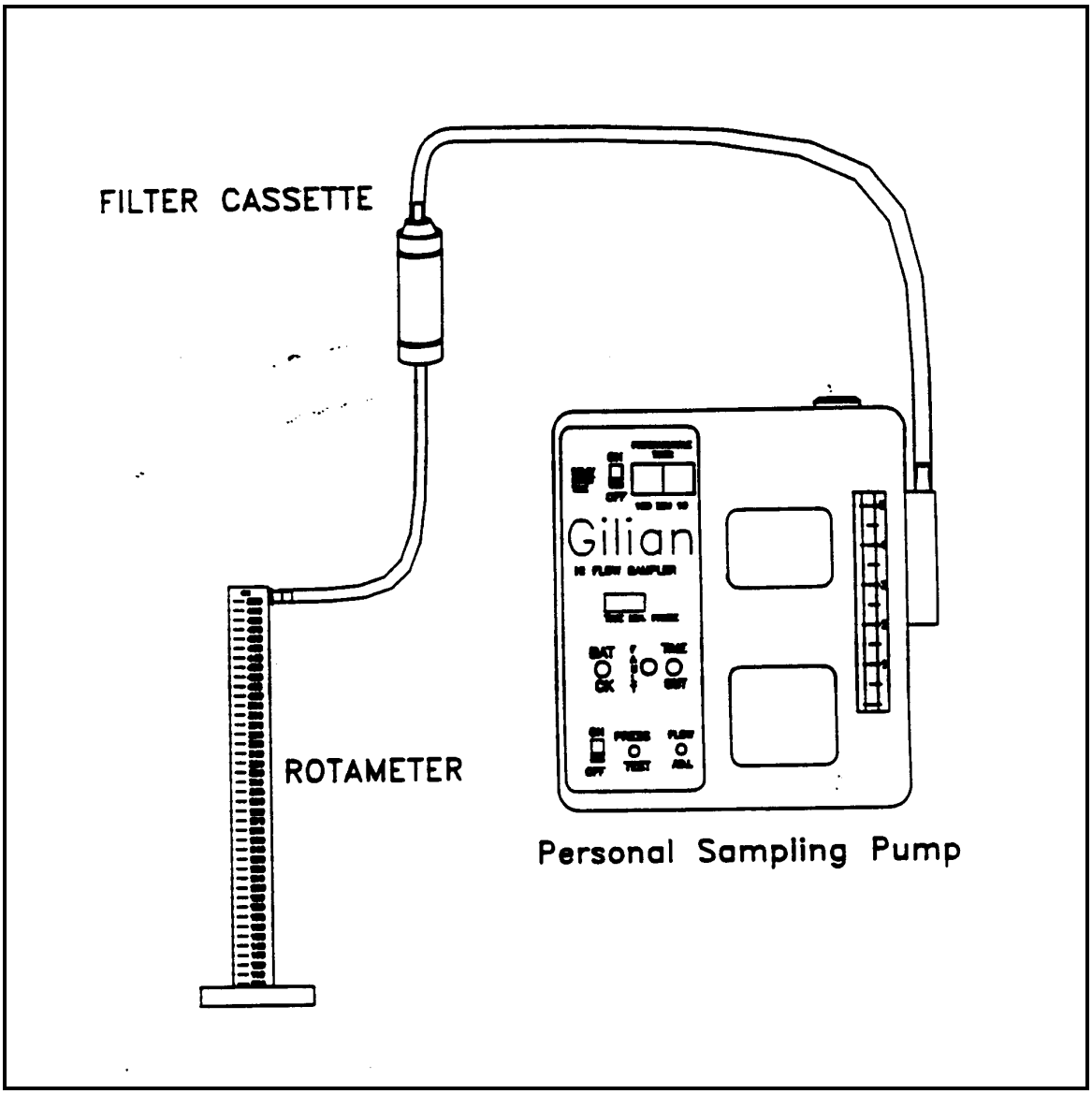


FIGURE 6. Personal Sampling Train for Asbestos

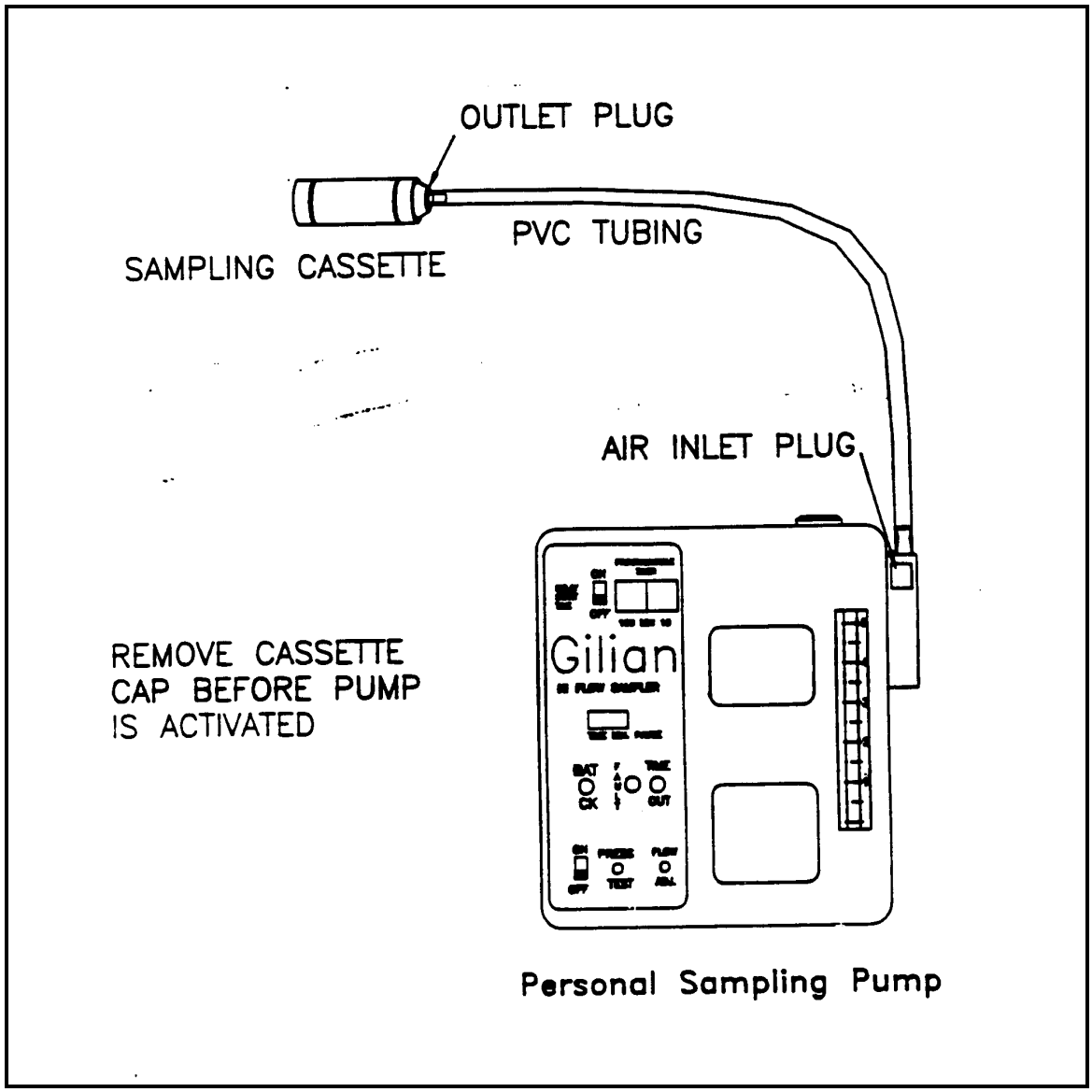
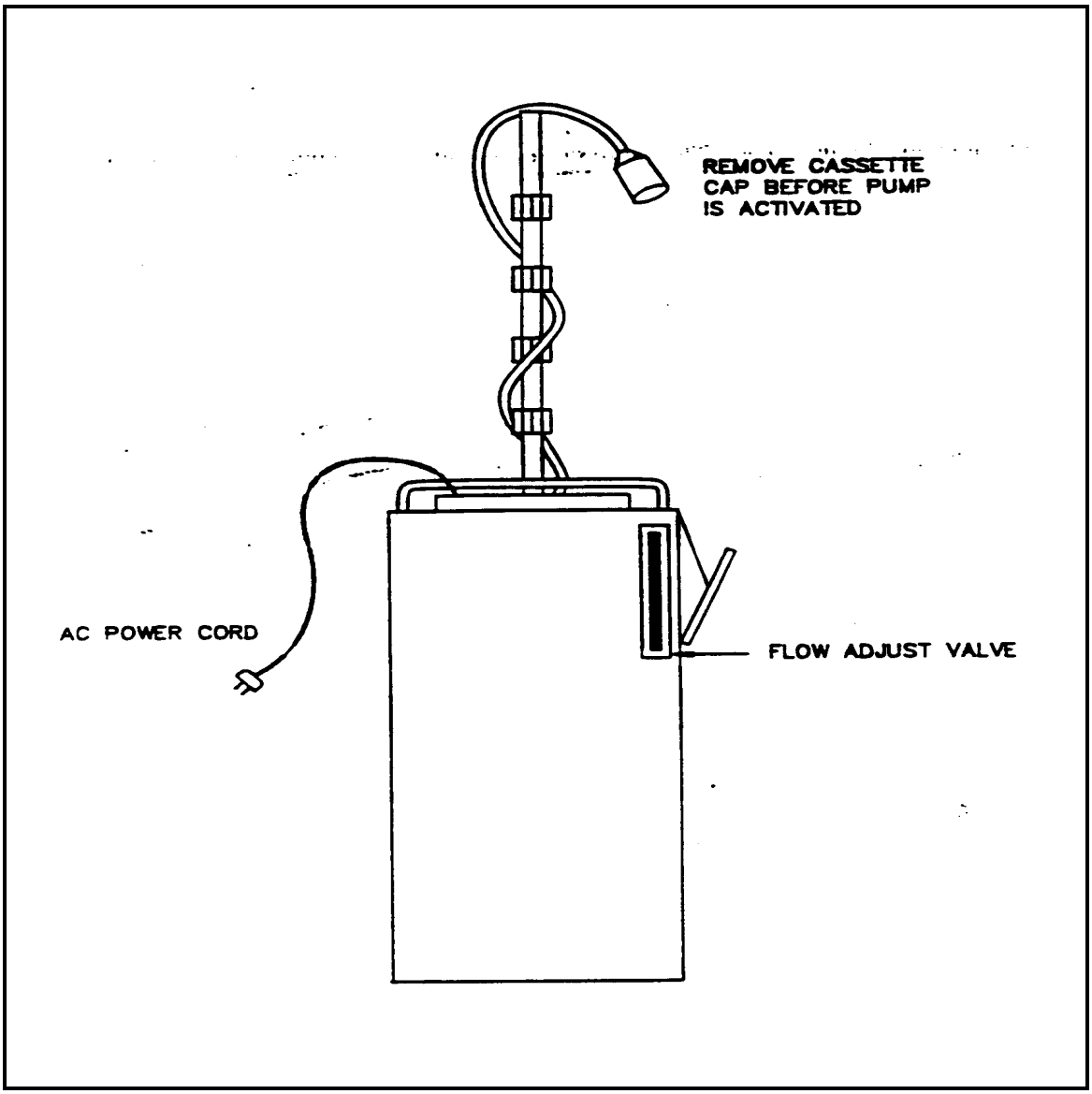


FIGURE 7. High Flow Sampling Train for Asbestos



SUMMA CANISTER SAMPLING

CONTENTS

* This section affected by Revision 0.1.

SUMMA CANISTER SAMPLING

SUPERCEDES: SOP #1704; Revision 0.0; 09/12/94

SUMMA CANISTER SAMPLING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to describe a procedure for sampling of volatile organic compounds (VOCs) in ambient air. The method is based on samples collected as whole air samples in Summa passivated stainless steel canisters. The VOCs are subsequently separated by gas chromatography (GC) and measured by mass-selective detector or multidetector techniques. This method presents procedures for sampling into canisters at final pressures both above and below atmospheric pressure (respectively referred to as pressurized and subatmospheric pressure sampling).

This method is applicable to specific VOCs that have been tested and determined to be stable when stored in pressurized and subatmospheric pressure canisters. The organic compounds that have been successfully collected in pressurized canisters by this method are listed in the Volatile Organic Compound Data Sheet (Appendix A). These compounds have been measured at the parts per billion by volume (ppbv) level.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Both subatmospheric pressure and pressurized sampling modes use an initially evacuated canister. Both modes may also use a mass flow controller/vacuum pump arrangement to regulate flow. With the above configuration, a sample of ambient air is drawn through a sampling train comprised of components that regulate the rate and duration of sampling into a pre-evacuated Summa passivated canister. Alternatively, subatmospheric pressure sampling may be performed using a fixed orifice, capillary, or adjustable micrometering valve in lieu of the mass flow controller/vacuum pump arrangement for taking grab samples or short duration time-integrated samples. Usually, the alternative types of flow controllers are appropriate only in situations where screening samples are taken to assess for future sampling activities.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

After the air sample is collected, the canister valve is closed, an identification tag is attached to the canister, and the canister is transported to a laboratory for analysis. Upon receipt at the laboratory, the canister tag data is recorded. Sample holding times and expiration should be determined prior to initiating field activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Contamination may occur in the sampling system if canisters are not properly cleaned before use. Additionally, all other sampling equipment (e.g., pump and flow controllers) should be thoroughly cleaned. Instructions for cleaning the Summa canisters are described inERT/SERAS SOP #1703, Summa Canister Cleaning Procedures.

5.0 EQUIPMENT/APPARATUS

The following equipment/apparatus (Figure 1, Appendix B) is required:

5.1 Subatmospheric Pressure Sampling Equipment

1. VOC canister sampler - whole air sampler capable of filling an initially evacuated canister by action of the flow controlled pump from vacuum to near atmospheric pressure. (Andersen Samplers Inc., Model 87-100 or equivalent).

2. Sampling inlet line - stainless steel tubing to connect the sampler to the sample inlet.

3. Sample canister - leak-free stainless steel pressure vessels of desired volume with valve and Summa passivated interior surfaces (Scientific Instrumentation Specialist, Inc., ID 83843, Andersen Samplers, Inc., or equivalent).

4. Particulate matter filter - 2-µm sintered stainless steel in-line filter (Nupro Co., Model SS-2F-K4-2, or equivalent).

5. Chromatographic grade stainless steel tubing and fittings - for interconnections (Alltech Associates, Cat. # 8125, or equivalent). All materials in contact with sample, analyte, and support gases should be chromatographic grade stainless steel.

6. Fixed orifice, capillary, or adjustable micrometering valve - used in lieu of the electronic flow controller/vacuum pump for grab samples or short duration time-integrated samples.

5.2 Pressurized Sampling Equipment

1. VOC canister sampler - whole air sampler capable of filling an initially evacuated canister by action of the flow controlled pump from vacuum to near atmospheric pressure. (Andersen Samplers Inc., Model 87-100).

2. Sampling inlet line - stainless steel tubing to connect the sampler to the sample inlet.

3. Sample canister - leak-free stainless steel pressure vessels of desired volume with valve and Summa passivated interior surfaces (Scientific Instrumentation Specialist, Inc., ID 83843, Andersen Samplers, Inc., or equivalent).

4. Particulate matter filter - 2-µm sintered stainless steel in-line filter (Nupro Co., Model SS-2F-K4-2, or equivalent).

5. Chromatographic grade stainless steel tubing and fittings - for interconnections (Alltech Associates, Cat. #8125, or equivalent). All materials in contact with sample, analyte, and support gases should be chromatographic grade stainless steel.

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURE

7.1 Subatmospheric Pressure Sampling

7.1.1 Sampling Using a Fixed Orifice, Capillary, or Adjustable Micrometering Valve

1. Prior to sample collection, the appropriate information is completed on the Canister Sampling Field Data Sheet (Appendix C).

2. A canister, which is evacuated to 0.05 mm Hg and fitted with a flow restricting device, is opened to the atmosphere containing the VOCs to be sampled.

3. The pressure differential causes the sample to flow into the canister.

4. This technique may be used to collect grab samples (duration of 10 to 30 seconds) or time-integrated samples (duration of 12 to 24 hours). The sampling duration depends on the degree to which the flow is restricted.

5. A critical orifice flow restrictor will have a decrease in the flow rate as the pressure approaches atmospheric.

6. Upon sample completion at the location, the appropriate information is recorded on the Canister Sampling Field Data Sheet.

7.1.2 Sampling Using a Mass Flow Controller/Vacuum Pump Arrangement (Andersen Sampler Model 87-100)

1. Prior to sample collection the appropriate information is completed on the Canister Sampling Field Data Sheet (Appendix C).

2. A canister, which is evacuated to 0.05 mm Hg and connected in line with the sampler, is opened to the atmosphere containing the VOCs to be sampled.

3. A whole air sample is drawn into the system through a stainless steel inlet tube by a direct drive blower motor assembly.

4. A small portion of this whole air sample is pulled from the inlet tube by a specially modified inert vacuum pump in conjunction with a mass flow controller.

5. The initially evacuated canister is filled by action of the flow controlled pump to near atmospheric pressure.

6. A digital time-program is used to pre-select sample duration and start and stop

times.

7. Upon sample completion at the location, the appropriate information is recorded on the Canister Sampling Field Data Sheet.

7.2 Pressurized Sampling

7.2.1 Sampling Using a Mass Flow Controller/Vacuum Pump Arrangement (Andersen Sampler Model 87-100)

1. Prior to sample commencement at the location, the appropriate information is completed on the Canister Sampling Field Data Sheet.

2. A canister, which is evacuated to 0.05 mm Hg and connected in line with the sampler, is opened to the atmosphere containing the VOCs to be sampled.

3. A whole air sample is drawn into the system through a stainless steel inlet tube by a direct drive blower motor assembly.

4. A small portion of this whole air sample is pulled from the inlet tube by a specially modified inert vacuum pump in conjunction with a mass flow controller.

5. The initially evacuated canister is filled by action of the flow controlled pump to a positive pressure not to exceed 25 psig.

6. A digital time-programmer is used to pre-select sample duration and start and stop times.

7. Upon sample completion at the location, the appropriate information is recorded on the Canister Sampling Field Data Sheet.

8.0 CALCULATIONS

1. A flow control device is chosen to maintain a constant flow into the canister over the desired sample period. This flow rate is determined so the canister is filled to about 88.1 kPa for subatmospheric pressure sampling or to about one atmosphere above ambient pressure for pressurized sampling over the desired sample period. The flow rate can be calculated by:

$$F = \frac{(P)(V)}{(T)(60)}$$

where:

F = flow rate (cm^3/min)
P = final canister pressure, atmospheres absolute
V = volume of the canister (cm^3)

T = sample period (hours)

For example, if a 6-L canister is to be filled to 202 kPa (two atmospheres) absolute pressure in 24 hours, the flow rate can be calculated by:

$$F = \frac{(2)(6000)}{(24)(60)} = .3 cm^3/min.$$

2. If the canister pressure is increased, a dilution factor (DF) is calculated and recorded on the sampling data sheet.

$$DF = \frac{Ya}{Xa}$$

where:

Xa = canister pressure (kPa, psia) absolute before dilution.
Ya = canister pressure (kPa, psia) absolute after dilution.

After sample analysis, detected VOC concentrations are multiplied by the dilution factor to determine concentration in the sampled air.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on standard chain of custody records, field data sheets, or site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety practices. Specifically, pressurizing of Summa canisters should be performed in a well ventilated room, or preferably under a fume hood. Care must be taken not to exceed 40 psi in the canisters. Canisters are under pressure, albeit only 20-30 psi, and should not be dented or punctured. They should be stored in a cool dry place and always be placed in their plastic shipping boxes during transport and storage.

12.0 REFERENCES

1. Ralph M. Riggin, Technical Assistance Document for Sampling and Analysis of Toxic Organic Compounds in Ambient Air, EPA-600/4-83-027 U. S. Environmental Protection Agency, Research Triangle Park, NC, 1983.

2. W. A. McClenny, J. D. Pleil, T. A. Lumpkin and K. D. Oliver, "Update on Canister-Based Samplers for VOCs," Proceedings of the 1987 EPA/APCA Symposium on Measurement of Toxic and Related Air Pollutants, May, 1987 APCA Publication VIP-8, EPA 600/9-87-010.

3. J. F. Walling, "The Utility of Distributed Air Volume Sets When Sampling Ambient Air Using Solid Adsorbents," Atmospheric Environ., 18:855-859, 1984.

4. J. F. Walling, J. E. Bumgarner, J. D. Driscoll,C. M. Morris, A. E. Riley, and L. H. Wright, "Apparent Reaction Products Desorbed From Tenax Used to Sample Ambient Air," Atmospheric Environ., 20:51-57, 1986.

5. Portable Instruments User's Manual for Monitoring VOC Sources, EPA-340/1-88-015, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, D.C., June 1986.

6. R. A. Rasmussen and J. E. Lovelock, Atmospheric Measurements Using Canister Technology, J. Geophys. Res., 83: 8369-8378, 1983.

7. R. A. Rasmussen and M. A. K. Khalil, "Atmospheric Halocarbon: Measurements and Analysis of Selected Trace Gases," Proc. NATO ASI on Atmospheric Ozone, BO: 209-23l.

8. EPA Method TO-14 "Determination of Volatile Organic Compounds (VOC's) in Ambient Air Using Summa Passivated Canister Sampling and Gas Chromatographic Analysis", May 1988.

APPENDIX A
Volatile Organic Compound Data Sheet
SOP #1704
July 1995

Volatile Organic Compound Data Sheet

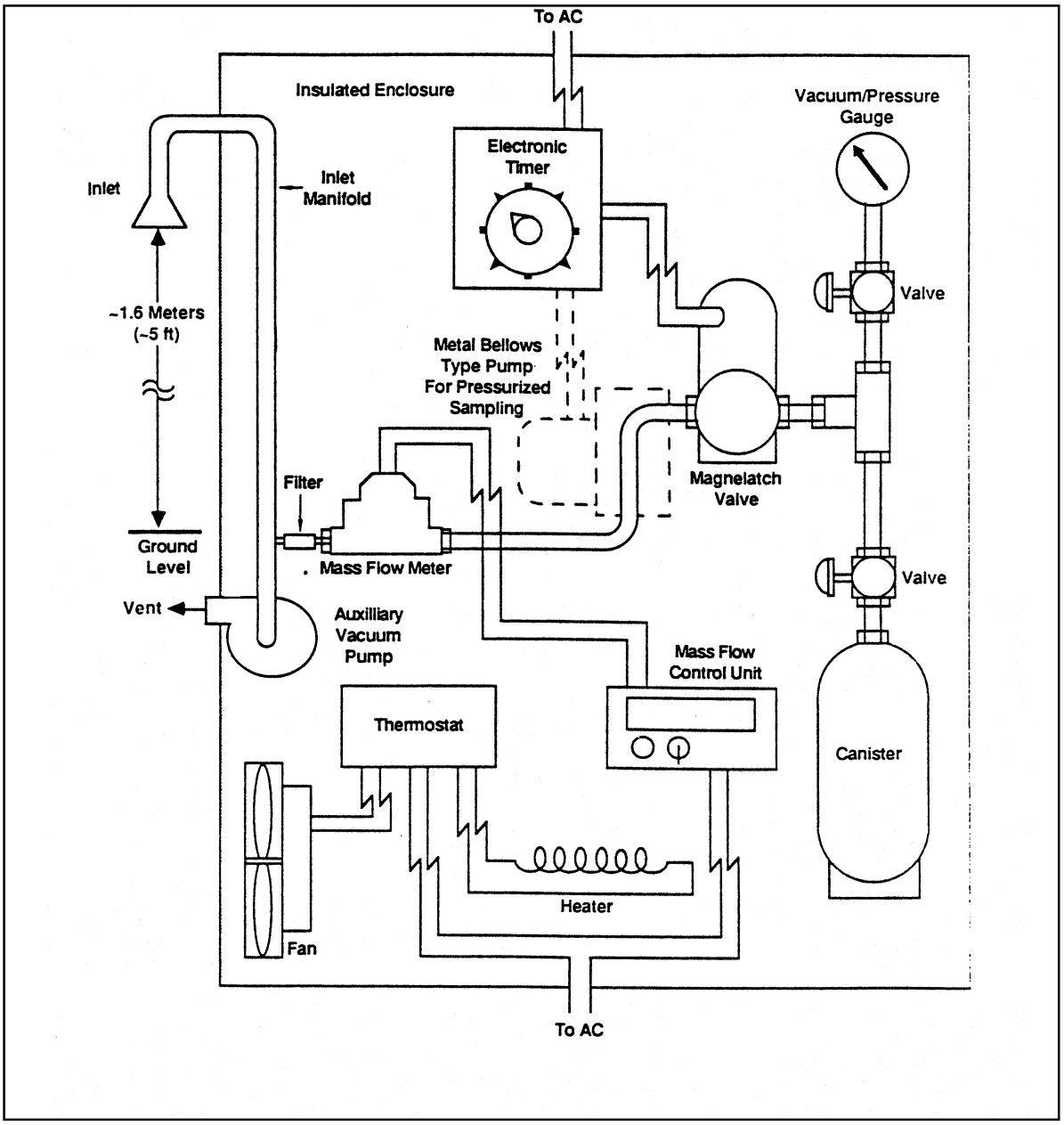
TABLE 1. VOLATILE ORGANIC COMPOUND DATA SHEET

COMPOUND (SYNONYM)	FORMULA	MOLECULAR WEIGHT	BOILING POINT (°C)	MELTING POINT (°C)	CAS NUMBER
Freon 12 (Dichlorodifluoromethane)	Cl_2CF_2	120.91	-29.8	-158.0	
Methyl chloride (Chloromethane)	CH_3Cl	50.49	-24.2	-97.1	74-87-3
Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	$ClCF_2CClF_2$	170.93	4.1	-94.0	
Vinyl chloride (Chloroethylene)	$CH_2=CHCl$	62.50	-13.4	-1538.0	75-01-4
Methyl bromide (Bromomethane)	CH_3Br	94.94	3.6	-93.6	74-83-9
Ethyl chloride (Chloroethane)	CH_3CH_2Cl	64.52	12.3	-136.4	75-00-3
Freon 11 (Trichlorofluoromethane)	CCl_3F	137.38	23.7	-111.0	
Vinylidene chloride (1,1-Dichloroethene)	$C_2H_2Cl_2$	96.95	31.7	-122.5	75-35-4
Dichloromethane (Methylene chloride)	CH_2Cl_2	84.94	39.8	-95.1	75-09-2
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	CF_2ClCCl_2F	187.38	47.7	-36.4	
1,1-Dichloroethane (Ethylidene chloride)	CH_3CHCl_2	98.96	57.3	-97.0	74-34-3
cis-1,2-Dichloroethylene	$CHCl=CHCl$	96.94	60.3	-80.5	
Chloroform (Trichloromethane)	$CHCl_3$	119.38	61.7	-63.5	67-66-3
1,2-Dichloroethane (Ethylene dichloride)	$ClCH_2CH_2Cl$	98.96	83.5	-35.3	107-06-2
Methyl chloroform (1,1,1-Trichloroethane)	CH_3CCl_3	133.41	74.1	-30.4	71-55-6
Benzene (Cyclohexatriene)	C_6H_6	78.12	80.1	5.5	71-43-2
Carbon tetrachloride (Tetrachloromethane)	CCl_4	153.82	76.5	-23.0	56-23-5
1,2-Dichloropropane (Propylene dichloride)	$CH_3CHClCH_2Cl$	112.99	96.4	-100.4	78-87-5
Trichloroethylene (Trichloroethene)	$ClCH=CCl_2$	131.29	87	-73.0	79-01-6
cis-1,3-Dichloropropene (cis-1,3-dichloropropylene)	$CH_3CCl=CHCl$	110.97	76		
trans-1,3-Dichloropropene (cis-1,3-Dichloropropylene)	$ClCH_2CH=CHCl$	110.97	112.0		
1,1,2-Trichloroethane (Vinyl trichloride)	$CH_2ClCHCl_2$	133.41	113.8	-36.5	79-00-5
Toluene (Methyl benzene)	$C_6H_5CH_3$	92.15	110.6	-95.0	108-88-3
1,2-Dibromoethane (Ethylene dibromide)	$BrCH_2CH_2Br$	187.88	131.3	9.8	106-93-4
Tetrachloroethylene (Perchloroethylene)	$Cl_2C=CCl_2$	165.83	121.1	-19.0	127-18-4
Chlorobenzene (Phenyl chloride)	C_6H_5Cl	112.56	132.0	-45.6	108-90-7
Ethylbenzene	$C_6H_5C_2H_5$	106.17	136.2	-95.0	100-41-4
m-Xylene (1,3-Dimethylbenzene)	$1,3-(CH_3)_2C_6H_4$	106.17	139.1	-47.9	
p-Xylene (1,4-Dimethylxylene)	$1,4-(CH_3)_2C_6H_4$	106.17	138.3	13.3	
Styrene (Vinyl benzene)	$C_6H_5CH=CH_2$	104.16	145.2	-30.6	100-42-5
1,1,2,2-Tetrachloroethane	$CHCl_2CHCl_2$	167.85	146.2	-36.0	79-34-5
o-Xylene (1,2-Dimethylbenzene)	$1,2-(CH_3)_2C_6H_4$	106.17	144.4	-25.2	
1,3,5-Trimethylbenzene (Mesitylene)	$1,3,5-(CH_3)_3C_6H_6$	120.20	164.7	-44.7	108-67-8
1,2,4-Trimethylbenzene (Pseudocumene)	$1,2,4-(CH_3)_3C_6H_6$	120.20	169.3	-43.8	95-63-6
m-Dichlorobenzene (1,3-Dichlorobenzene)	$1,3-Cl_2C_6H_4$	147.01	173.0	-24.7	541-73-1
Benzyl chloride (α-Chlorotoluene)	$C_6H_5CH_2Cl$	126.59	179.3	-39.0	100-44-7
o-Dichlorobenzene (1,2-Dichlorobenzene)	$1,2-Cl_2C_6H_4$	147.01	180.5	-17.0	95-50-1
p-Dichlorobenzene (1,4-Dichlorobenzene)	$1,4-Cl_2C_6H_4$	147.01	174.0	53.1	106-46-7
1,2,4-Trichlorobenzene	$1,2,4-Cl_3C_6H_3$	181.45	213.5	17.0	120-82-1
Hexachlorobutadiene (1,1,2,3,4,4-Hexachloro-1,3-butadiene)					

APPENDIX B

Figure
SOP #1704
July 1995

FIGURE 1. Subatmospheric/Pressurized Sampling Equipment



APPENDIX C

Canister Sampling Field Data Sheet
SOP #1704
July 199

Page ____of____

EPA/Environmental Response Team
Scientific, Engineering, Response and Analytical Services
Lockheed Martin Corp., Edison, NJ
U.S. EPA Contract No. EP-W-09-031

Air Sampling Work Sheet

Site: _____ WA# _____

Sampler: _____ U.S. EPA/ERT WAM:_____

Date: _____ REAC Task Leader:_____

Sample #					
Location					
Summa #					
Orifice ID					
Analysis/Method					
Start Pressure					
End Pressure					
Time/Counter (Start)					
Time/Counter (Stop)					
Total Time					
Flow Rate (Start)					
Flow Rate (End)					
Flow Rate Average					
Sample Volume					

MET Station on Site?: Y / N

SUMMA CANISTER FIELD STANDARDS

CONTENTS

SUPERCEDES: SOP #1706; Revision 2; 07/30/90; U.S. EPA Contract EP-W-09-031.

SUMMA CANISTER FIELD STANDARDS

1.0 SCOPE OF APPLICATION

The objective of this procedure is to establish standard operating practices for the use of Summa canisters. Summa polished canisters are used to store calibration gas standards for transport to field sampling sites. These standards contained in the Summa canisters will be used for calibration of field instrumentation. In addition, a series of different concentrations of gas standards, or dilutions in the field of a single canister, can be used to construct calibration curves and to ascertain minimum detection limits on various field instrumentation currently used by Scientific, Engineering, Response and Analytical Services (SERAS) and Environmental Protection Agency/Environmental Response Team (EPA/ERT).

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

A clean evacuated Summa canister is obtained. A certified gas standard cylinder is selected and a delivery pressure of 20-30 psi is set. The lines are bled with the gas standard. Then, the Summa canister is opened while still attached to the gas standard line, and is charged to 20-30 psi with the certified gas standard cylinder. The Summa canister is closed and the gas standard lines are removed. A "tee" with a septum is attached onto the Swagelok fitting of the Summa canister. The "tee" is purged with the contents of the Summa canister. The Summa canister valve is opened and samples can be taken via a gas tight syringe through the septum on the "tee." The valve is closed when not in use. Tedlar bags can also be filled from the "tee."

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples and gas standards can be kept several months in the Summa polished canisters. Care must be taken to ensure no leaks occur when the "tee" and septum are used. In addition, the needle valve on the Summa canister must be completely closed when not in use. When transporting and storing, the Summa canister is placed in a plastic shipping container. This will protect the canister from accidental punctures or dents.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

As long as the gas standards and all transfer lines are clean, no interferences are expected. The initial pressure of the Summa canister should be recorded after filling. In addition, the pressure should be recorded after each use. A dramatic drop in pressure (i.e., five psi or more) may invalidate the use of that canister.

5.0 EQUIPMENT/APPARATUS

- Summa Canister, 6-liter total volume
  Cat # 87-300, Anderson Samplers, Inc.
  4215 Wendell Drive, Atlanta, GA 30376
  PN # 0650, SIS, P.O. Box 8941, 815 Courtney St., Moscow, Idaho 83843

- Certified gas standard from Scott Gas, Matheson or other reliable manufacturer.

- Hamilton gas tight syringe with Teflon seal plugs in various sizes.

- Clean Teflon tubing, 1/4" O.D.
- Swagelok "tee" 1/4" O.D. Teflon
- 1/4" Teflon Swagelok nuts & ferrules.
- 9-mm septa, preferably Teflon backed
- Swagelok on/off or needle valve, 1/4" O.D. stainless steel.

6.0 REAGENTS

All standards must be vapor phase pressurized gas cylinders, certified by the manufacturer to be within ±2% accuracy, and to be NBS traceable. Scott Specialty Gas or Matheson Gas can provide these standards. If field dilution is required, a cylinder of ultra high purity air is required.

7.0 PROCEDURES

1. Obtain a Summa polished canister that has been cleaned and evacuated as per ERT/SERAS SOP #1703, Summa Canister Cleaning Procedures, and select a compressed gas cylinder of a certified standard. This standard should be certified by the manufacturer to be within ±2% for the accuracy of the concentration level and be NBS traceable.

2. A high purity dual stage regulator is attached to the standard cylinder. This must deliver 20-30 psi pressure at an accuracy of ±10% or better.

3. A section of clean, unused 1/4" O.D. Teflon tubing is attached to the Teflon "tee."

4. The side port of the "tee" has an on/off valve or needle valve connected to it (Figure 1, Appendix A).

5. A vent line is temporally connected to the outlet port of the side valve and placed in a fume hood or on an outside vent. The Summa canister charging system appears in Figure 2 (Appendix A).

6. The standard cylinder is opened at 20-30 psi from the outlet of the cylinder regulator.

7. The needle valve on the Summa canister is still closed at this point. The side valve on the "tee" is opened and the standard cylinder's 1/4" Teflon feed lines are allowed to vent for one-two minutes.

8. The valve is then closed tightly and the needle valve on the Summa canister is slowly opened. A hissing noise should be heard. Do not fill the Summa canisters too rapidly. Allow the canister to continue filling.

9. Periodically check the pressure on the dual stage regulator attached to the standard cylinder to ensure 20-30 psi is being delivered.

10. Once the hissing stops, the canister should be filled to approximately the same pressure as the line delivery pressure.

11. Close the needle valve on the Summa canister tightly.

12. Close the standard cylinder and vent the feed lines.

13. Remove the feed line from the top of the Teflon "tee."

14. Place a Swagelok back ferrule, in the inverted position, on the top of the "tee." This will provide a flat surface on which a Teflon-backed septum can be placed.

15. Place the Teflon-backed septum, Teflon side down. The septum should create a gas tight fit once a 1/4" Swagelok nut is tightened onto the top of the "tee" (Figures 3 and 4, Appendix A).

16. Open the needle valve on the Summa canister to check for leaks throughout the "tee", particularly in the septum fitting. Do this with the valve on the side of the "tee" closed.

17. Afterwards, slowly open the side valve of the "tee" and vent for 1/2 minute and re-close. The septum "tee" is now ready for sampling from the canister using a gas tight syringe through the septum seal.

18. Close the Summa canister needle valve between sample taking with the gas tight syringe.

19. Periodically, vent or flush the "tee" to provide fresh standard for sampling. The side valve can also be used, after flushing, to fill Tedlar bags with the standard from the Summa canister.

8.0 CALCULATIONS

The procedure for performing field dilutions of the standards from the Summa canisters must be documented. This allows for the recalculation of concentrations of standards if any discrepancies arise in the calibration of the field instrumentation. Simple volumetric dilutions using Hamilton gas tight syringes, are performed using Tedlar bags with ultra high purity air as the diluent.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The concentration levels of the certified gas standards must be recorded. The vendor typically provides the analysis of certification with each standards cylinder; a copy should be provided with the Summa canister.

As previously stated, the pressure of the canister along with the date and time, should be recorded at the initial filling and at the end of each use of the canister. A drop in pressure of 5-10 psi in between usages may invalidate the canister for use as a calibration standard. Certification of canister cleaning and evacuation should be noted prior to filling with standards.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

Pressurizing of Summa canisters should be performed in a well ventilated room, or preferably under a fume hood.

Care must be taken not to exceed 40 psi in the canisters. Canisters are under pressure, albeit only 20-30 psi, and should not be dented or punctured. They should be stored in a cool dry place and always be placed in their plastic shipping boxes during transport and storage.

12.0 REFERENCES

This section is not applicable to this SOP.

APPENDIX A
Figures
SOP #1706
September 1994

FIGURE 1. Teflon "Tee" Setup

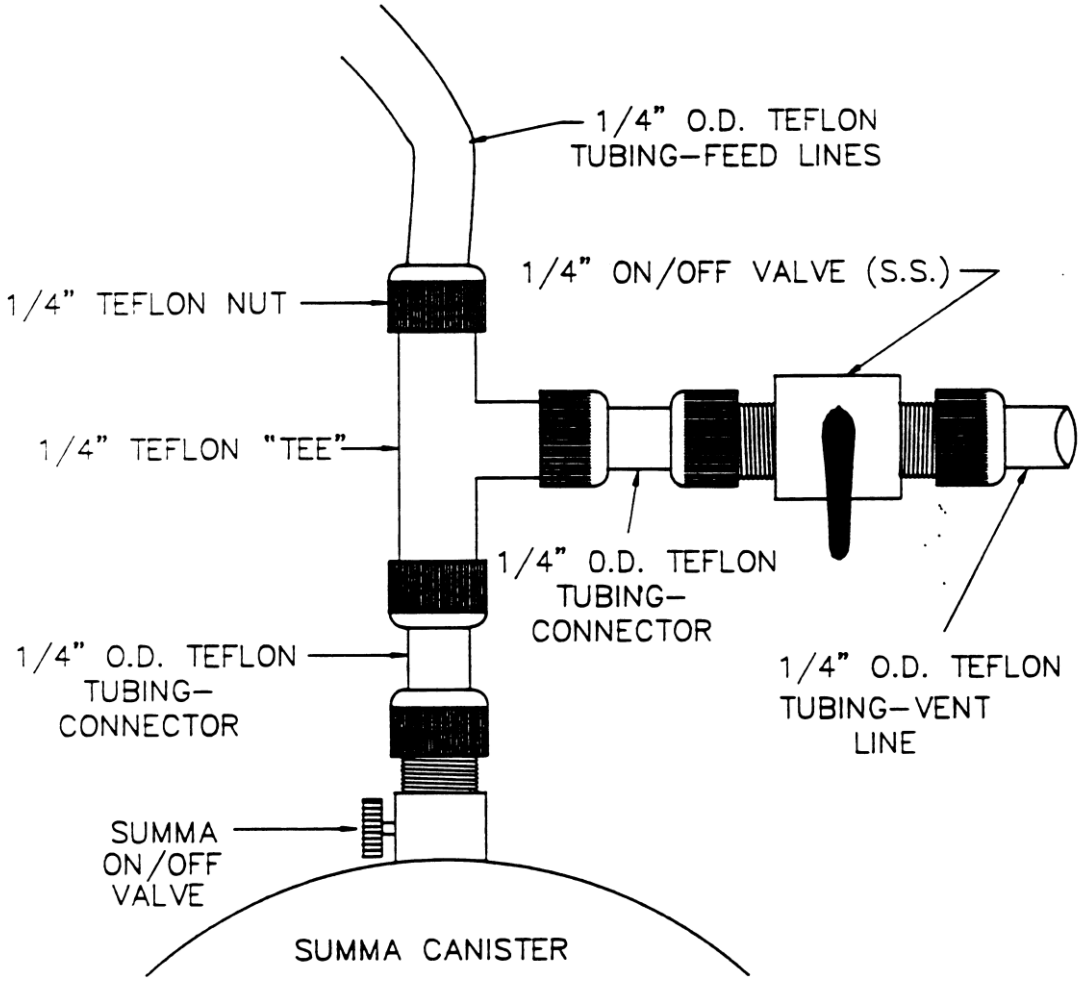


FIGURE 2. Summa Canister Charging System

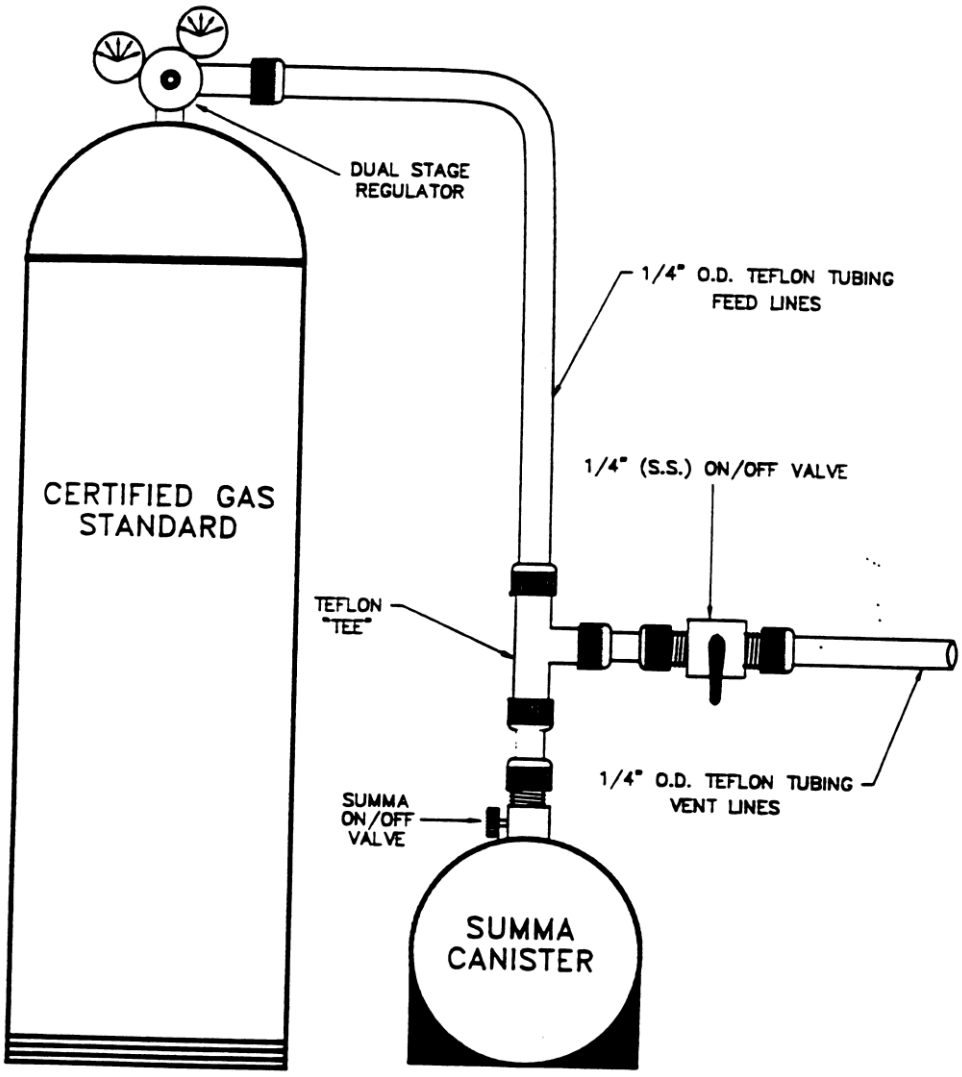


FIGURE 3. Septum "Tee" Setup

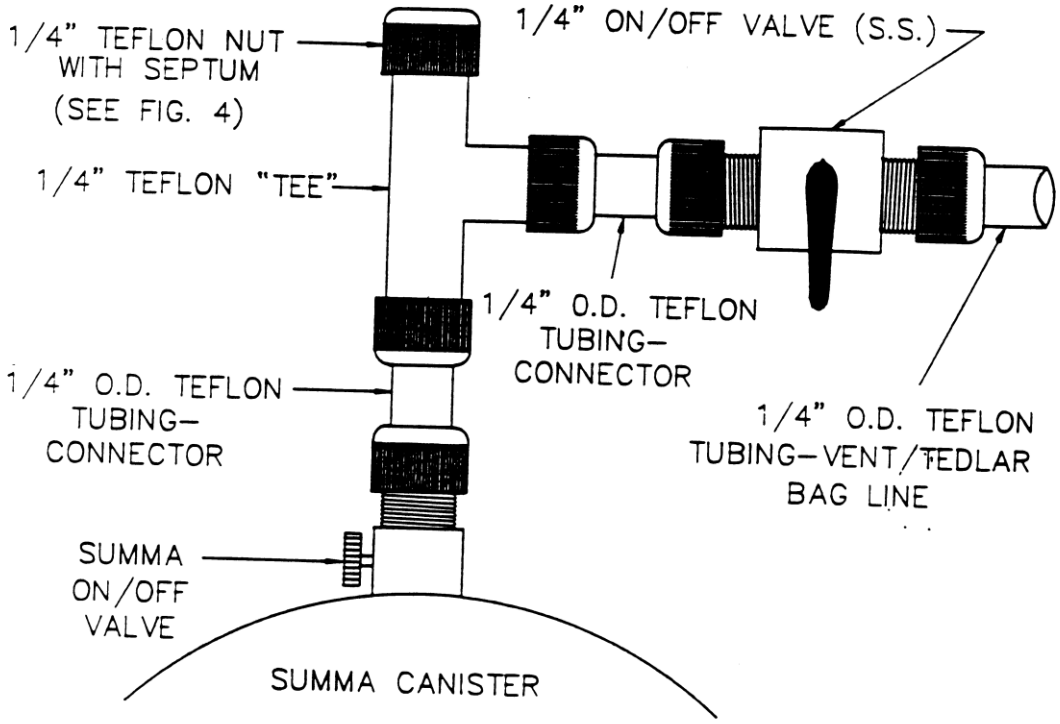
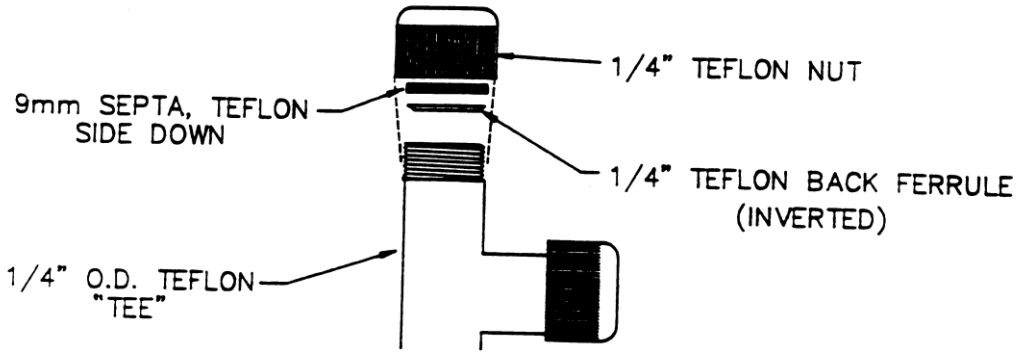


FIGURE 4. Teflon Nut with Septum



STANDARD OPERATING PROCEDURES

GENERAL FIELD SAMPLING GUIDELINES

CONTENTS

*These sections affected by Revision 0.0.

SUPERCEDES: SOP #2001; Revision 2.0; 12/19/91; U.S. EPA Contract EP-W-09-031.

GENERAL FIELD SAMPLING GUIDELINES

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide general field sampling guidelines that will assist SERAS personnel in choosing sampling strategies, location, and frequency for proper assessment of site characteristics. This SOP is applicable to all field activities that involve sampling.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling is the selection of a representative portion of a larger population, universe, or body. Through examination of a sample, the characteristics of the larger body from which the sample was drawn can be inferred. In this manner, sampling can be a valuable tool for determining the presence, type, and extent of contamination by hazardous substances in the environment.

The primary objective of all sampling activities is to characterize a hazardous waste site accurately so that its impact on human health and the environment can be properly evaluated. It is only through sampling and analysis that site hazards can be measured and the job of cleanup and restoration can be accomplished effectively with minimal risk. The sampling itself must be conducted so that every sample collected retains its original physical form and chemical composition. In this way, sample integrity is insured, quality assurance standards are maintained, and the sample can accurately represent the larger body of material under investigation.

The extent to which valid inferences can be drawn from a sample depends on the degree to which the sampling effort conforms to the project's objectives. For example, as few as one sample may produce adequate, technically valid data to address the project's objectives. Meeting the project's objectives requires thorough planning of sampling activities, and implementation of the most appropriate sampling and analytical procedures. These issues will be discussed in this procedure.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected, and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest, and are discussed in ERT/SERAS SOP #2003, Sample Storage, Preservation, and Handling, for the soil and water matrices. Sample preservation, containers, handling, and storage for air and waste samples are discussed in the specific SOPs for air and waste sampling techniques.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The nature of the object or materials being sampled may be a potential problem to the sampler. If a material is homogeneous, it will generally have a uniform composition throughout. In this case, any sample increment can be considered representative of the material. On the other hand, heterogeneous

samples present problems to the sampler because of changes in the material over distance, both laterally and vertically.

Samples of hazardous materials may pose a safety threat to both field and laboratory personnel. Proper health and safety precautions should be implemented when handling this type of sample.

Environmental conditions, weather conditions, or non-target chemicals may cause problems and/or interferences when performing sampling activities or when sampling for a specific parameter. Refer to the specific SOPs for sampling techniques.

5.0 EQUIPMENT/APPARATUS

The equipment/apparatus required to collect samples must be determined on a site specific basis. Due to the wide variety of sampling equipment available, refer to the specific SOPs for sampling techniques which include lists of the equipment/apparatus required for sampling.

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed and are summarized in ERT/SERAS SOP #2003, Sample Storage, Preservation, and Handling. Decontamination solutions are specified in ERT/SERAS SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Types of Samples

In relation to the media to be sampled, two basic types of samples can be considered: the environmental sample and the hazardous sample.

Environmental samples are those collected from streams, ponds, lakes, wells, and are off-site samples that are not expected to be contaminated with hazardous materials. They usually do not require the special handling procedures typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples.

Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree.

The importance of making the distinction between environmental and hazardous samples is two-fold:

(1) Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel.

(2) Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to the International Air Transport Association (IATA) Dangerous Goods Regulations or Department of Transportation (DOT) regulations and U.S. EPA guidelines.

7.2 Sample Collection Techniques

In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or hazardous samples.

Grab Samples

A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

Composite Samples

Composites are nondiscrete samples composed of more than one specific aliquot collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits.

Compositing is often used for environmental samples and may be used for hazardous samples under certain conditions. For example, compositing of hazardous waste is often performed after compatibility tests have been completed to determine an average value over a number of different locations (group of drums). This procedure generates data that can be useful by providing an average concentration within a number of units, can serve to keep analytical costs down, and can provide information useful to transporters and waste disposal operations.

For sampling situations involving hazardous wastes, grab sampling techniques are generally preferred because grab sampling minimizes the amount of time sampling personnel must be in contact with the wastes, reduces risks associated with compositing unknowns, and eliminates chemical changes that might occur due to compositing.

7.3 Types of Sampling Strategies

The number of samples that should be collected and analyzed depends on the objective of the investigation. There are three basic sampling strategies: random, systematic, and judgmental sampling.

Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of a site. Systematic sampling involves collection of samples based on a grid or

a pattern which has been previously established. When judgmental sampling is performed, samples are collected only from the portion(s) of the site most likely to be contaminated. Often, a combination of these strategies is the best approach depending on the type of the suspected/known contamination, the uniformity and size of the site, the level/type of information desired, etc.

7.4 QA Work Plans (QAWP)

A QAWP is required when it becomes evident that a field investigation is necessary. It should be initiated in conjunction with, or immediately following, notification of the field investigation. This plan should be clear and concise and should detail the following basic components, with regard to sampling activities:

- Objective and purpose of the investigation.
- Basis upon which data will be evaluated.
- Information known about the site including location, type and size of the facility, and length of operations/abandonment.
- Type and volume of contaminated material, contaminants of concern (including concentration), and basis of the information/data.
- Technical approach including media/matrix to be sampled, sampling equipment to be used, sample equipment decontamination (if necessary), sampling design and rationale, and SOPs or description of the procedure to be implemented.
- Project management and reporting, schedule, project organization and responsibilities, manpower and cost projections, and required deliverables.
- QA objectives and protocols including tables summarizing field sampling and QA/QC analysis and objectives.

Note that this list of QAWP components is not all-inclusive and that additional elements may be added or altered depending on the specific requirements of the field investigation. It should also be recognized that although a detailed QAWP is quite important, it may be impractical in some instances. Emergency responses and accidental spills are prime examples of such instances where time might prohibit the development of site-specific QAWPs prior to field activities. In such cases, investigators would have to rely on general guidelines and personal judgment, and the sampling or response plans might simply be a strategy based on preliminary information and finalized on site. In any event, a plan of action should be developed, no matter how concise or informal, to aid investigators in maintaining a logical and consistent order to the implementation of their task.

7.5 Legal Implications

The data derived from sampling activities are often introduced as critical evidence during litigation of a hazardous waste site cleanup. Legal issues in which sampling data are important may include cleanup cost recovery, identification of pollution sources and responsible parties, and technical validation of remedial design methodologies. Because of the potential for involvement in legal actions, strict adherence to technical and administrative SOPs is essential during both the development and implementation of sampling activities.

Technically valid sampling begins with thorough planning and continues through the sample collection and analytical procedures. Administrative requirements involve thorough, accurate

documentation of all sampling activities. Documentation requirements include maintenance of a chain of custody, as well as accurate records of field activities and analytical instructions. Failure to observe these procedures fully and consistently may result in data that are questionable, invalid and non-defensible in court, and the consequent loss of enforcement proceedings.

8.0 CALCULATIONS

Refer to the specific SOPs for any calculations which are associated with sampling techniques.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

Refer to the specific SOPs for the type and frequency of QA/QC samples to be analyzed, the acceptance criteria for the QA/QC samples, and any other QA/QC activities which are associated with sampling techniques.

10.0 DATA VALIDATION

Refer to the specific SOPs for data validation activities that are associated with sampling techniques.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

OPERATION OF THE HYDROLAB 4a WATER QUALITY MANAGEMENT SYSTEM

CONTENTS

CONTENTS (cont)

Complete Rewrite, Revision 0.0, March, 2002.

SUPERCEDES: SOP#2041; Revision 1.0; 05/05/95.

OPERATION OF THE HYDROLAB 4a WATER QUALITY MANAGEMENT SYSTEM

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the procedures for assembly, pre-calibration verification, usage, and post-use verification of the Hydrolab Surveyor 4a and Data Sonde 4a Water Quality Management System. This system is used to collect representative *in situ* water quality data. The parameters that may be quantified include: temperature in degrees Celsius (^{o}C), pH in standard units, dissolved oxygen (DO) in milligrams per liter (mg/L), conductivity in microsiemens per centimeter (□S/cm), turbidity in nephelometric turbidity units (NTU), oxidation/reduction potential (ORP) in millivolts (mV), and salinity in parts per thousand (ppt). Always refer to the Hydrolab manufacturer User's Manual for complete instructions. A copy of the User's Manual can be found in the Scientific, Engineering, Response, and Analytical Services (SERAS) Biological Laboratory, Edison, New Jersey.

2.0 METHOD SUMMARY

The Hydrolab 4a Water Quality Management System calibration is verified prior to data collection in the field. The instrument calibration will also be verified immediately following field usage. Water quality data collected *in situ* will be transcribed from the digital display into a field logbook at the time of collection, as per SERAS SOP #4001, *Logbook Documentation.*

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Water should be monitored *in situ.* However, if it is necessary to collect a sample in a container for monitoring, the container should be clean and large enough for the probe end of the instrument to be completely submerged without coming into contact with the sides or bottom of the container. Monitoring should be performed as soon as possible; preservatives should not be used since that may alter the physical/chemical properties of the water.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Prior to field assembly, the battery must be checked and charged if less than 10.5 volts (v). A bad or poorly charged battery will give inaccurate measurements. If any parameters begin to drift during field measurements, consult the Hydrolab Surveyor 4a or Data Sonde 4a Operating Manual: Troubleshooting Section, or call Technical Support at the HydroLab Corporation at 1-800-949-3766.

It is important to complete the instrument calibration verification procedures as soon as possible, without interruption at or near the sampling location/site base station. Changes in barometric pressure, altitude, or ambient air temperature as a result of moving the instrument to a new location, or allowing too much time to pass will affect the accuracy of the instrument.

5.0 EQUIPMENT/APPARATUS

The following equipment is required:

- Hydrolab 4a Water Quality Management System (Surveyor 4a and Data Sonde 4a)
- pH maintenance kit
- DO maintenance kit
- Scissors or pocket knife (for trimming DO membrane)

- National Institute of Standards and Technology (NIST) traceable hydrometer and 1000 milliliter (mL) graduated cylinder
- NIST traceable thermometer
- Ring stand
- Clamp
- Barometer/Altimeter
- Logbook
- Storage/calibration cup with cap
- Graduated cylinders, 250 mL, 1000 mL or equivalent
- Scissors or pocket knife (for trimming membrane in Section 7.6.1)
- Soft paper wipes
- Two gallon bucket (or similar)
- Rope
- Bail (connects rope to instrument for lowering and raising out of water)

6.0 REAGENTS

The following reagents are required for proper calibration verification/operation of the Hydrolab 4a System:

- Deionized or distilled water
- Potassium chloride (KCl) solution, 3 Molar (3 M), saturated with silver chloride (AgCl)
- KCl solution (2 M)
- NIST traceable pH buffer solutions (4.00, 7.00, and 10.00 standard units)
- NIST traceable turbidity solution 40 NTUs
- NIST traceable conductivity solutions (100 µS, 1000 µS, or anticipated field range)
- Zobell's solution (redox calibration solution)
- Manganous sulfate solution
- Alkaline-iodide-sodium azide reagent
- Concentrated sulfuric acid
- 0.025Normal (N) sodium thiosulfate solution
- Starch indicator solution

7.0 PROCEDURES

7.1 Assembly

There are three major components of the Hydrolab 4a System: the Surveyor 4a, the calibration or data cable, and the Data Sonde 4a. Connect the calibration or data cable to the Data Sonde 4a. The user must align the larger pin on the Data Sonde 4a male connector to the indicator dots on the cable's marine connector. Do not force the pins into the connectors. Connect the remaining end of the cable to the Surveyor 4a. The HydroLab 4a System is now ready for calibration verification and use.

7.2 Calibration Verification

7.2.1 Pre-verification Procedures

Pre-verification for the following parameters is performed in the laboratory prior to transporting the instrument to the sampling site: pH, conductivity, DO, and turbidity. Assemble a ring stand and clamp to support the Data Sonde 4a. Prior to clamping the Data Sonde 4a, hold the unit with the storage cup down, unscrew the cup, and discard any water in the cup. It is important that when verifying calibration of the HydroLab 4a System, only NIST-traceable standards are used. Before deployment of the instrument on site these parameters should be checked, and if necessary adjusted. In addition, the current barometric pressure should be checked using a barometer. If the value is different than what is programmed into the instrument, DO measurements will be incorrect; adjust the barometric pressure value as necessary. If salinity and depth measurements are required, these verifications are also performed on site prior to deployment.

7.2.2 Dissolved Oxygen Calibration Verification

Prior to DO verification, determine the local absolute barometric pressure in millimeters of mercury (mm Hg) using a barometer/altimeter (the Hydrolab will later "ask" the user to enter the barometric pressure). Next, vigorously aerate approximately 3.0 liters (L) of deionized or distilled water using an aquarium air stone and pump for approximately one hour, and determine the DO of the aerated water by Winkler titration.

The steps for a Winkler titration as per Standard Methods, 1992 are as follows:

1. Fill three separate 300 mL Biological Oxygen Demand (BOD) bottles with aerated water being sure to exclude any air bubbles.

2. Add 1.0 mL of manganous sulfate solution below the water surface in each bottle.

3. Add 1.0 mL alkaline-iodide-sodium azide reagent below the water surface in each bottle.

4. Stopper the bottles so that a complete seal is obtained, and invert the bottles 15 times.

5. Allow the precipitate to settle halfway, invert the bottles an additional 15 times, and let settle again.

6. Remove the stoppers and add 1.0 mL of concentrated sulfuric acid.

7. Stopper the bottles and mix gently by inversion until dissolution is complete.

8. Decant 201 mL of the solution into a 300-mL beaker or similar container.

9. Titrate the solution with 0.025 N sodium thiosulfate to a pale straw yellow color.

10. Add 1.0 mL of starch indicator solution (solution will turn blue in color).

11. Continue titrating until the first disappearance of the blue color.

12. For every one mL of sodium thiosulfate used, 1.0 mg/L of DO is present in the

water.

13. Repeat steps 8 to 12 with the other two bottles.

14. Average the three concentrations of DO measured in each bottle to get the actual DO of the aerated water sample. Verify that the DO concentration obtained using the average of the three bottles matches with the correct DO concentration on the oxygen solubility/temperature/salinity conversion table, which is included in each Hydrolab 4a System storage/transport case.

Pour off the water in the calibration cup, and refill the cup with the aerated deionized or distilled water so the level is above the DO sensor. Agitate the Data Sonde 4a, making sure no air bubbles adhere to the sensor. Select "Setup/Cal" on menu of the Surveyor 4a; then select "Calibrate"; then select "Sonde"; and then toggle down the menu to "DO: mg/L" and select "Select". Adjust the display to read the average DO concentration of the aerated water used. This completes the calibration verification of the DO system.

7.2.3 Conductivity Calibration Verification

Rinse the calibration cup and sensors with deionized or distilled water followed by a small amount of the 100 µS conductivity solution, and refill the cup above the conductivity sensor with the 100 µS conductivity solution. Agitate the Data Sonde 4a, making sure no air bubbles adhere to the sensor. Select "Setup/Cal" on menu of the Surveyor 4a; then select "Calibrate"; then select "Sonde"; and then toggle down the menu to "SpCond: µS" and select "Select". Adjust the display to read the conductivity of the standard solution used. Discard the conductivity standard solution and rinse with deionized or distilled water. Repeat the following procedure using the 1000 µS conductivity solution and discard after use. This completes the calibration verification of the conductivity system.

7.2.4 pH Calibration Verification

Rinse the calibration cup and sensors with deionized or distilled water followed by a small amount of the 7.00 pH buffer solution, and refill the cup above the pH sensor with the 7.00 pH buffer solution. Agitate the Data Sonde 4a, making sure no air bubbles adhere to the sensor. Select "Setup/Cal" on menu of the Surveyor 4a; then select "Calibrate"; then select "Sonde"; and then toggle down the menu to "pH:Units" and select "Select". Adjust the display to read 7.00. Discard the pH 7.00 buffer solution and rinse the cup and sensors with deionized or distilled water. Repeat the procedure using the 4.0 pH buffer solution or 10.0 pH buffer solution and discard after use. The second buffer solution used should be closest to the expected range of pH at the field site. If surface water is expected to have a pH below 7.0, the second buffer used should be the 4.0 buffer. If the surface water is expected to be above 7.0 (as in brackish or marine systems) the second buffer used should be the 10.0 buffer. This completes the calibration verification of the pH system.

7.2.5 Turbidity Calibration Verification

Rinse the calibration cup with deionized or distilled water followed by a small amount of

the 40.0 NTU turbidity standard and refill the cup above the turbidity sensor with the 40.0 NTU turbidity standard. It is important to slowly pour the turbidity standard in as not to introduce air bubbles. Agitate the Data Sonde 4a, making sure no air bubbles adhere to the sensor. Select "Setup/Cal" on menu of the Surveyor 4a; then select "Calibrate"; then select "Sonde"; and then toggle down the menu to "Turb:NTUs" and select "Select". Adjust the display to read the turbidity of the standard solution used (40 NTU). Discard the turbidity standard solution and rinse with deionized or distilled water. This completes the calibration verification of the turbidity system.

7.2.6 Oxidation Reduction Potential Calibration Verification

Rinse the calibration cup and sensors with deionized or distilled water followed by a small amount of the Zobell's solution, and refill the cup above the ORP sensor with Zobell's solution. Agitate the Data Sonde 4a, making sure no air bubbles adhere to the sensor. Select "Setup/Cal" on menu of the Surveyor 4a; then select "Calibrate"; then select "Sonde"; and then toggle down the menu to "ORP:mV" and select "Select". Adjust the display to read the ORP of the standard solution used. Discard the ORP standard solution and rinse with deionized or distilled water. This completes the calibration verification of the ORP system.

7.2.7 Salinity Calibration Verification

Salinity calibration is done using water collected from the area to be sampled as the calibration solution. Prior to salinity calibration, fill a 1000-mL graduated cylinder (or equivalent) with the collected water, and measure the temperature of the water using a NIST traceable thermometer. Place a hydrometer into the graduated cylinder, and record the specific gravity (read at the base of the meniscus). Using the temperature and specific gravity readings, look up the salinity of the water on a standard specific gravity/temperature/density/salinity conversion table that is kept in each Hydrolab 4a System storage/transport case.

Rinse the calibration cup and sensors with deionized or distilled water, and refill the cup above the conductivity sensor with the water of a known salinity. Agitate the Data Sonde 4a, making sure no air bubbles adhere to the sensor. Select "Setup/Cal" on menu of the Surveyor 4a; then select "Calibrate"; then select "Sonde"; and then toggle down the menu to "Sal:ppt" and select "Select". Adjust the display reading to the salinity of the water used. Discard the water and rinse with deionized or distilled water. This completes the calibration verification of the salinity system.

7.2.8 Depth Calibration Verification

Place the Data Sonde 4a just above the surface of the water. Select "Setup/Cal" on menu of the Surveyor 4a; then select "Calibrate"; then select "Sonde"; and then toggle down the menu to "Dep100:meters" and select "Select". Adjust the display reading to "0". This completes the calibration verification of the depth system.

7.3 Field Measurements

Remove the calibration or storage cup, thread on the weighted guard, attach the bail and an

appropriate length of rope, and place the Data Sonde 4a in the water. Do not use the data cable as a means of lowering and/or retrieving the Data Sonde 4a. Always allow ample time for the readings to stabilize to ensure accurate readings. Record these parameters in a field logbook. When measurements are complete, remove the weighted guard and replace the storage cup (half filled with water). Never allow the sensors to dry out. After all measurements are complete, rinse the probes several times with distilled water and replace the storage cup, with approximately 50 mL of tap water.

7.4 Post-Use Verification

Follow the same procedures for initial calibration verification except instead of adjusting the display unit to read the correct parameter value, record the readings for each parameter, without adjustment into a logbook. This is important; post-verification insures the reliability of the field measurements by demonstrating that the instrument calibration did not drift throughout the sampling period. Any significant deviations in the calibration status of the instrument should be incorporated into the final interpretation of the water quality data.

7.5 Decontamination

The following steps describe the procedure to decontaminate and clean the Hydrolab 4a System. These steps should be followed for any contaminants noticeably accumulated on the Data Sonde 4a unit or any of the individual probes.

1. Wipe the entire Data Sonde 4a unit and the data cable with a cloth and mild liquid detergent solution and rinse them with clean water. If necessary, a soft brush or cotton swab may be used to clean between the probes. Repeat this step as many times as necessary to remove all visible contamination.

2. Add deionized or distilled water to the storage cup and fasten to the Hydrolab.

3. Agitate the instrument to further remove any contaminants.

4. Once all visible contamination is removed, the pH probe must be cleaned.

5. Polish the pH probe with lens cleaner or a cotton swab. Do not use abrasive cloths to polish these probes.

6. Repeat Steps 2 through 5 until the probes are clean. **Do not use acetone, organic solvents, nitric acid or harsh detergents to clean the instrument**. Once the unit is clean, it is ready for calibration verification or for storage, following the procedures outlined in Section 7.2.

7.6 General Maintenance

7.6.1 DO Sensor

The membrane on the DO probe should be replaced on a regular basis (approximately every 3 to 4 months), or when needed (e.g., damaged, or contaminated) using the membranes and standard electrolyte provided in the factory maintenance kit located in

each Hydrolab 4a System storage/transport case. The following are steps for regular DO probe maintenance:

1. Turn the Data Sonde unit so that the probes are facing up and secure with ring stand and clamp.

1. Remove the o-ring on the DO sensor, remove the old membrane, and discard.

2. Pour off old electrolyte solution. Rinse the DO sensor with deionized water and add fresh DO electrolyte fluid (2M KCl) until overflowing, and a meniscus forms above the sensor.

3. Place a new membrane over the DO sensor. Handle the new membrane by the edges, using tweezers if necessary (fingerprints may affect the measurements).

4. Once the membrane is in place, slip the o-ring over the probe until the o-ring fits into the groove on the DO probe. Make sure there are no air bubbles trapped under the membrane.

5. Carefully trim away the excess membrane.

7.6.2 pH Reference Electrode

The pH reference solution should be replaced on a regular basis (approximately every 3 to 4 months) using the standard electrolyte provided in the factory maintenance kit located in each Hydrolab 4a System storage/transport case. The following are steps for regular maintenance of the pH reference electrode:

1. Turn the Data Sonde 4a unit so the probes are facing up and secure with the ring stand and clamp.

2. Unscrew the Teflon® junction cap, and pour out the old electrolyte solution.

3. Refill the reference electrode housing with fresh electrolyte solution (3M KCL saturated with $AgCl_2$) and rinse.

4. Refill again with fresh electrolyte solution making sure no air bubbles are trapped, and screw the Teflon junction cap back on.

7.6.3 Other Sensors

The remaining sensors should be cleaned when needed following the procedures outlined in Section 7.5.

7.6.4 Sensor Replacement

Sensor replacement is only needed when a sensor is damaged or malfunctions, and is not part of regular scheduled maintenance. The following are steps for sensor replacement:

1. Remove the screws on the Data Sonde 4a pressure housing with an Allen key, and pull out the internal circuit board.

2. Remove the screws on the retainer brackets located at the base of the pressure housing, and locate the sensor to be replaced. This is done by following the wires leading from the base of the sensor to the pins on the circuit board.

3. Unplug and carefully remove the sensor.

4. Lubricate the O rings on the new sensor with silicon grease, and insert (wires first) into the base of the pressure housing.

5. Plug the new sensor into the pins on the circuit board.

6. Tighten the retainer brackets.

7. Carefully slide the internal circuit board back into the Data Sonde4a pressure housing and tighten the screws.

8. Verify calibration of the instrument as per Section 7.2.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following QA/QC procedures apply:

1. Equipment will have its calibration verified prior to and after field measurements as per Sections 7.2 and 7.4.

2. All data must be documented in field logbooks as per SERAS SOP #4001, *Logbook Documentation.*

3. All maintenance must be recorded in the instrument logbook included in each Hydrolab 4a System storage/transport case.

4. Record the manufacturer lot numbers and expiration dates of all standards used in the instrument logbook. Ensure standards and solutions are used before their expiration dates.

10.0 DATA VALIDATION

Results of the post field deployment checks will be evaluated for instrument drift. This information will be utilized to qualify the environmental sample results accordingly with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health Administration (OSHA), and corporate health and safety procedures. More specifically, refer to SERAS

SOP #3001, *SERAS Health and Safety Program Policy and Implementation*.

12.0 REFERENCES

Clesceri, L.S., A.E. Greenberg, and R.R. Trussell, Editors. *Standard Methods for the Examination of Water and Wastewater*. 1992. 18th ed., 4500-O, Azide Modification, 4-152-4-153.

Hydrolab Corporation. 1999. *Surveyor 4 Water Quality Data Display User's Manual*, Revision D.

Hydrolab Corporation. 1999. *Data Sonde 4 and MiniSonde Water Quality Multiprobes User's Manual,* Revision G.

13.0 APPENDICES

This section is not applicable to this SOP.

SOIL GAS SAMPLING

CONTENTS

CONTENTS (cont'd)

* These sections are affected by Revision 0.0

SOIL GAS SAMPLING

1.0 SCOPE AND APPLICATION

Soil gas monitoring provides a quick means of detecting volatile organic compounds (VOCs) in the soil subsurface. Using this method, underground VOC contamination can be identified, and the source, extent, and movement of pollutants can be traced.

This standard operating procedure (SOP) outlines the methods used for the installation of soil gas wells; the collection of soil gas using Tedlar bags, sorbent tubes, and/or Summa canisters; and measurement of organic vapor levels in the soil gas using a Photo Ionization Detector (PID), Flame Ionization Detector (FID) and/or other air monitoring devices.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute United States Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

A d-inch (")diameter hole is driven into the ground using manual (i.e., slam bar) or power driven mechanical (i.e., Geoprobe) methods. Soil gas can be sampled at specific depths by controlled penetration and/or the use of a longer bar or bar attachments. A ¼"outer diameter (O.D.) stainless steel probe is inserted into the hole. The hole is sealed around the top of the probe using clean modeling clay. The gas contained in the interstitial spaces of the soil is pulled through the probe using an air sampling pump. The sample may be stored in Tedlar bags, drawn through sorbent cartridges, or analyzed directly using a field portable instrument such as a PID. An air sampling pump is not used for Summa canister sampling of soil gas; sampling is achieved by soil gas equilibration with the evacuated Summa canister.

Power driven mechanical devices may be used to make holes when conditions make the use of manual devices unfeasible (i.e., frozen ground, very dense clays, pavement, etc.). Commercially available soil gas sampling probes (hollow, ½" O.D. steel probes) can be driven to the desired depth using a power hammer (e.g., demolition hammer or Geoprobe). Soil gas samples can be drawn through the probe itself, or through Teflon tubing inserted through the probe and attached to the probe point. Samples are collected and analyzed as described below.

Other field air monitoring devices, such as the Combustible Gas Indicator (CGI) and the Organic Vapor Analyzer (OVA), can also be used, depending on specific site conditions. Measurement of soil temperature using a temperature probe may also be desirable. Bagged samples may be analyzed in a field laboratory using portable gas chromatography (GC) instrumentation, or shipped to a laboratory using an overnight service.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Tedlar Bags

Soil gas samples are generally collected in 1.0-liter (L) Tedlar bags. Bagged samples should be stored in the dark (i.e., in opaque containers) and protected from mechanical damage during transit

to the laboratory. Further, bagged samples should be maintained at ambient temperature by placing them in coolers and out of direct sunlight. Samples should be analyzed as soon as possible, preferably within 24 to 48 hours following sample collection. Refer to ERT/SERAS SOP# 2102, *Tedlar Bag Sampling*, for additional information.

3.2 Sorbent Tubes

Soil gas can be drawn directly onto sorbent tubes (i.e., Tenax tubes) and analyzed by Gas Chromatography/Mass Spectrometer (GC/MS) methodologies. Bagged samples can also be drawn onto tubes. If sorbent tubes are to be used, special care must be taken to avoid contamination. Refer to ERT/SERAS SOP# 2104, *Tenax/CMS Tube Sampling*, for additional information. Samples should be refrigerated at 4 ^{o}C during storage and analyzed within 30 days of collection. Samples taken on multi-sorbent tubes should be analyzed as soon as possible after sampling.

3.3 Summa Canisters

The Summa canisters used for soil gas sampling have a 6-L sample capacity and are certified clean by GC/MS analysis before being used in the field. After sampling is completed, they are stored and shipped in travel cases. Most volatile organic compounds (VOCs) can be recovered from canisters with minimal loss up to thirty days. Refer to ERT/SERAS SOP# 1704, *Summa Canister Sampling*, for additional information.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

4.1 PID Measurements

A number of factors specific to soil gas can affect the response of a PID (e.g., HNu PI 101). High humidity can cause lamp fogging and decreased sensitivity. This can occur when soil moisture levels are high, or when a soil gas probe is in the saturated zone. High concentrations of methane can cause a downscale deflection of the meter. High and low temperature, electrical fields, FM radio transmission, and naturally occurring compounds, such as terpene hydrocarbons in wooded areas, will affect instrument response. Refer to ERT/SERAS SOP# 2114, *Photoionization Detector (PID) HNu* for additional information.

4.2 FID Measurements

A number of factors specific to soil gas can affect the response of an FID (e.g., OVA Model 128). High humidity can cause the FID to flame out or not ignite at all. This can be significant when soil moisture levels are high, or when a soil gas probe is in the saturated zone. The FID can only read organic based compounds (they must contain carbon in the molecular structure). The FID also responds poorly to hydrocarbons and halogenated hydrocarbons (such as gasoline, propane fuel). High and low temperature, electrical fields and FM radio transmission will also affect instrument response. Consult the instrument manual for additional information.

4.3 Factors Affecting the Concentrations of Organic Compounds in Soil Gas

Concentrations of organic compounds in soil gas can be affected by the physical and chemical characteristics of the soil and by soil moisture. Organic molecules can be tightly adsorbed to the

surface of chemically active soil particles, such as clays, thus reducing the concentration in the soil interstitial spaces. Similarly, some organic compounds can be dissolved in the soil water or associated with soil organic components (i.e., humic acids).

Soil porosity and permeability will affect the movement of soil gas and the recharge rate of the soil gas well. The movement of organic vapors through fine textured soil may be very slow, thus limiting the sample volume available and the use of this technique. Existing information and soil surveys prepared by the Soil Conservation Service should be consulted prior to planning and designing a soil gas survey.

The presence of a high, or perched water table, or of an impermeable underlying layer (such as a clay lens or layer of buried slag) may interfere with the movement and sampling of the soil gas. Knowledge of site geology is useful in such situations, and can prevent inaccurate sampling.

4.4 Soil Probe Clogging

A common problem with the soil gas sampling is clogging of the probe. A clogged probe can be identified by using an in-line vacuum gauge or by listening for the sound of the pump laboring. This problem can usually be eliminated by using a wire cable to clear the probe (see Section 7.1.3.).

4.5 Underground Utilities

Prior to selecting sample locations, an underground utility search must be completed. The local utility companies can be contacted and requested to mark the locations of their underground lines. Each sample location should also be screened with a metal detector or magnetometer to verify that no underground metallic or ferro-magnetic pipes or drums are present.

5.0 EQUIPMENT/APPARATUS

5.1 Slam Bar Method

- Slam bar
- Soil gas probes: stainless steel tubing, 1/4" O.D., 5-foot (ft) length
- Flexible wire or cable
- "Quick Connect" fittings
- Modeling clay.
- Vacuum box
- Pumps, capable of drawing approximately 3.0 L/min
- ¼" Teflon tubing, 2-ft to 3-ft lengths
- ¼" Tygon tubing
- Tedlar bags, 1.0-L
- Sample documentation (soil gas sample labels, field data sheets, logbook, etc.)
- PID/FID, or other field air monitoring devices
- Cooler(s)
- Metal detector or magnetometer
- Portable GC instrument
- Summa canisters (plus shipping cases)

- Large dark plastic bags

5.2 Power Hammer Method

- Power (Demolition) hammer
- ½" O.D. steel probes, extensions, and points
- Dedicated aluminum sampling points
- ¼" Teflon tubing, 2-ft to 3-ft lengths
- "Quick Connect" fittings
- Modeling clay.
- Vacuum box
- Pumps, capable of drawing approximately 3.0 L/min
- ¼" Tygon tubing
- Tedlar bags, 1.0-L
- Sample documentation (soil gas sample labels, field data sheets, logbook, etc.)
- PID/FID or other field air monitoring devices
- Cooler(s)
- Metal detector or magnetometer
- Portable GC instrument
- Summa canisters (plus shipping cases)
- Generator w/extension cords.
- High lift jack assembly
- Large dark plastic bags

5.3 Direct-Push (Geoprobe) Method

- Tubing; polyethylene, Teflon, or stainless steel
- Gas sampling cap
- robe rods
- Tubing adaptor(s)
- Expendable point holder, threaded
- Expendable drive point(s)
- O-rings for expendable point holder
- O-rings for adaptor
- O-rings for probe rods
- O-rings for gas sampling cap
- Vacuum pumps
- Tape
- Tedlar bags, 1.0-L
- Summa canisters (plus shipping cases)
- Sample documentation (soil gas labels, field data sheets, logbook, etc.)
- Metal detector or magnetometer
- Cooler(s)
- Large dark plastic bags
- Portable GC instrument

6.0 REAGENTS

- Calibration and spike gases
- Deionized, organic-free water
- Methanol, High Performance Liquid Chromatography (HPLC) grade
- Ultra-zero grade compressed air
- Propane torch

7.0 PROCEDURES

7.1 Soil Gas Probe Installation

7.1.1 Slam Bar Method

1. A hole slightly deeper than the desired sampling depth is made. For sampling up to 5 feet, a 5-ft single piston slam bar is used. For deeper depths, a piston slam bar with threaded 4-ft-long extensions is used.

2. The tip of the rod is placed on the ground and the piston of the slam bar is used to drive the rod to the desired depth. The number of blows required to reach the desired depth is recorded.

3. After the hole is made, the slam bar is carefully withdrawn to prevent the collapse of the walls.

4. The soil gas probe is carefully inserted into the hole. To prevent plugging of the probe, a decontaminated metal wire or cable, slightly longer than the probe and with an O.D. slightly less than the inner diameter (I.D.) of the rod, is inserted in the probe rod; 1- to 2-inches of wire should protrude from the end of the probe. The probe is inserted to full depth of the hole, then pulled up three to six inches. The probe is cleared by moving the cable up and down several times.

5. The top of the sample hole is sealed at the surface to prevent infiltration of ambient air. A golf-ball size lump of clean modeling clay is kneaded until it becomes soft. The clay is carefully molded around the probe at the soil surface to seal the space between the probe and the hole.

6. If semi-permanent soil gas installations are required, the probe remains in the hole, which may be sealed by backfilling with clean sand, soil, or bentonite.

7.1.2 Power Hammer Method

1. A power hammer may be used to make holes when the soil is very hard, frozen or fine textured (clay), or when soil gas from beneath pavement or concrete is collected.

2. A power hammer is used to drive the probe to the desired depth (up to 12 feet may be attained with extensions). Threaded extensions are added until the desire depth is needed.

3. After the hole is made, the threaded rod is carefully withdrawn. This should be done

in such a manner to prevent collapse of the walls. If necessary, a jack assembly may be used to retrieve the rods.

4. The soil gas probe is installed in the hole as described in Section 7.1.1, Steps 4 and 5.

5. If semi-permanent soil gas installations are required, the probe remains in the hole, which may be sealed by backfilling with clean sand, soil, or bentonite.

7.1.3 Direct-Push Method

1. Direct-push sampling technology refers to soil gas samplers that are inserted into the ground without the use of slam bars, demolition hammers, or drilling rigs. The U.S. EPA/ERT utilizes a Direct-Push unit mounted on an all-terrain track mounted vehicle, and direct push tools. These tools are able to collect samples at depths greater than 50 feet, depending on soil conditions.

2. Sampling probes, consisting of 3-foot sections of flush-threaded, 1¼-inch hardened steel alloy steel rod tipped by an expendable steel point, are driven into the ground to the target depth. The probe tools are withdrawn to release the expendable tip and allow soil gas to flow into the tool's tubing.

3. To ensure a representative soil gas sample, a discrete volume of gas is purged to rid the tubing of atmospheric air and allow the subsurface soil gas to enter the probe tubing. The volume of gas removed is determined by the volume of tubing employed in the probe. (Unlike groundwater sampling, purging of a soil gas probe is designed to remove only the ambient air within the tubing.)

4. After allowing the system to return to atmospheric pressure, an aliquot of soil gas is withdrawn from the probe. Duplicate samples are collected as necessary and required.

5. If semi-permanent soil gas installations are required, the probe remains in the hole, which may be sealed by backfilling with clean sand, soil, or bentonite.

7.2 Screening with Field Instruments

1. It is recommended that any appropriate SOPs and the manufacturers' manuals be consulted for the correct use and calibration of all instrumentation. Pumps should be calibrated prior to use in the field.

2. An amount of air, equivalent to the volume of the soil gas well must be calculated prior to sampling. Connect a vacuum pump to the sample probe using a section of Teflon tubing. The pump is turned on and adjusted to a flow rate of 3.0 L/minute. The calculated volume of air is evacuated from the hole by pulling a vacuum through the probe for the specified length of time. Longer time is required for sample wells of greater depths.

3. After evacuation, a monitoring instrument (i.e. HNu or OVA) is connected to the probe using a Teflon connector. Upon stabilization, the reading is recorded on soil gas data sheets.

4. Readings may be above or below the range set on the field instruments. The range may be reset, or the response recorded as a greater than or less than figure. The recharge rate of the well with soil gas must be considered when resampling at a different range setting.

7.3 Tedlar Bag Sampling

1. Follow step 1 of section 7.2 to evacuate well volume. If air monitoring instrument screening was performed prior to sample collection, evacuation is not necessary.

2. Use the vacuum box and sampling train (Figure 1) to collect the sample. The sampling train is designed to minimize the introduction or loss of contaminants due to adsorption and other factors. All parts used are either Teflon or stainless steel, and a vacuum is drawn indirectly to avoid contamination from sample pumps.

3. Place the Tedlar bag inside the vacuum box, attach it to the sampling port and open the valve. The sample probe is attached to the sampling port via Teflon tubing and a "Quick Connect" fitting.

4. Draw a vacuum around the outside of the bag, using a pump connected to the vacuum box evacuation port, via Tygon tubing and a "Quick Connect" fitting. The negative pressure inside the box causes the bag to inflate, drawing the sample into the bag.

5. Break the vacuum by removing the Tygon line from the pump. Remove the bagged sample from the box and close the valve. Record the date, time, sample location ID, and the PID/FID instrument reading(s) on sample bag label and on data sheets or in logbooks.

6. Bags should not be labeled directly with a marker or pen (particularly those containing volatile solvents) nor should adhesive labels be affixed directly to the bags. Inks and adhesive may diffuse through the bag material and contaminate the sample. Labels should be tied to the metal eyelets provided on the bags.

Chain of custody sheets must accompany all samples.

7.4 Sorbent Tube Sampling

Samples collected in Tedlar bags may be adsorbed onto sorbent tubes for further analysis by GC/MS.

7.4.1 Additional Apparatus

- Syringe, with a Luer-lock tip, capable of drawing a soil gas or air sample from a Tedlar bag onto a sorbent tube. The syringe capacity is dependent upon the volume of sample being drawn onto the tube.

- Adapters, for fitting the sorbent tube between the Tedlar bag and the sampling syringe. The adapter attaching the Tedlar bag to the sorbent tube consists of a reducing union (¼" to 1/16" O.D. - Swagelok cat. # SS-400-6-ILV or equivalent) and a length of ¼" O.D. Teflon tubing, which replaces the nut on the 1/16" (Tedlar bag) side. A ¼" I.D. Teflon or silicone O-ring replaces the ferrules in the nut on the

¼" (sorbent tube) side of the union.

- The adapter, attaching the sampling syringe to the sorbent tube, consists of a reducing union (¼" to 1/16" O.D. - Swagelok Cat. # SS-400-6-ILV or equivalent) and a ¼" I.D. Teflon or silicone O-ring, which replaces the ferrules in the nut on the ¼" (sorbent tube) side and the needle of a Luer-lock syringe inserted into the 1/16" side (held in place with a 1/16" ferrule). The Luer-lock end of the needle can be attached to the sampling syringe. It is useful to have a Luer-lock on/off valve situated between the syringe and the needle.

- Two-stage glass sampling cartridge (¼" O.D. x c" I.D. x 5c") contained in a flame-sealed tube containing two sorbent sections retained by glass wool:

- Teflon-capped culture tubes or stainless steel tube containers for sorbent tube storage and shipping. These containers should be conditioned by baking at 120^{o} C for at least two hours. The culture tubes should contain a glass wool plug to prevent sorbent tube breakage during transport. Reconditioning of the containers should occur between uses or after extended periods of disuse (i.e., two weeks or more).

- Nylon gloves or lint-free cloth. (Hewlett Packard Part # 8650-0030 or equivalent.)

7.4.2 Sample Collection

- Handle sorbent tubes with care, using nylon gloves (or other lint-free material) to avoid contamination.

- Immediately before sampling, break one end of the sealed tube and remove the sorbent cartridge.

- Connect the valve on the Tedlar bag to the sorbent tube adapter. If using a Tenax/CMS sorbent tube, connect the sorbent tube to the sorbent tube adapter with the Tenax (white granular) side of the tube facing the Tedlar bag. Connect the sampling syringe assembly to the carbon molecular sieve [CMS (black)] side of the sorbent tube. Fittings on the adapters should be finger-tight. Open the valve on the Tedlar bag. Open the on/off valve of the sampling syringe. Depending on work plan stipulations, at least 10% of the soil gas samples analyzed by field screening methods must be submitted for confirmation GC/MS analysis (according to a modified TO-17method for sorbent tubes). Each soil gas sample must be absorbed on replicate sorbent tubes. The volume adsorbed on a sorbent tube is dependent on the total concentration of the compounds measured by field screening methods as follows:

Total Concentration (ppm)	Sample Volume (mL)
>10	Use Serial Dilution
10	10-50
5	20-100
1	100-250

- After sampling, remove the tube from the sampling train with gloves or a clean

cloth. DO NOT LABEL OR WRITE ON THE SORBENT TUBE.

- Place the sorbent tube in a conditioned stainless steel tube holder or culture tube. Culture tube caps should be sealed with Teflon tape.
- Each sample tube container (not tube) must be labeled with the site name, sample number, date sampled, and volume sampled. Verify that all sample containers are properly labeled.
- Chain of custody sheets must accompany all samples to the laboratory.

7.5 Summa Canister Sampling

1. Follow Section 7.2, step 1, to evacuate well volume. If PID/FID readings were taken prior to taking a sample, evacuation is not necessary.
2. Attach a certified clean, evacuated 6-L Summa canister via the ¼" Teflon tubing.
3. Open valve on Summa canister. The soil gas sample is drawn into the canister by pressure equilibration. The approximate sampling time for a 6-L canister is 20 minutes.
4. Sample number, sample location, date collected and work assignment number must be recorded on a chain of custody form and on a blank tag attached to the canister.
5. Chain of custody sheets must accompany all samples to the laboratory.

8.0 CALCULATIONS

8.1 Field Screening Instruments

Instrument readings are usually read directly from the meter. In some cases, the background level at the soil gas location may be subtracted:

Final Reading = Sample Reading - Background Reading

8.2 Field Portable GC Analysis

Calculations used to determine concentrations of individual components by field portable GC analysis are beyond the scope of this SOP and are covered ERT/SERAS SOP #2109, *Photovac GC Analysis for Soil, Water and Air/Soil Gas*.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

9.1 Sample Sorbent Tubes

Before field use, a quality assurance (QA) check must be performed on each batch of sorbent tubes by thermal desorption/cryogenic trapping GC/MS. These tubes are prepared and cleaned in accordance with EPA Method EMSL/RTP-SOP-EMD-013 by the vendor. Prior to purchasing a lot of tubes from a vendor, ten tubes from the lot are sent to the SERAS laboratory where the tubes

are tested for cleanliness, precision and reproducibility.

Sample tubes should be stored out of ultraviolet (UV) light (i.e., sunlight) and kept on ice until analysis. Samples should be collected in duplicate, whenever possible.

9.2 Sample Probe Contamination

Sample probe contamination is checked between each sample by drawing ambient air through the probe using a vacuum pump (e.g., Gilian pump) and checking the response of the FID/PID. If readings are higher than background, replacement or decontamination is necessary.

Sample probes may be decontaminated simply by drawing ambient air through the probe until the HNu reading is at background. Contamination can also be removed by decontaminating with methanol and deionized water, then air drying. For persistent contamination, use of a portable propane torch may be needed. Using a pair of pliers to hold the probe, run the torch up and down the length of the sample probe for approximately 1-2 minutes. Let the probe cool before handling. When using this method, make sure to wear gloves to prevent burns. Having more than one probe per sample team will reduce lag times between sample stations while probes are decontaminated.

9.3 Sample Train Contamination

The Teflon line forming the sample train from the probe to the Tedlar bag should be changed on a daily basis. If visible contamination (soil or water) is drawn into the sampling train, it must be changed immediately. When sampling in highly contaminated areas, the sampling train should be purged with ambient air, via a vacuum pump (e.g., Gilian pump), for approximately 30 seconds between each sample. After purging, the sampling train can be checked using an FID or PID, or other field monitoring device, to establish the cleanliness of the Teflon line.

9.4 FID/PID Calibration

The FID and PID must be calibrated at least once a day using the appropriate calibration gases.

9.5 Trip Blanks

A trip blank detects any sample contamination during shipping and storage. With the exception of Summa canisters, the trip blank is prepared and added to the site samples after sampling has been completed and prior to shipment.

9.5.1 Tedlar Bags

Each cooler containing Tedlar bag samples must contain one Tedlar bag of ultra-zero grade air, acting as a trip blank, when samples are shipped to an outside laboratory. A chain of custody record must accompany each cooler of samples and should include the blank that is dedicated to that group of samples.

9.5.2 Sorbent Tubes

At least one trip blank per cooler must be submitted with the sorbent tube samples. The ends of the sorbent tube are broken but no air is drawn through the tube.

9.5.3 Summa Canisters

Canister trip blanks are evacuated containers that are shipped to and from the site with the canisters used for air sampling.

9.6 Field Blanks

A field blank detects sample contamination during the handling and shipping process. The field blank must be associated with an actual sampling event.

9.6.1 Tedlar Bags

For each day of sampling, a Tedlar bag is filled with ultra-zero air at the beginning of the day. The field blank is handled in the same manner as the samples.

9.6.2 Sorbent Tubes

For each day of sampling, a field blank must be submitted for sorbent tubes. The ends of the sorbent tube are broken at the beginning of the day but no air is drawn through the tube.

9.7 Trip Standards

If Tedlar bags are used for sampling, each cooler containing samples should contain a Tedlar bag of standard gas to calibrate the analytical instruments (Photovac GC, etc.). This trip standard will be used to determine any changes in concentrations of the target compounds during the course of the sampling day (e.g., migration through the sample bag, degradation, or adsorption). A fresh trip standard must be provided and placed in each cooler pending additional sample collection. A chain of custody record must accompany each cooler of samples and should include the trip standard that is dedicated to that group of samples.

9.8 Lot Blanks

9.8.1 Tedlar Bags

Prior to use, one bag is removed from each lot of Tedlar bags to be used for sampling and checked for possible contamination as follows: Fill the test bag with ultra-zero grade air; withdraw a sample from the bag and analyze using a field portable GC or any other applicable field instrument used for sample analysis. This procedure will ensure sample container cleanliness prior to the start of the sampling effort.

9.8.2 Summa Canister Check

From each lot of four cleaned Summa canisters, one is used for a GC/MS certification check. If the canister passes certification, it is re-evacuated and all four canisters from that lot are available for sampling. If the chosen canister is contaminated, the entire lot of four Summa canisters must be re-cleaned, and a single canister is re-analyzed by GC/MS for certification.

9.8.3 Sorbent Tubes

Provide a minimum of one sorbent tube per sampling event. Do not break the ends of the tube.

9.9 Options

9.9.1 Duplicate Samples

A minimum of 5% of all samples should be collected in duplicate (i.e., if a total of 100 samples are to be collected, five samples should be collected in duplicate). In choosing which samples to duplicate, the following criteria applies: if, after filling the first Tedlar bag and evacuating the well for 15 seconds, the second HNu reading (or other field monitoring device being used) matches or is close to (within 20%) the first reading, a duplicate sample may be taken.

9.9.2 Spikes

A Tedlar bag spike and sorbent tube spike may be desirable in situations where high concentrations of contaminants other than the target compounds are found to exist (landfills, etc.). The additional level of QA/QC attained by this practice can be useful in determining the effects of interferences caused by these non-target compounds. Summa canisters containing samples are not spiked.

10.0 DATA VALIDATION

10.1 Blanks

For each target compound, the concentration found in the sample must be greater than three times the level (for that compound) found in the appropriate blank (lot, field, and trip) that accompanied that sample, to be considered valid.

11.0 HEALTH AND SAFETY

Because the sample is being drawn from underground, and no contamination is introduced into the breathing zone, soil gas sampling usually occurs in Level D. Nevertheless, ambient air should be constantly monitored using the HNu P101 to obtain background and breathing zone readings during the sampling procedure. As long as the levels in ambient air do not rise above background, no upgrade of the level of protection is needed.

When conducting soil gas sampling, appropriate personal protective equipment [PPE (leather gloves, steel-toed shoes, Tyvek safety suit)] should be worn, and proper slam bar techniques should be implemented Also, an underground utility search must be performed prior to sampling (See Section 4.5).

12.0 REFERENCES

Gilian Instrument Corp. 1983. *Instruction Manual for Hi Flow Sampler: HFS113, HFS 113 T, HFS 113U, HFS 113 UT.*

HNu Systems, Inc. 1975. *Instruction Manual for Model PI 101 Photoionization Analyzer.*

New Jersey Department of Environmental Protection. 1992. *Field Sampling Procedures Manual*.

U.S. Environmental Protection Agency. 1984. *Characterization of Hazardous Waste Sites - A Methods Manual: Volume II.* Available Sampling Methods. 2nd ed. EPA-600/4-84-076.

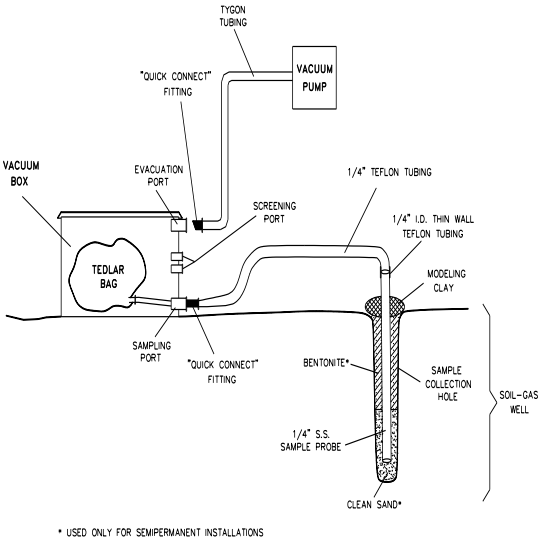
U.S. Environmental Protection Agency. 1995. *Superfund Program Representative Sampling Guidance. Volume 2: Air (Short-Term Monitoring).* EPA 540-R-95/140. Interim Final.

13.0 APPENDICES

A - Figures
B - HNu Field Procedure

APPENDIX A
Figure
SOP # 2042
April 2001

FIGURE 1. Sampling Train Schematic



APPENDIX B

HNu Field Procedure
SOP # 2042
April 2001

HNu Field Procedure

The following sections detail the procedures that are to be followed when using the HNu in the field.

Startup Procedure

a. Before attaching the probe, check the function switch on the control panel to ensure that it is in the off position. Attach the probe by plugging it into the interface on the top of the readout module. Use care in aligning the prongs in the probe cord with the plug in; don't force the probe cord.

b. Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery area on the scale. If not, recharge the battery. If the red indicator light comes on, the battery needs recharging.

c. Turn the function switch to any range setting. Look into the end of the probe for no more than two to three seconds to see if the lamp is on. If it is on, it will give a purple glow. Do not stare into the probe any longer than three seconds. Long term exposure to UV light can damage eyes. Also, listen for the hum of the fan motor.

d. To ZERO the instrument, turn the function switch to the standby position and rotate the zero adjustment until the meter reads zero. A calibration gas is not needed for this instrument. If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted, if necessary. Wait 15 to 20 seconds to ensure that the zero reading is stable. If necessary, readjust the instrument to zero.

Operational Check

a. Follow the start-up procedure.

b. With the instrument set on the 0-20 ppm range, hold a solvent-based magic marker near the probe tip. If the meter deflects upscale, the instrument is working.

Field Calibration Procedure

a. Follow the start-up procedure and the operational check.

b. Set the function switch to the range setting for the concentration of the calibration gas.

c. Attach a regulator to a disposable cylinder of isobutylene gas. Connect the regulator to the probe of the HNu with a piece of clean Tygon tubing. Turn on the regulator valve.

d. After fifteen seconds, adjust the span dial until the meter reading equals the concentration of the calibration gas used. Be careful to unlock the span dial before adjusting it. If the span has to be set below 3.0, calibrate the instrument internally or return to equipment maintenance for repair.

e. Record in the field logbook: the instrument ID no. (EPA decal or serial number if the instrument is a rental); the initial and final span settings; the date and time; concentration and type of calibration gas used; and the name of the person who calibrated the instrument.

Operation

a. Follow the start-up procedure, operational check, and calibration check.

b. Set the function switch to the appropriate range. If the concentration of gases or vapors is unknown, set the function switch to the 0-20 ppm range. Adjust it if necessary.

c. While taking care not to permit the HNu to be exposed to excessive moisture, dirt, or contamination, monitor the work activity as specified in the site specific Health and Safety Plan.

d. When the activity is completed or at the end of the day, carefully clean the outside of the HNu with a damp disposable towel to remove any visible dirt. Return the HNu to a secure area and place on charge.

e. With the exception of the probe's inlet and exhaust, the HNu can be wrapped in clear plastic to prevent it from becoming contaminated and to prevent water from getting inside in the event of precipitation.

MANUAL WATER LEVEL MEASUREMENTS

CONTENTS

* These sections affected by Revision 1.0

SUPERCEDES: SOP #2043; Revision 0.0, 02/11/00; U.S. EPA Contract 68-C99-223

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to set guidelines for the determination of the depth to water measurements in an open borehole, a cased borehole, a monitor well, or a piezometer.

Generally, water-level measurement data from boreholes, piezometers, or monitor wells are used to construct water table or potentiometric surface maps, and to determine groundwater flow direction, groundwater level recovery following a pumping event, or to determine other aquifer characteristics. Therefore, all water level measurements at a given site should be collected within a 24-hour period. However, certain situations may produce rapidly changing groundwater levels that necessitate taking measurements within a condensed time frame. Rapid groundwater level changes may occur due to:

- Atmospheric pressure changes;
- Tidal influences;
- Changes in river stage, impoundments levels, or flow in unlined ditches;
- Pumping of nearby wells;
- Precipitation.

2.0 METHOD SUMMARY

A permanent survey mark should be placed on the top of the riser pipe or casing as a reference point for groundwater level measurements. If the lip of the riser pipe is not flat, the reference point may be located on the grout apron or the top of the outer protective casing (if present). If using a measurement reference point, it must be documented in the site logbook, the sampler's personal log book, or on field data sheets (Figure 1, Appendix A). All field personnel must be informed of the measurement reference point used in order to ensure the collection of comparable data. NOTE: All data recorded in the sampler's personal log book must be photocopied and retained in the project files.

Before measurements are made, water levels in piezometers and monitor wells should be allowed to stabilize for a minimum of 24 hours after well construction and development. In low yield situations, recovery of water levels to static equilibrium may take longer. All measurements should be recorded to one hundredth (0.01) of a foot. Water level measuring equipment must be decontaminated prior to and after each use at each measuring location. When possible, measurements should be taken from the least to the most contaminated borehole, well, or piezometer.

Open the well and monitor the head space with an appropriate air monitoring instrument to determine the presence of volatile organic compounds (VOCs). For electrical sounders, ground the measuring equipment, and then lower the water level probe into the well until the water surface is SERAShed, as indicated by a tone or meter deflection. Record the distance from the water surface to the reference point. (Measurement with a chalked tape will necessitate lowering the tape below the water level and holding a convenient foot marker at the reference point. Record the water level as indicated on the chalked tape section and the depth mark held at the reference point. The depth to water is the difference between these two readings.) Remove the water level probe, replace the riser pipe cap, and decontaminate the equipment as necessary. Note: If a separate phase product is present, a product/water interface probe is required for the measurement of product thickness and water level.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- Cascading water, particularly in open-hole or rock wells and especially during aquifer pumping tests, may interfere with the water level measurement.
- Some older types of electric sounders are only marked at 5-foot intervals. A surveyor's tape is necessary to extrapolate between the 5-foot marks.
- Oil or other product floating on the water column can insulate the contacts of the probe on an electric sounder and give false readings. For accurate level measurements in wells containing separate phase product, a special product/water level indicator is required.
- Tapes (electrical or surveyor) may have damaged or missing sections, or may be spliced inaccurately. Always examine the tape for continuity and completeness.
- An air line may be the only available means to take measurements in sealed production wells, and is not described here. The method is generally accurate to approximately two-tenths (0.2) of a foot.
- When using a chalked steel tape, it is necessary to lower the tape below the water level in order to take a measurement. This method is more successful when the operator has knowledge of the approximate groundwater level.

5.0 EQUIPMENT/APPARATUS

- Electric water level indicator, marked in increments of 0.01-foot
- Steel tape, chalked, marked in increments of 0.01-foot
- Appropriate air monitoring equipment [photoionization detector (PID) and/or flame ionization detector (FID)]
- Product/water interface probe
- Chalk
- Ruler/Measuring tape
- Site logbook, personal logbook, and/or field data sheets
- Decontamination supplies
- Paper towels and trash bags

6.0 REAGENTS

No chemical reagents are used in this procedure; however, decontamination solutions may be necessary. If decontamination of equipment is required, refer to Environmental Response Team/Scientific, Engineering, Response and Analytical Services (ERT/SERAS) SOP #2006, *Sampling Equipment Decontamination*, and the approved site Work Plan (WP).

7.0 PROCEDURES

7.1 Preparation

1. Determine the number of measurements needed, the methods to be employed, and the equipment and supplies needed.

2. Decontaminate or pre-clean equipment, and ensure that it is in working order.

3. Coordinate sampling schedule with staff, clients, and regulatory agency, if appropriate.

4. If this is an initial visit, perform a general site survey prior to site entry in accordance with the current approved site specific Health and Safety Plan (HASP).

5. Identify sampling locations.

7.2 Water Level Determination

1. If possible, and when applicable, measure those wells that are least contaminated and proceed to those most contaminated.

2. Clean all the equipment used to measure water levels (which enters the well) by the following decontamination procedure:

   - Rinse equipment with deionized water.
   - Wash the equipment with an Alconox solution, followed by a deionized water rinse.
   - Rinse the equipment with an appropriate solvent suitable for the type and material composition (e.g., methanol, isopropyl alcohol, acetone) as per the WP, if organic contamination is suspected.
   - Triple rinse the equipment with deionized water.
   - Place the equipment on clean surface such as a Teflon or polyethylene sheet to air dry.

3. Remove the (locking) well cover, note the well identification (ID), the date and time of day, and the participating field personnel in the site logbook, a personal logbook, and/or on a field data sheet.

4. Remove well cap.

5. If organic contaminants are suspected, monitor the head space of the well with a photoionization detector (PID) or flame ionization detector (FID). Record the results in the site logbook, personal logbook, and/or on a field data sheet.

6. Lower a water-level measuring device into the well. Electrical tapes are lowered to the water surface. Chalked steel tapes are lowered generally a foot or more below the water surface; steel tapes are generally chalked so that a 1- to 5-foot long section will fall below the expected water level. Record all measurements in the site logbook, the sampler's personal log book, and/or on field data sheets. NOTE: All data recorded in a personal log book must be photocopied and retained in the project files.

7. For electrical tapes, record the distance from the water surface, as determined by the audio signal or meter, to the reference measuring point. For chalked tapes, an even foot mark is held at the reference point, once the chalked section of the tape is below the water level. Both the water level on the tape and the foot mark held at the reference point is recorded. The depth to the water is the difference between the two readings. In addition, note the reference point used (top of the outer casing, top of the riser pipe, ground surface, or some other permanent reproducible position on the well head). Repeat the measurement to ensure reproducibility and accuracy. Preferably the same person and level measurement equipment should be used to eliminate any sources of error related to the measurement readings.

8. Remove all water level measuring equipment, replace the well cap and the locking steel caps.

9. Decontaminate all equipment as outlined in Step 2 (above), and store for transport to the next sampling location.

10. Note any physical changes, such as erosion or cracks in protective concrete pad or variation in the total depth of the well, in a site logbook, a personal logbook, and/or on a field data sheet.

8.0 CALCULATIONS

To determine groundwater elevation above mean sea level, use the following equation:

$$E_w = E - D$$

where:

E_W = Elevation of water above mean sea level (feet) or local datum
E = Elevation above sea level or local datum at point of measurement (feet)
D = Depth to water (feet)

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general quality assurance/quality control (QA/QC) procedures apply:

1. All data must be documented in site logbooks, personal logbooks, and/or field data sheets.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the WP.

3. Each well must be tested at least twice in order to compare results. If results do not agree within 0.02 of a foot, a third measurement must be taken and the readings averaged. Consistent failure of consecutive readings to agree suggests that levels are changing because of one or more conditions, as indicated in Section 1.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potential hazardous materials, follow U.S. EPA, Occupational Safety and Health Administration (OSHA) and corporate health and safety procedures.

If the FID/PID results obtained while monitoring the head space and breathing zones indicate that VOCs are present, the personal protection level may need to be upgraded from that denoted in the HASP.

12.0 REFERENCES

Driscoll, F.G. 1986. Groundwater and Wells. *Collection and Analysis of Pumping Test Data*. 2nd ed. Chapter 16. St. Paul, Minnesota: Johnson Filtration Systems Inc. pp 534-579.

U.S. Environmental Protection Agency, 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*. p. 207.

U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. 1987. *A Compendium of Superfund Field Operations Methods.* EPA/540/p-87/001.

APPENDIX A
Example Field Data Sheet
SOP #2043
December 2002

FIGURE 1. EXAMPLE FIELD DATA SHEET

PAGE __ OF

SITE NAME: _____ LOGGER NAME: _____

SITE LOCATION: _____ ERTC WAM: _____

LOG DATE: _____ WBS #: RIA _____

Well I.D.	Time	Elevation of well[(1)] (TOC)	Depth to bottom of well (feet)	Depth to Water (feet)	Depth to product (feet)	COMMENTS (pH, temperature, specific conductance)

TOC: top of casing (1) feet above mean sea level

MEASUREMENT REFERENCE POINT FROM_____GROUND SURFACE OR_____TOP OF CASING

Weather Conditions: Temperature (^{o}C):_____ Rain: Heavy: ____Medium:____ Light:____(Circle one)

Other significant observations:

MONITOR WELL DEVELOPMENT

CONTENTS

*These sections affected by Revision 0.1.

SUPERCEDES: SOP #2044; Revision 0.0; 2/18/00; U.S. EPA Contract EP-W-09-031.

MONITOR WELL DEVELOPMENT

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide an overview of monitor well development practices. The purpose of monitor well development is to ensure removal of fine grained sediments (fines) from the vicinity of the well screen. This allows the water to flow freely from the formation into the well, and also reduces the turbidity of the water during sampling. The most common well development methods are: surging, jetting, overpumping, and bailing.

Surging involves raising and lowering a surge block or surge plunger inside the well. The resulting surging motion forces water into the formation and loosens sediment, pulled from the formation into the well. Occasionally, sediments must be removed from the well with a sand bailer to prevent sand locking of the surge block. This method may cause the sand pack around the screen to be displaced to a degree that damages its value as a filtering medium. Channels or voids may form near the screen if the filter pack sloughs away during surging (Keel and Boating, 1987).

Surging with compressed air is done by injecting a sudden charge of compressed air into the well with an air line so that water is forced through the well screen. The air is then turned off so that the water column falls back into the well and the process is repeated. Periodically, the air line is pulled up into a pipe string (educator) and water is pumped from the well using air as the lifting medium (air-lift pumping). The process is repeated until the well is sediment free. Method variations include leaving the air line in the pipe string at all times or using the well casing as the educator pipe.

Jetting involves lowering a small diameter pipe into the well and injecting a high velocity horizontal stream of water or air through the pipe into the screen openings. This method is especially effective at breaking down filter cakes developed during mud rotary drilling. Simultaneous air-lift pumping is usually used to remove fines.

Overpumping involves pumping at a rate rapid enough to draw the water level in the well as low as possible, and then allowing the well to recharge to the original level. This process is repeated until sediment-free water is produced.

Bailing includes the use of a simple manually operated check-valve bailer to remove water from the well. The bailing method, like other methods, should be repeated until sediment free water is produced. Bailing may be the method of choice in a shallow well or well that recharges slowly.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with a final report.

Mention of trade names or commercial products does not constitute United States Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

After installation, development of a well should occur as soon as it is practical. It should not occur any sooner than 48 hours after grouting is completed, especially if a vigorous well development method (i.e. surging) is being used. If a less vigorous method (i.e. bailing) is used, it may be initiated shortly after

installation. The method used for development should not interfere with the setting of the well seal.

Several activities must take place prior to well development. First, open the monitor well, take initial measurements (i.e., head space air monitoring readings, water level, total depth of the well) and record results in the site logbook. Develop the well by the appropriate method to accommodate site conditions and project objectives. Continue until the development water is clear and free of sediments, or until parameters such as pH, temperature, and specific conductivity stabilize. Containerize all purge water from wells with known or suspected contamination. Record final measurements in the site logbook. Decontaminate equipment as appropriate prior to use in the next well.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The following problems may be associated with well development:

1. Overpumping is not as vigorous as surging and jetting, and is probably the most desirable method for monitor well development. The possibility of disturbing the filter pack is greatest with surging and jetting well development methods.

2. The introduction of external water or air by jetting may alter the hydro chemistry of the aquifer.

3. Surging with air may produce “air locking” in some formations, preventing water from flowing into the well.

4. The use of surge blocks in formations containing clay may cause plugging of the screen.

5. Small (2-inch nominal diameter) submersible pumps that will fit in 2-inch diameter well casing are especially susceptible to clogging if used in well development applications.

6. Chemicals/reagents used during the decontamination of drilling equipment may complicate well development.

5.0 EQUIPMENT/APPARATUS

The type of equipment used for well development is dependent on the diameter of the well and the development method. For example, the diameter of most submersible pumps is too large to fit into a two-inch inner diameter (I.D.) well, and other development methods should be used. Obtaining the highest possible yield is not usually an objective in developing monitor wells and vigorous development is not always necessary. Many monitor wells are constructed in fine-grained formations that would not normally be considered aquifers. Specifications for the drilling contract should include the necessary well development equipment (air compressors, pumps, air lines, surge blocks, generators).

6.0 REAGENTS

The use of chemicals in developing wells that will be used to monitor groundwater quality should be avoided if possible; however, polyphosphates (a dispersing agent), acids, or disinfectants are often used in general well development. Polyphosphates should not be used in thinly bedded sequences of sands and clays. The use of decontamination solutions may also be necessary. If decontamination of equipment is required at a well, refer to Environmental Response Team/Scientific Engineering, Response and Analytical is Services (ERT/REAC) SOP #2006, *Sampling Equipment Decontamination* and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Coordinate site access and obtain keys to well locks.

2. Obtain information on each well to be developed (i.e., drilling method, well diameter, well depth, screened interval, anticipated contaminants).

3. Obtain a water level meter, a depth sounder, air monitoring instruments, materials for decontamination, and water quality instrumentation capable of measuring, at a minimum, pH, specific conductivity, temperature, and turbidity. Dissolved oxygen (DO) and salinity are also useful parameters.

4. Assemble containers for temporary storage of water produced during well development. Containers must be structurally sound, compatible with anticipated contaminants, and easy to manage in the field. The use of truck-mounted or roll-off tanks may be necessary in some cases; alternately, a portable water treatment unit (i.e., activated carbon) may be used to decontaminate the purge water.

7.2 Operation

Development should be performed as soon as it is practical after the well is installed, but no sooner than 48 hours after well completion.

1. Assemble necessary equipment on a plastic sheet surrounding the well.

2. Record pertinent information in the site or personal logbook (personnel, time, location ID, etc.).

3. Open monitor well, take air monitor reading at the top of casing and in the breathing zone as appropriate.

4. Measure depth to water and the total depth of the monitor well. Calculate the water column volume of the well (Equation 1, Section 8.0).

5. Begin development and measure the initial pH, temperature, turbidity, and specific conductivity of the water and record in the site logbook. Note the initial color, clarity, and odor of the water.

6. Continue to develop the well and periodically measure the water quality parameters indicated in step 5 (above). Depending on project objectives and available time, development should proceed until these water quality parameters stabilize, or until the water has a turbidity of less than 50 nephelometric turbidity units (NTUs).

7. All water produced by development of contaminated or suspected contaminated wells must be containerized or treated. Each container must be clearly labeled with the location ID, date collected, and sampling contractor. Determination of the appropriate disposal method will be based on the analytical results from each well.

8. No water shall be added to the well to assist development without prior approval by the appropriate U.S. EPA ERT Work Assignment Manager (WAM) and/or appropriate state personnel. In some cases , small amounts of potable water may be added to help develop a poor yielding well. It is essential that at least five times the amount of water injected must be recovered from the well in order to assure that all injected water is removed from the formation.

9. Note the final water quality parameters in the site or personal logbook along with the following data:

- ·Well designation (location ID)
- ·Date(s) of well installation
- ·Date(s) and time of well development
- ·Static water level before and after development
- ·Quantity of water removed, and initial and completion time
- ·Type and capacity of pump or bailer used
- ·Description of well development techniques

7.3 Post-Operation

1. Decontaminate all equipment;

2. Secure holding tanks or containers of development water;

3. Review analytical results and determine the appropriate water disposal method. Actual disposal of the purge water is generally carried out by the On-Scene Coordinator (OSC).

8.0 CALCULATIONS

To calculate the volume of water in the well, the following equation is used:

$$\text{Well volume}(V) = \pi r^2 h\,(cf)$$

where:
π = pi (3.14)
r = radius of monitoring well in feet (ft)

h = height of the water column in ft. [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor in gallons per cubic foot (gal/ft^3) = 7.48 gal/ft^3. [In this equation,7.48 gal/ft^3 is the necessary conversion factor.]

Monitor well diameters are typically 2-, 3-, 4-, or 6-inches. A number of standard conversion factors can be used to simplify the above equation using the diameter of the monitor well. The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

$$V\ gal/ft) = \pi r^2 h(cf)$$

where:

π = pi
r = radius of monitoring well (feet)
cf = conversion factor (7.48 gal/ft^3)

For example, a two inch diameter well, the volume per linear foot can be calculated as follows:

$$V\ gal/ft) = \pi r^2 h(cf)$$
$$= 3.14\ (1/12\ ft)^2\ \ 7.48\ gal/ft^3$$
$$= 0.1631\ gal/ft$$

NOTE: The diameter must be converted to the radius in feet as follows:

$$\frac{\text{Well Diameter (inches)}}{12} \times 0.5 = \text{Well Radius (feet)}$$

The volume in gallons/feet for the common size monitor wells are as follows:

Well diameter (inches)	2	3	4	6
Volume (gal/ft)	0.1631	0.3670	0.6524	1.4680

If you utilize the volumes for the common size wells above, Equation 1 is modified as follows:

Well volume = (h)(f)

where:

h = height of water column (feet)
f = the volume in gal/ft calculated from Equation 2

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance activities, which apply to the implementation of these procedures. However, the following general quality assurance/quality control (QA/QC) procedures apply:

1. All data must be documented in site and/or personal logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health (OSHA), and corporate health and safety practices.

12.0 REFERENCES

Driscoll, F. G. 1986. "Development of Water Wells." In: *Groundwater and Wells.* Second Edition. Chapter 15. Johnson Filtration Division, St. Paul, Minnesota. p. 497-533.

Freeze, Allan R. and John A. Cherry. 1979. *Groundwater*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Keel, J.F. and Kwasi Boating. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 1: Conceptualizations*".Groundwater,* 25(3):300-313.

Keel, J.F. and Kwasi Boating. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 2: Case Histories". *Groundwater*, 25(4):427-439.

13.0 APPENDICES

This section is not applicable to this SOP.

SLUG TESTS

CONTENTS

SUPERCEDES: SOP #2158; Revision 2; 08/30/90; U.S. EPA Contract EP-W-09-031.

SLUG TESTS

1.0 SCOPE AND APPLICABILITY

This procedure is applicable to determine the horizontal hydraulic conductivity of distinct geologic horizons under in-situ conditions. The hydraulic conductivity (K) is an important parameter for modeling the flow of groundwater in an aquifer.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S.EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

A slug test involves the instantaneous injection or withdrawal of a volume or slug of water or solid cylinder of known volume. This is accomplished by displacing a known volume of water from a well and measuring the artificial fluctuation of the groundwater level.

The primary advantages of using slug tests to estimate hydraulic conductivities are numerous. First, estimates can be made in-situ, thereby avoiding errors incurred in laboratory testing of disturbed soil samples. Second, tests can be performed quickly at relatively low costs because pumping and observation wells are not required. And lastly, the hydraulic conductivity of small discrete portions of an aquifer can be estimated (e.g., sand layers in a clay).

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

This section is not applicable to this Standard Operating Procedure (SOP).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Limitations of slug testing include: 1) only the hydraulic conductivity of the area immediately surrounding the well is estimated which may not be representative of the average hydraulic conductivity of the area, and 2) the storage coefficient, S, usually cannot be determined by this method.

5.0 EQUIPMENT/APPARATUS

The following equipment is needed to perform slug tests. All equipment which comes in contact with the well should be decontaminated and tested prior to commencing field activities.

- Tape measure (subdivided into tenths of feet)
- Water pressure transducer
- Electric water level indicator
- Weighted tapes
- Steel tape (subdivided into tenths of feet)

- Electronic data-logger (if transducer method is used)
- Stainless steel slug of a known volume
- Watch or stopwatch with second hand
- Semi-log graph paper (if required)
- Water proof ink pen and logbook
- Thermometer
- Appropriate references and calculator
- Electrical tape
- 21X micrologger
- Compact portable computer or equivalent with Grapher installed on the hard disk

6.0 REAGENTS

No chemical reagents are used in this procedure; however, decontamination solvents may be necessary. If decontamination of the slug or equipment is required, refer to ERT/SERAS SOP #2006, Sampling Equipment Decontamination and the site specific work plan.

7.0 PROCEDURES

7.1 Field Procedures

The following general procedures may be used to collect and report slug test data. These procedures may be modified to reflect site specific conditions:

1. When the slug test is performed using an electronic data-logger and pressure transducer, all data will be stored internally or on computer diskettes or tape. The information will be transferred directly to the main computer and analyzed. A computer printout of the data shall be maintained in the files as documentation.

   If the slug test data is collected and recorded manually, the slug test data form (Figure 1, Appendix A) will be used to record observations. The slug test data form shall be completed as follows:

   - Site ID - Identification number assigned to the site.
   - Location ID - Identification of location being tested.
   - Date - The date when the test data was collected in this order: year, month, day (e.g., 900131 for January 31, 1990).
   - Slug volume (ft^3) - Manufacturers specification for the known volume or displacement of the slug device.
   - Logger - identifies the company or person responsible for performing the field measurements.
   - Test method - The slug device is either injected or lowered into the well or withdrawn or pulled-out from the monitor well. Check the method that is applicable to the test situation being run.
   - Comments - Appropriate observations or information for which no other blanks are provided.

- Elapsed time (min) - Cumulative time readings from beginning of test to end of test, in minutes.
- Depth to water (ft) - Depth to water recorded in tenths of feet.

2. Decontaminate the transducer and cable.

3. Make initial water level measurements on monitor wells in an upgradient to downgradient sequence, if possible.

4. Before beginning the slug test, information will be recorded and entered into the electronic data-logger. The type of information may vary depending on the model used. When using different models, consult the operator's manual for the proper data entry sequence to be used.

5. Test wells from least contaminated to most contaminated, if possible.

6. Determine the static water level in the well by measuring the depth to water periodically for several minutes and taking the average of the readings, (see ERT/SERAS SOP #2043, Water Level Measurements).

7. Cover sharp edges of the well casing with duct tape to protect the transducer cables.

8. Install the transducer and cable in the well to a depth below the target drawdown estimated for the test but at least two feet from the bottom of the well. Be sure the depth of submergence is within the design range stamped on the transducer. Temporarily tape the transducer cable to the well to keep the transducer at a constant depth.

9. Connect the transducer cable to the electronic data-logger.

10. Enter the initial water level and transducer design range into the recording device according to manufacturer’s instructions (the transducer design range will be stamped on the side of the transducer). Record the initial water level on the recording device.

11. "Instantaneously" introduce or remove a known volume or slug of water to the well. Another method is to introduce a solid cylinder of known volume to displace and raise the water level, allow the water level to restabilize and remove the cylinder. It is important to remove or add the volumes as quickly as possible because the analysis assumes an "instantaneous" change in volume is created in the well.

12. At the moment of volume addition or removal assigned time zero, measure and record the depth to water and the time at each reading. Depths should be measured to the nearest 0.01 foot. The number of depth-time measurements necessary to complete the test are variable. It is critical to make as many measurements as possible in the early part of the test. The number and intervals between measurements will be determined from earlier previous aquifer tests or evaluations.

13. Continue measuring and recording depth-time measurements until the water level

returns to equilibrium conditions or a sufficient number of readings have been made to clearly show a trend on a semi-log plot of time versus depth.

14. Retrieve slug (if applicable).

Note: The time required for a slug test to be completed is a function of the volume of the slug, the hydraulic conductivity of the formation and the type of well completion. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. The length of the test may range from less than a minute to several hours.

If the well is to be used as a monitoring well, precautions should be taken that the wells are not contaminated by material introduced into the well. If water is added to the monitoring well, it should be from an uncontaminated source and transported in a clean container. Bailers or measuring devices should be cleaned prior to the test. If tests are performed on more than one monitor well, care must be taken to avoid cross contamination of the wells.

Slug tests shall be conducted on relatively undisturbed wells. If a test is conducted on a well that has recently been pumped for water sampling purposes, the measured water level must be within 0.1 foot of the water level prior to sampling. At least one week should elapse between the drilling of a well and the performance of a slug test.

7.2 Post Operation Procedures

When using an electronic data-logger use the following procedure:

1. Stop logging sequence.

2. Print data.

3. Send data to computer by telephone.

4. Save memory and disconnect battery at the end of the day's activities.

5. Review field forms for completeness.

8.0 CALCULATIONS

The simplest interpretation of piezometer recovery is that of Hvorslev (1951). The analysis assumes a homogenous, isotropic medium in which soil and water are incompressible. Hvorslev's expression for hydraulic conductivity (K) is:

$$K = \frac{r^2 \ln (L/R)}{2 L T_o} \text{ for } L/R > 8$$

where:

K = hydraulic conductivity [ft/sec]
r = casing radius [ft]
L = length of open screen (or borehole) [ft]
R = filter pack (borehole) radius [ft]
T_0 = Basic Time Lag [sec]; value of t on semi-logarithmic plot of $H-h/H-H_0$ vs. t, where $H-h/H-H_0 = 0.37$
H = initial water level prior to removal of slug
H_0 = water level at t = 0
h = recorded water level at t > 0

(Hvorslev, 1951; Freeze and Cherry, 1979)

The Bower and Rice method is also commonly used for K calculations. However, it is much more time consuming than the Hvorslev method. Refer to Freeze and Cherry or Applied Hydrogeology (Fetter) for a discussion of these methods.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on standard Chain of Custody records, field data sheets, or within personal/site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

The following specific quality assurance activity will apply:

1. Each well should be tested at least twice in order to compare results.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potential hazardouse materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

12.0 REFERENCES

Bower, H., 1978. Groundwater Hydrology, McGraw-Hill Book Company, New York, New York.

Bower, H., and R.C. Rice, 1980. "A Slug Test for Determining the Hydraulic Properties of Tight

Formations", Water Resources Research, Vol. 16, No. 1 pp. 233-238.

Cooper, Jr. H.H., J.D., Bredehoeft, and S.S. Papadopulos, 1967. "Response of a Finite-Diameter Well to an Instantaneous Charge of Water", Water Resources Research, Vol. 13, No. 1.

DOI (U.S. Department of the Interior), Ground Water Manual, U.S. Government Printing Office, New York, New York, Washington, D.C.

Earlougher, R.C., 1977. Advances in Well Test Analysis, Society of Petroleum Engineers of AIME.

Ferris, J.G., and D.B., Knowles, 1954. "The Slug Test for Estimating Transmissivity", U.S. Geological Survey Ground Water Note 26.

Freeze, R. Allen and John A. Cherry, 1979. Groundwater, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Hvorslev, 1951. "Time Lag and Soil Permeability in Ground Water Observations", Bulletin No. 36, U.S. Army Corps of Engineers p. 50.

Johnson Division, UOP, Inc., 1966. Ground Water and Wells, Johnson Division, UOP, Inc., St. Paul, Minnesota.

Lohman, S.W., 1982. "Ground Water Hydraulics", U.S. Geological Survey, Paper 708, p. 70.

Neuman, S.P., 1972. "Theory of Flow in Unconfined Aquifers Considering Delayed Response of the Water Table", Water Resources Research, Vol. 8, No. 4, p. 1031.

Papadopulos, S.S., J.D., Bredehoeft, H.H., Cooper, Jr., 1973. "On the Analysis of Slug Test Data", Water Resources Research, Vol. 9, No. 4.

Todd, David K., 1980. Ground Water Hydrology, 2nd ed. John Wiley & Sons.

APPENDIX A
Slug Test Data Form
SOP #2046
October 1994

Page __ of __

FIGURE 1. Slug Test Data Form

DATE: _____

SITE ID: _____ SLUG VOLUME (ft^3): _____

LOCATION ID: _____ LOGGER: _____

TEST METHOD: _____ SLUG INJECTION _____ SLUG WITHDRAWAL

COMMENTS _____

_____

_____

Time Beginning of Test #1 _____ Time Beginning of Test #2 _____

Time End of Test #1 _____ Time End of Test #2 _____

ELAPSED TIME (MIN)	DEPTH TO WATER (FT)	ELAPSED TIME (MIN)	DEPTH TO WATER (FT)

MONITOR WELL INSTALLATION

CONTENTS

CONTENTS (cont)

*These sections affected by Revision 0.0

SUPERSEDES: SOP #2048, Revision 0.0; 2/29/96; US EPA Contract EP-W-09-031.

MONITOR WELL INSTALLATION

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide an overview of the methods used for the installation of groundwater monitor wells. Monitor well installation creates a permanent access for the collection of samples to assess groundwater quality and the hydrogeologic properties of the aquifer, in which contaminants may exist. Such wells should not alter the medium which is being monitored.

The most commonly used drilling methods are: hollow-stem auger, cable tool, and hydraulic rotary. Rotary drilling can utilize mud rotary or air rotary methods.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, depending on site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute United States Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

There is no ideal monitor well installation method for all conditions; therefore, hydrogeologic conditions at the site, as well as project objectives, must be considered before deciding which drilling method is appropriate.

2.1 Hollow-Stem Augering

Outside diameters of hollow-stem augers generally range from 6.25 inches to 22 inches with corresponding inner diameters ranging from 2.25 inches to 13 inches. Auger lengths are usually 5 feet, which allows relatively easy handling. However, lengths of 10 or 20 feet may be used for deeper holes drilled with machines capable of handling the extended lengths. Formation samples can be taken in a number of ways, depending on the accuracy required. Cuttings may suffice for shallow depths but become less representative with depth, particularly below the water table. The most accurate samples are obtained with various coring devices, such as split spoons or shelby tubes, which can be used inside the augers. Continuous cores may be taken with a thin-walled tube that is inserted into the lowest auger and locked in place. The tube is retracted with a wire line and hoist after the hole has been advanced the length of the auger. A bottom plug in the cutting head or bit prevents cuttings from entering the augers until the first core sample is taken and the plug is knocked out.

In unconsolidated material, the augers serve as a temporary casing. Gravel-packed wells can be constructed inside the augers and then the augers are withdrawn. Well development is usually less difficult than with wells drilled by the mud rotary method because a bentonite drilling fluid is not normally used.

2.2 Cable Tool Drilling

Cable tool drilling is a percussion method in which a bit, attached to a weighted drilling string, is

alternately lifted and dropped. The drilling string, consists (bottom to top) of the drill bit, drill stem, drilling jars, socket, and wire cable. A walking beam on the drilling rig provides the lifting and dropping motion to the wire cable and hence to the drilling string. The repeated action breaks or loosens the formation material, which mixes with formation water, or water added to the borehole by the operator, to form a slurry. The slurry facilitates the removal of the cuttings, which are periodically removed from the hole with a bailer. In unconsolidated formations, steel casing must be driven or pushed into the ground as the drilling progresses in order to maintain the wall of the borehole and prevent collapse. A hardened steel drive shoe on the bottom end of the casing prevents damage during driving. A well may then be constructed inside the steel casing before the casing is pulled back. In consolidated formations, the casing may be driven through the weathered zone and seated in solid rock. The hole below the casing may remain open or may be fitted with a smaller diameter inner casing and screen, depending on the sampling requirements. Depending on formation material, extensive well development may often not be necessary.

2.3 Rotary Drilling

2.3.1 Mud Rotary Method

In the mud rotary method, the drill bit is rotated rapidly to cut the formation material and advance the borehole. The drill bit is attached to hollow drilling rods, which transfer power from the rig to the bit. In conventional rotary drilling, cuttings are removed by pumping drilling fluid (water, or water mixed with bentonite or other additives) down through the drill rods and bit, and up the annulus between the borehole and the drill rods. The drilling fluid flows into a mud pit where the cuttings settle out, and the "fluid" is pumped back down the drill rods. The drilling fluid cools and lubricates the bit and prevents the borehole from collapsing in unconsolidated formations.

Sampling may be done from the cuttings, but these types of samples are generally mixed and the amount of fine material may not be accurately represented. Coring may be done through the drill rods and bit, if a coring bit (with a center opening big enough to allow passage of the coring tube) is used. When drilling unconsolidated formations, a temporary surface or shallow casing may have to be installed in order to prevent cross-contamination, hole collapse, or wall erosion by the drilling fluid. Casing (riser pipe), screen, and gravel pack are usually installed in the open hole or through the surface casing. Once the well is constructed, extensive well development may be necessary in order to remove drilling fluid from the formation.

2.3.2 Air Rotary Method

The air rotary method uses air as the drilling fluid. Air is forced down the drill rods by an air compressor, escapes out of the bit and returns to the surface in the annular space between the hole wall and the drill string. Cuttings are moved out of the hole by the ascending air and collect around the rig. Cuttings are mixed and may not always be representative of the depth currently being drilled. In the conventional air rotary method, the drill string operates in a manner similar to that described for the mud rotary

system. In a "hammer" or "down-the-hole" air rotary method, the bit is pneumatically driven rapidly against the rock in short strokes while the drilling string slowly rotates. The use of air rotary methods are generally limited to consolidated and semi-consolidated formations. Casing is often used in semi-consolidated formations and through the weathered portion of consolidated formations to prevent hole collapse. In environmental work, the air supply must be filtered to prevent introduction of contamination (typically oil from the air compressor) into the borehole.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Often, a primary objective of the drilling program is to obtain representative lithologic or environmental samples. The most common techniques for retrieving samples are:

In unconsolidated formations:

- Split spoon sampling, carried out continuously or at discrete intervals during drilling
- Shelby tube sampling, when an undisturbed sample is required from clay or silt soils, especially for geotechnical evaluation or chemical analysis
- Cutting collection, when a general lithologic description and approximate depths are sufficient

In consolidated formations:

- Rock coring at continuous or discrete intervals
- Cutting collection, when a general lithologic description and approximate depths are sufficient

The amount of sample to be collected, the proper sample container (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest, and are discussed in ERT/SERAS SOP #2003, *Sample Storage, Preservation and Handling*.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The advantages and disadvantages of the various drilling methods are summarized below.

4.1 Auger Drilling

The advantages of auger drilling are:

- Relatively fast and inexpensive
- Because augers act as temporary casing, drilling fluids are not used, resulting in reduced well development

The disadvantages of auger drilling are:

- Very slow or impossible to use in coarse materials such as cobble or boulders
- Cannot be used in consolidated formations and is generally limited to depths of approximately 100 feet below ground surface in order to be efficient

4.2 Cable Tool Drilling

The advantages of cable tool drilling are:

- Relatively inexpensive with minimum labor requirements
- Water table and water bearing zones are easily identified
- Driven casing stabilizes the open borehole and minimizes potential for cross-contamination
- Especially successful in caving formations or formations containing boulders
- Accurate formation samples can usually be obtained from cuttings

The disadvantages of cable tool drilling are:

- Extremely slow rate of drilling
- Necessity to drive casing may limit depth in large diameter holes.

4.3 Rotary Drilling

4.3.1 Mud Rotary Drilling

The advantages of mud rotary drilling are:

- Fast, typically more than 100 feet of borehole advancement per day
- Provides an open borehole, necessary for some types of geophysical logging and other tests

The disadvantages of mud rotary drilling are:

- Potential for cross-contamination of water-bearing zones
- Drill cuttings may be mixed and not accurately represent lithologies at a given drilling depth
- Drilling mud may alter the groundwater chemistry
- Water levels can only be determined by constructing wells
- Drilling mud may change local permeability of the formation and may not be entirely removed during well development
- Disposal of large volumes of drilling fluid and cuttings may be necessary if they are contaminated

4.3.2 Air Rotary Drilling

The advantages of air rotary drilling are:

- Fast, typically more than 100 feet of borehole advancement a day
- Preliminary estimates of well yields and water levels are often possible
- No drilling mud to plug the borehole

The disadvantages of air rotary drilling are:

- Generally cannot be used in unconsolidated formations
- In contaminated zones, the use of high-pressure air may pose a significant hazard to the drill crew because of transport of contaminated material up the hole
- Introduction of air to the groundwater could reduce concentration of volatile organic compounds

5.0 EQUIPMENT/APPARATUS

The following equipment is necessary for the site geologist:

- Metal clipboard box case (container for well logs)
- Ruler
- Depth sounder
- Water level indicator
- Health and safety gear
- Sample collection jars
- Trowels
- Description aids (Munsell color change, grain size charts, etc.)
- Field Logbook

Equipment and tools required for well installation are provided by the drilling contractor.

6.0 REAGENTS

Reagents are not required for preservation of soil samples. Samples should, however, be cooled to 4^0C and protected from sunlight in order to minimize degradation and any potential reaction due to the light sensitivity of the sample. Decontamination solutions are specified in ERT/SERAS SOP# 2006, *Sampling Equipment Decontamination*, and the site-specific work plan.

7.0 PROCEDURES

7.1 Preparation

All drilling and well installation programs must be planned and supervised by a licensed professional geologist/hydrogeologist.

The planning, selection and implementation of any monitor well installation program should include the following:

- Review existing data on site geology and hydrogeology including publications, air photos, water quality data, and existing maps. These may be obtained from local, state or federal agencies

- Assess site to determine potential access problems for drill rig, locate water supply sources, establish equipment storage area, and observe outcrops

- Perform utilities check, note location of underground utilities and of overhead electrical

wires

- Prepare a site-specific Health and Safety Plan (HASP)
- Select drilling, sampling and well development methods
- Determine well construction specifications (i.e., casing and screen materials, casing and screen diameter, screen length and screen interval, filter pack and screen slot size)
- Determine need for containing drill cuttings and fluids and their method of disposal
- Prepare the site-specific Work Plan (WP) including all of the above
- Prepare and execute the drilling contract

7.2 Field Preparation

Prior to mobilization, the drill rig and all associated equipment must be thoroughly decontaminated by a steam/pressure washer to remove all oil, grease, mud, etc. Before drilling each boring, all "down-the-hole" drill equipment should be steam cleaned and rinsed with potable water to minimize cross-contamination. Special attention should be given to the threaded section of the casings and to the drill rods. All drilling equipment must be steam-cleaned at completion of the project to ensure that no contamination is transported from the sampling site.

7.3 Well Construction

The well casing material should not interact with the groundwater. Well casings for environmental projects are usually constructed of polyvinyl chloride (PVC), Teflon, fiberglass, or stainless steel. Details of the construction methods are given in Sections 7.3.1 and 7.3.2.

7.3.1 Bedrock Wells

Wells installed in bedrock will be drilled using the air or mud rotary method. Crystalline rock wells are usually drilled most efficiently with the air rotary method while consolidated sedimentary formations are drilled using either the air rotary or mud rotary method. The compressed air supply will be filtered prior to introduction into the borehole to remove oil or other contaminants. Bedrock wells may be completed as an open-hole, providing that borehole cave-in is not a possibility.

Bedrock wells will be advanced with air or mud rotary methods until a minimum of 5 feet of competent rock has been drilled. Minimum borehole diameter will be 8 inches. The drill string will then be pulled from the borehole and 6-inch inner diameter (I.D.) Schedule 80 or 40 polyvinyl chloride (PVC) casing inserted. Portland cement/bentonite grout will be pumped through a tremie pipe (placed at the bottom of the borehole) into the annular space outside the casing. After the grout has set (minimum of 24 hours), the cement will be drilled out (if needed) and the borehole advanced to the desired depth. Figure 1 (Appendix A) shows typical construction details for an open-hole bedrock well.

The preferred method of well completion for the bedrock wells will be open-hole. However, if the open borehole is subject to cave-in, the well will be completed as a screened and cased sand-packed well. For details of completion, see Section 7.3.2.

7.3.2 Overburden Well Construction

Any of the drilling methods discussed in this SOP can be used to drill or set a well in the overburden. The hollow-stem augering method is the preferred choice for shallow (<100 feet total depth) overburden wells because the well can be constructed inside of the augers. Details of the construction are provided below and are shown in Figure 2 (Appendix A).

1. The screen slot size will be determined by the site geologist/hydrogeologist, based on the sand-pack size. The length of screen used will be site-dependent. Casing sections will be flush-threaded. Screw-threaded bottom plugs will be used. To prevent introduction of contaminants into the well, no glue-connected fittings will be used. Each piece of PVC pipe, screen, and the bottom plug will be steam-cleaned before lowering into the borehole. The site geologist/hydrogeologist is responsible for the supervision of all steam cleaning procedures.

2. The annular space between the well screen and the borehole wall will be filled with a uniform gravel/sand pack to serve as a filter media. For wells deeper than approximately 50 feet, or when recommended by the site geologist, the sand pack will be emplaced using a tremie pipe. A sand slurry composed of sand and potable water will be pumped through the tremie pipe into the annulus throughout the entire screened interval, and over the top of the screen. Allowance must be made for settlement of the sand pack.

3. The depth of the top of the sand will be determined using the tremie pipe and a weighted measuring tape, thus verifying the thickness of the sand pack. Additional sand shall be added to bring the top of the sand pack to approximately 2 to 3 feet above the top of the well screen.

   Under no circumstances should the sand pack extend into any aquifer other than the one to be monitored. In most cases, the well design can be modified to allow for a sufficient sand pack without threat of crossflow between producing zones through the sand pack.

4. For materials that will not maintain an open borehole using hollow-stem augers, the temporary or outer casing will be withdrawn gradually during placement of sand pack/grout. For example, after filling two feet with sand pack, the outer casing should be withdrawn 2 feet. This step of placing more sand and withdrawing the outer casing should be repeated until the level of the sand pack is approximately 3 feet above the top of the well screen. This ensures there is no locking of the permanent (inner) casing within the outer casing.

5. A bentonite seal of a minimum 2-foot vertical thickness will be placed in the annular space above the sand pack to separate the sand pack from the cement surface seal. The bentonite will be placed through a tremie pipe or poured directly into the annular space, depending upon the depth and site conditions. The bentonite will be pourable pellets. The geologist/hydrogeologist will record the start and stop times of the bentonite seal emplacement, the interval of the seal, the amount of bentonite used, and any problems that arise. The type of bentonite and the supplier will also be recorded.

   A cap placed over the top of the well casing, before pouring the bentonite pellets, will prevent pellets from entering the well casing.

6. If a slurry of bentonite is used as an annular seal, it is prepared by mixing powdered or granular bentonite with potable water. The slurry must be of sufficiently high specific gravity and viscosity to prevent its displacement by the grout to be emplaced above it. As a precaution (regardless of depth) and depending on fluid viscosity, a few handfuls of bentonite pellets may be added to solidify the bentonite slurry surface.

7. Cement and/or bentonite grout is placed from the top of the bentonite seal to the ground surface.

   Only Type I or II cement without accelerator additives may be used. An approved source of potable water must be used for mixing grout materials. The following mixes are acceptable:

   - Neat cement, a maximum of 6 gallons of water per 94 pound bag of cement
   - Granular bentonite, 1.5 pounds of bentonite per 1 gallon of water
   - Cement-bentonite, 5 pounds of pure bentonite per 94 pound bag of cement with 7-8 gallons of water.
   - Cement-bentonite, 6 to 8 pounds of pure bentonite per 94 pound bag of cement with 8-10 gallons of water, if water mixed
   - Non-expandable cement, mixed at 7.5 gallons of water to one half (½) teaspoon of Aluminum Hydroxide, 94 pounds of cement (Type I) and 4 pounds of bentonite
   - Non-expandable cement, mixed at 7 gallons of water to one half (½) teaspoon of Aluminum Hydroxide, and 94 pounds of cement (Type I and Type II)

8. Grout is pumped through a tremie pipe (normally a 1.25-inch PVC or steel pipe) to the bottom of the annulus until undiluted grout flows from the annulus at the ground surface.

9. In materials that will not maintain an open hole, the temporary steel casing should be withdrawn in a manner that prevents the level of grout from dropping below the bottom of the casing.

10. Additional grout may be added to compensate for the removal of the temporary

casing and the tremie pipe to ensure that the top of the grout is at or above ground surface. After the grout has set (about 24 hours), any depression due to settlement is filled with a grout mix similar to that described above.

11. The protective casing should now be set. The casing may be a 5 foot minimum length of black iron or galvanized pipe extending about 1.5 to 3 feet above the ground surface, and set in concrete or cement grout. The protective casing diameter should be at least 2 inches greater than the well casing. A 0.5-inch drain hole may be installed near ground level. A flush-mount protective casing may also be used in areas of high traffic or where access to other areas would be limited by a well stick-up.

12. A protective steel cap, secured to the protective casing by a padlock, should be installed.

13. Steel guard posts should be installed around the protective casing in areas where vehicle traffic may be a problem. Posts should have a minimum diameter of 3 inches and be a minimum of 4 feet high.

14. All monitor wells should be labeled and dated with paint or steel tags.

7.4 Well Development

Well development is the process by which the aquifer's hydraulic conductivity is restored by removing drilling fluids, and fine-grained formation material from newly installed wells. Two methods of well development that are commonly used are surging and bailing, and overpumping. A well is considered developed when the pH and conductivity of the groundwater stabilizes and the measured turbidity is <50 nephelometric turbidity units (NTUs).

Surging and bailing will be performed as follows:

1. Measure the total depth (TD) of the well and depth to water (DTW).

2. Using an appropriately sized surge block, surge 5-foot sections of well screen, using 10-20 up/down cycles per section. Periodically remove the surge block and bail accumulated sediment from the well, as required.

3. For open-hole wells, a 6-inch surge block will be used inside the cased portion of the well. Sediments will be bailed periodically, as required. Overpumping may be used in combination with surging and bailing for development of bedrock wells. The method(s) used will be based on field conditions encountered, and will be determined by the site geologist/hydrogeologist. However, sediment will initially be removed from the wells by bailing in order to minimize the volume of development water generated.

The pump used must be rated to achieve the desired yield at a given depth. The pump system should include the following:

- A check valve to prevent water from running back into the well when the pump is shut off
- Flexible discharge hose
- Safety cable or rope to remove the pump from the well
- Flow meter (measuring bucket or inline flow meter)
- Generator
- Amp meter, to measure electrical current (load)

The amp meter is used to monitor pump performance. If the pump becomes clogged, the amperage will increase due to stress on the pump. If the water level drops below the intake ports, the current will drop due to decreased resistance on the pump.

8.0 CALCULATIONS

To maintain an open borehole during rotary drilling, the drilling fluid must exert a pressure greater than the formation pore pressure. Typical pore pressures for unconfined and confined aquifers are 0.433 pounds per square inch per foot (psi/ft) and 0.465 psi/ft, respectively.

The relationship for determining the hydrostatic pressure of the drilling fluid is:

***Hydrostatic Pressure* (*psi*) *Fluid Density* (*lb/gal*) × *Height of Fluid Column* (*ft*) × 0.052**

The minimum grout volume necessary to grout a well can be calculated using:

***rout Vol.* (*ft* 3) *Vol. of Borehole* (*ft* 3) *Vol. of Casing* (*ft* 3) *L* (*r*2*B r* 2**

where:

L = length of borehole to be grouted (ft)
r_B = radius of boring (ft)
r_C = radius of casing (ft)

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance activities that apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on standard well completion forms, field data sheets or within field/site logbooks.

2. All instrumentation must be operated in accordance with the operating instructions as provided by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

Drilling rigs and equipment present a variety of safety hazards. All personnel working around drilling rigs should know the position of the emergency "kill" switch. Wirelines and ropes should be inspected and frayed or damaged sections discarded. Swivels and blocks should turn freely. Gauges should be operational and controls clearly marked. All underground utilities should be clearly marked, and drillers should be aware of any overhead hazards such as power lines. Avoid drilling in these areas. Ear protection should be worn when working around drilling equipment for extended periods of time, particularly air rotary equipment. Failure to follow safety procedures or wear the proper personal protection gear, on the part of either the drilling crew or SERAS personnel, may result in dismissal from the job.

When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health Administration (OSHA), and corporate health and safety practices.

12.0 REFERENCES

American Society for Testing and Materials. 1991. Annual Book of ASTM Standards. Designation: D5092-90. *Standard Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers.* Philadelphia, PA. p. 1081-1092.

Boateng, K., P.C. Evens, and S.M. Testa. 1984. "Groundwater Contamination of Two Production Wells: A Case History." *Groundwater Monitoring Review*, 4(2):24-31.

Keely, J.F. and Kwasi Boateng. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 1: Conceptualizations." *Groundwater* 25(3):300-313.

Keely, J.F. and Kwasi Boateng. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 2: Case Histories." *Groundwater* 25(4):427-439.

Driscoll, F.G. 1986. *Groundwater and Wells.* 2nd ed. Johnson Division, UOP Inc., St. Paul, MN. p. 1089

U.S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*. EPA/540/P-87/001. Office of Emergency and Remedial Response. Washington, DC.

American Society for Testing and Materials. 1991. Annual Book of ASTM Standards. Designation: D1586-84. *Split Barrel Sampling.* Philadelphia, PA.

13.0 APPENDICES

A - Figures

APPENDIX A
Figures
SOP #2048
July 2001

FIGURE 1. Typical Bedrock Well Construction

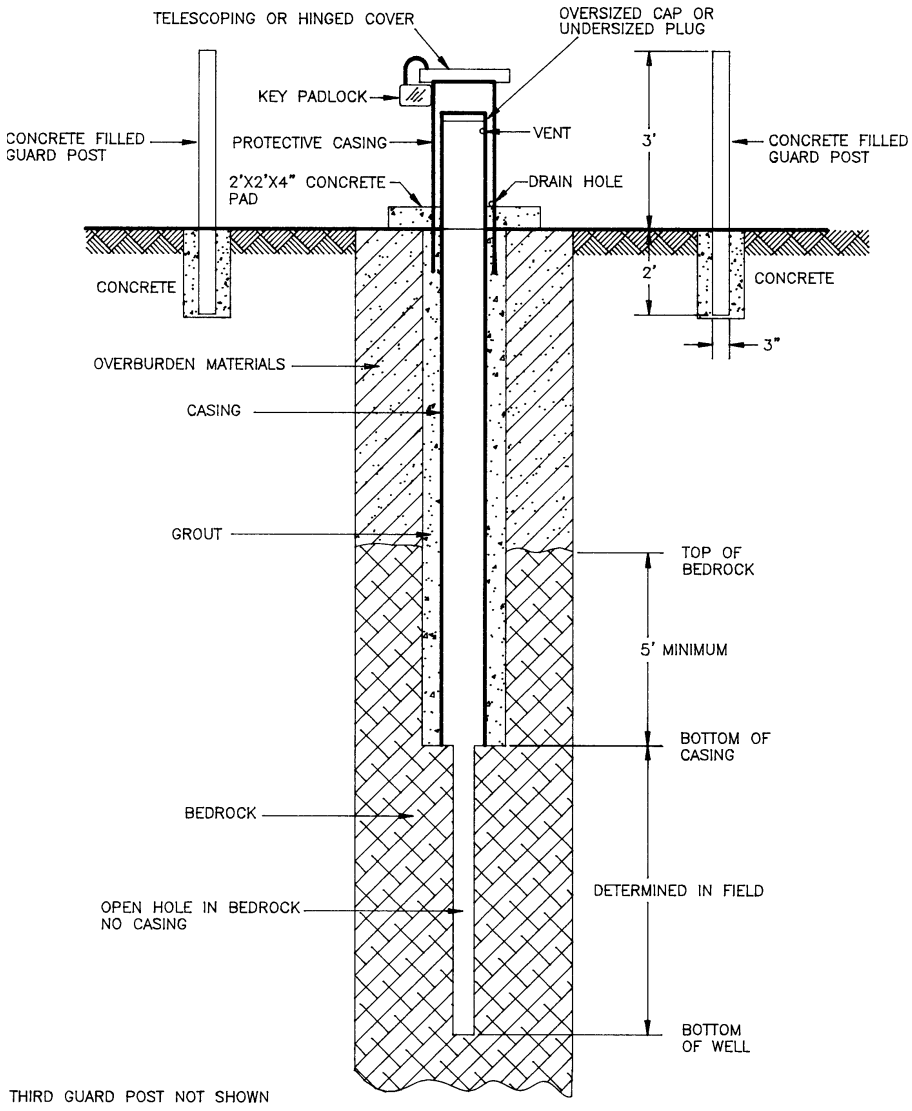
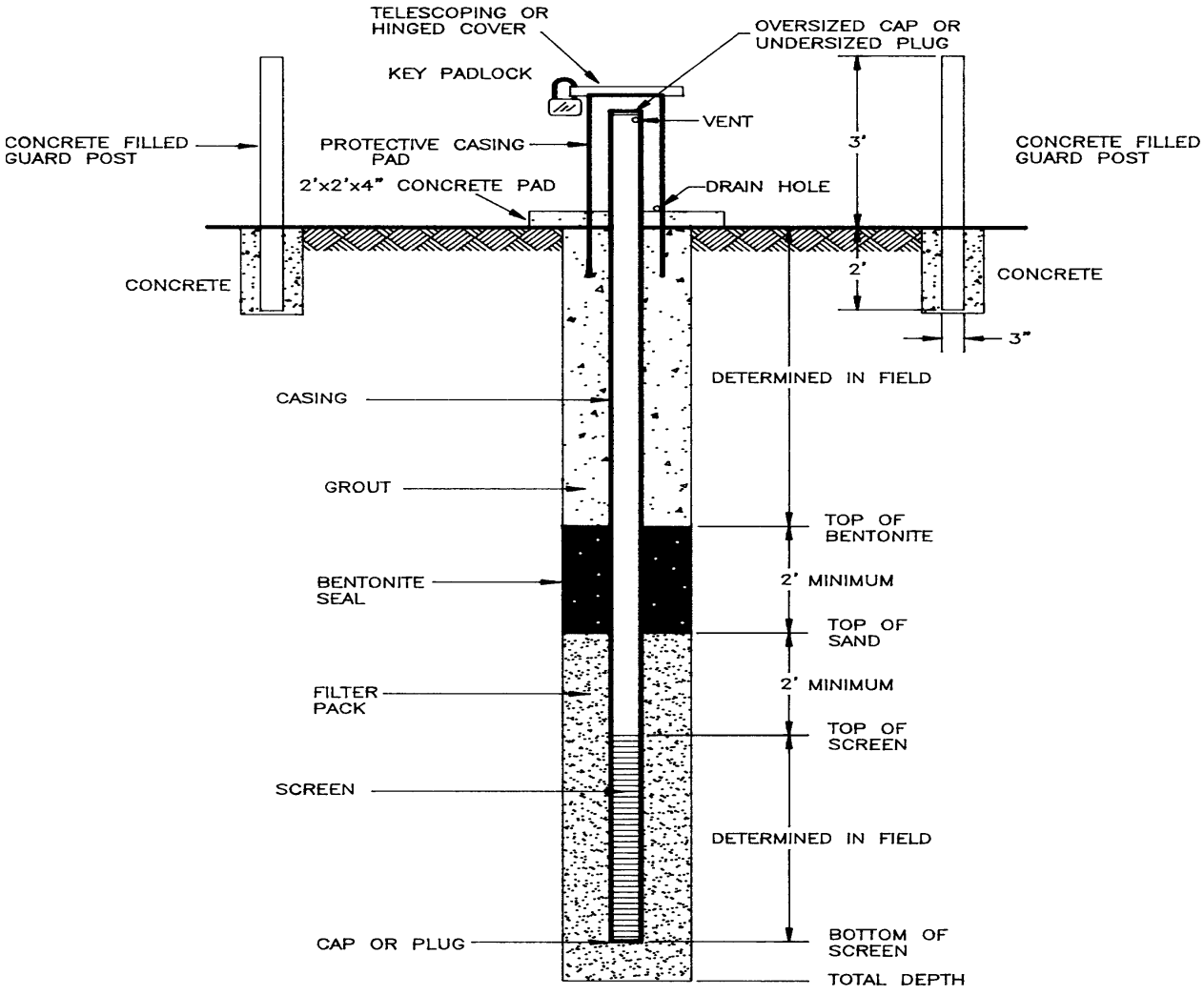


FIGURE 2. Typical Overburden Well Construction



INVESTIGATION-DERIVED WASTE MANAGEMENT

CONTENTS

SUPERCEDES: SOP #2170; Revision 0.0; 03/22/94; U.S. EPA Contract EP-W-09-031.

1.0 SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to provide general reference information on management of investigation-derived wastes (IDW) generated during SERAS site investigations. IDW includes soil cuttings, drilling muds, purged groundwater, decontamination fluids (water and other fluids), disposable sampling equipment, and disposable personal protective equipment (PPE).

This SOP is applicable only if the U.S. Environmental Protection Agency (U.S. EPA) On-Scene Coordinator, Remedial Project Manager, or other Regional Manager does not have procedures in place for IDW management.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Prior to site activities, the Task Leader should determine if the On-Scene Coordinator, Remedial Project Manager, or other Regional Manager has procedures in place for IDW management. This should be done by contacting the Work Assignment Manager.

If it is determined that procedures are not in place, then the Task Leader should evaluate IDW handling and management options based on:

- The site contaminants and their concentrations, and total projected volume of IDW.
- Media potentially affected (e.g., groundwater, soil) by management options.
- Location of the nearest population(s) and likelihood and/or degree of site access.
- Potential exposure to workers.
- Potential environmental impacts.

Every effort must be made to ensure the selection of investigation method(s) that minimize the generation of IDW, contact with contaminants, and cost of disposal. Efforts made to characterize IDW shall be consistent with the scope and purpose of the site investigation.

The QA Work Plan describing the anticipated approach and procedures for IDW management shall be clear, detailed, and concise. Any deviation or modification due to unexpected and unforeseen field conditions will be noted in the site logbook.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

IDW can be contaminated with various hazardous substances. To handle IDW in compliance with

regulations, reasonable efforts should be made to characterize the wastes.

5.0 EQUIPMENT/APPARATUS

Equipment, materials, and supplies needed for containerizing IDW are generally selected based on waste characteristics or constituents. Other considerations include the case of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, 5-gallon buckets, plastic bags, etc. can help segregate contaminated materials. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

5.1 Waste Disposal

- Trash bags
- Trash containers
- 55-gallon drums or 5-gallon pails
- Metal/plastic buckets/containers for storage and disposal of decontamination solutions

5.2 Decontamination Equipment

- Drop cloths of plastic or other suitable materials
- Large galvanized tubs
- Wash solutions
- Rinse solutions
- Long-handled, soft-bristled brushes
- Paper or cloth towels
- Metal or plastic cans or drums
- Soap or wash solution

6.0 REAGENTS

There are no reagents used in this procedure aside from decontamination solutions. In general, the following solvents are typically utilized for decontamination purposes:

- 10% nitric acid
- Acetone (pesticide grade)
- Hexane (pesticide grade)
- Methanol

7.0 PROCEDURES

7.1 Regulatory Background and Options for Management of IDW

This SOP is based on the following guidance document:

OERR Directive 9345.3-02, "Management of Investigation-Derived Wastes During Site Inspections," May 1991.

The guidance document presents a general regulatory background and options for management of IDW generated during Superfund site activities. IDW includes soil cuttings, drilling muds, purged groundwater, decontamination fluids (water and other fluids), disposable sampling equipment and disposable PPE. The National Contingency Plan (NCP) requires that management of IDW generated during site investigations complies with all applicable or relevant and appropriate requirements (ARARs) to the extent practicable. In addition, other legal and practical considerations may affect the handling of IDW.

IDW from site inspections may contain hazardous substances as defined by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Some CERCLA hazardous substances are hazardous wastes under Subtitle C of the Resource Conservation and Recovery Act (RCRA), while other substances are regulated by other federal laws such as the Safe Drinking Water Act (SDWA), Clean Air Act (CAA), Toxic Substances Control Act (TSCA), and the Clean Water Act (CWA). The U.S. EPA estimates that RCRA hazardous IDW have been generated at fewer than 15% of CERCLA sites. However, RCRA regulations, and in particular the RCRA Land Disposal Restrictions, are very important as potential ARARs since they regulate treatment, storage, and disposal of many of the most toxic and hazardous materials.

The U.S. EPA's strategy for managing RCRA hazardous IDW is based on:

- The NCP directive that site investigations comply with ARARs to the extent practicable.
- The area of contamination (AOC) unit concept.

The most important general elements of managing IDW are as follows:

- Leaving a site in no worse condition than existed prior to the investigation.
- Removing those wastes that pose an immediate threat to human health or the environment.
- Leaving on site those wastes that do not require off-site disposal or long-term above-ground containerization.
- Complying with federal and state ARARs to the extent practicable.
- Planning and coordination for IDW management.
- Minimizing the quantity of wastes generated.

The specific elements of the approach are as follows:

- Characterizing IDW through the use of existing information (manifests, Material Safety Data Sheets, previous test results, knowledge of the waste generation process, and other relevant records) and best professional judgment.
- Delineating an AOC unit for leaving RCRA hazardous soil cuttings within the unit.
- Containerizing and disposing of RCRA hazardous groundwater, decontamination fluids, PPE, and disposable sampling equipment (if generated in excess of 100 kg/month) at RCRA Subtitle C facilities.
- Leaving on site RCRA nonhazardous soil cuttings, groundwater, and decontamination fluids

preferably without containerization and testing.

The U.S. EPA does not recommend the removal of wastes from all sites and, in particular, from those sites where IDW does not pose any immediate threat to human health or the environment.

Based on this information and the guidelines included in the following sections, the SERAS Task Leader should include a plan for handling IDW in the QA Work Plan. Any deviations from or modifications to the plan due to unexpected or unforeseen field conditions must be noted in the site logbook.

7.2 Identification of IDW

To handle IDW properly, the Task Leader must know whether it contains CERCLA hazardous substances and whether these substances are RCRA hazardous wastes or contaminants regulated under other statutes. To handle IDW in compliance with regulations, reasonable efforts should be made to characterize them. However, these efforts should be consistent with the scope and purpose of the site investigation.

In particular, extensive testing is not warranted in most cases; instead, the nature of the wastes should be assessed by applying professional judgment, using readily available information about the site (such as manifests, storage reports, preliminary assessments, and results of earlier studies), as well as direct observation of the wastes for discoloration, odor, or other indicators of contamination. Similarly, RCRA procedures for determining whether a waste exhibits RCRA hazardous characteristics do not require testing if the decision can be made by applying knowledge of the characteristic in light of the materials or process used. In most instances, a determination may be made based on available information and professional judgment. This does not mean that IDW can be assumed to be nonhazardous unless clearly proven otherwise. Given the limited information available, the Task Leader, in conjunction with the Work Assignment Manager, must determine whether it more likely than not that the wastes are hazardous.

Even if the IDW do not contain RCRA hazardous waste, the Task Leader should determine whether they contain other CERCLA hazardous substances. CERCLA hazardous substances include, in addition to RCRA hazardous wastes, substances, elements, compounds, solutions, or mixtures designated as hazardous or toxic under CERCLA itself or under the authority of other laws such as TSCA, CWA, CAA, and SDWA. Therefore, even if RCRA is not applicable, one of these statutes may be.

IDW may include, but is not limited to, the following items:

<u>Solid Waste</u>

- Soil
- Sediment
- Sludge/slag
- Drum solids
- Drill cuttings
- Used glassware
- Dedicated/expendable equipment (bailers, fitters, hose, buckets, XRF cups, etc.)
- Biological tissue
- Clean trash

- PPE
- Decontamination equipment (buckets, brushes, clothing, tools, etc.)
- Field analytics waste (immunoassay, chlor-n-oil, chlor-in-soil, HACH kits, sample extracts, etc.)

Aqueous Waste

- Drilling fluids
- Purge water
- Development water
- Decontamination fluids

7.3 Management of IDW

7.3.1 Waste Minimization

The Task Leader should select site investigation methods that minimize the generation of IDW, particularly RCRA hazardous wastes. The site investigation team should limit contact with contaminants and use drilling and decontamination methods (such as steam cleaning) that minimize PPE, disposable equipment, decontamination fluids, and soil cuttings. In particular, the inspection team should minimize the amounts of solvents used for decontamination or eliminate solvents altogether. Minimizing the amount of wastes generated reduces the number of IDW handling problems and costs of disposal.

7.3.2 Types, Hazards, and Quantities of IDW

To handle IDW properly, the Task Leader must determine the types (such as soil cuttings, groundwater, decontamination fluids, PPE, or disposable equipment), characteristics (whether RCRA hazardous or containing other CERCLA hazardous substances), and quantities of anticipated wastes. As discussed previously, testing will generally not be required to characterize waste.

Upon determining the types of anticipated IDW, the Task Leader should determine IDW characteristics, in particular whether it is expected to be RCRA hazardous or to contain high concentrations of PCBs. For RCRA hazardous IDW, the Task Leader should determine whether it poses an increased hazard to human health and the environment relative to conditions that existed prior to the site investigation. Field analytical screening results, if available, may be helpful indicators of IDW characteristics. However, the Task Leader must remember that these are not RCRA tests and that the test results usually do not identify RCRA hazardous wastes. The Task Leader must also determine the exact properties of RCRA nonhazardous IDW to select an appropriate disposal facility when the off-site disposal is required.

Upon determining the type and characteristics of IDW to be generated, the Task Leader must assess the anticipated quantities of waste. This should be done based on past experience with site investigations of similar scope.

7.3.3 On-Site IDW Handling Options

In planning the scope of work, the Task Leader must decide if IDW can be left on site or

if it must be disposed off site.

Handling of RCRA hazardous IDW and IDW with high PCB concentrations (greater than 50 ppm) may involve either moving the IDW within an AOC unit, or containerization, storage, testing, treatment, and off-site disposal. Handling of RCRA nonhazardous IDW usually involves various methods of on-site disposal. It is preferable to leave both RCRA hazardous and nonhazardous IDW on site whenever it complies with regulations and does not pose any immediate threat to human health and the environment.

If IDW are RCRA nonhazardous soil or water, they should be left on site unless other circumstances, such as state ARARs or a high probability of serious community concerns, require off-site disposal. RCRA hazardous soil also may be left on site within an AOC unit. The Task Leader must determine procedures for handling IDW on site in conjunction with the Work Assignment Manager.

The on-site handling options available to the Task Leader when IDW are RCRA nonhazardous are listed below.

For soil cuttings:

1. Spread around the well.
2. Put back into the boring.
3. Put into a pit within the AOC.
4. Dispose of at the site's operating treatment/disposal unit (TDU).

For groundwater:

1. Pour onto ground next to well to allow infiltration.
2. Dispose of at the site's TDU.

For decontamination fluids:

1. Pour onto ground (from containers) to allow infiltration.
2. Dispose of at the site's TDU.

For decontaminated PPE and disposable equipment:

1. Double bag and deposit in the site or U.S. EPA dumpster, or in any municipal landfill.
2. Dispose of at the site's TDU.

If IDW are considered RCRA nonhazardous due to lack of information on the waste hazard, the Task Leader should have an alternate plan for handling IDW if field conditions indicate that these wastes are hazardous. In such a case, there should be an adequate number of containers available for collecting groundwater, decontamination water, soil cuttings, etc.

If IDW consists of RCRA hazardous soils that pose no immediate threat to human health and the environment, the Task Leader should plan on leaving it on site within a delineated AOC unit. However, the Task Leader must consider the proximity of

residents and workers in the surrounding area and use best professional judgment to make these decisions. Planning for leaving RCRA hazardous waste on site involves:

- Delineating the AOC unit.
- Determining pit locations close to the borings within the AOC unit for waste burial.
- Covering hazardous IDW in the pits with surficial soil.
- Not containerizing and testing wastes designated to be left on site.

Another alternative for handling RCRA hazardous soil is disposal in a TDU located on the same property as the AOC under investigation. If the TDU is outside the AOC, it must comply with the off-site policy. If any decontamination fluids are generated which are RCRA hazardous wastes, they should be disposed of off site in compliance with the off-site policy or in compliance with the conditionally exempt small quantity generator exemption. Small quantities (i.e., no more than 100 kg/month) of decontamination fluids may be containerized prior to delivery to a hazardous waste facility.

7.3.4 Off-Site Disposal of IDW Options

IDW should be disposed of off site in the following situations:

- When they are RCRA hazardous water.
- When they are RCRA hazardous soil that may pose a substantial risk if left at the site.
- When they are RCRA hazardous PPE and disposable equipment.
- If leaving them on site would create increased risks at the site.

RCRA nonhazardous wastes could be disposed of off-site at appropriate RCRA nonhazardous facilities that are in compliance with CERCLA section 121(d)(3) and off-site policy when it is necessary to comply with legally enforceable requirements such as state ARARs that preclude on-site disposal. IDW designated for off-site disposal must be properly containerized, tested, and stored before pick up and disposal. Decontaminated PPE and disposable equipment should be double-bagged if sent to an off-site dumpster or municipal landfill.

Planning for off-site disposal should include the following guidelines:

- Informing the Work Assignment Manager that containerized IDW may be temporarily stored on site while awaiting pick up for off-site disposal.
- Initiating the procurement process for IDW testing, pick up and disposal.
- Coordinating IDW testing and pick-up activities.
- Preparing adequate numbers and types of containers. Drums should be used for collecting small amounts of IDW. Larger amounts of soil and water can be contained in Baker tanks, poly tanks, and bins. PPE and disposable equipment should be double-bagged for disposal at a municipal landfill or collected in drums for disposal at a hazardous waste facility.
- Designating a storage area (either within the site's existing storage facility, existing fenced area, or within a temporary fence constructed for the site investigation). No humans, children in particular, may have access to the storage area.

All IDW shipped off site, whether RCRA hazardous or not, must go to facilities that comply with the RCRA disposal policy, and the Task Leader, in conjunction with the

SERAS Purchasing Department, must verify that the facilities operate in accordance with this policy.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

a. There are no specific quality assurance activities which apply to the implementation of these procedures. However all IDW disposal information must be documented within site logbooks. Additionally, all shipping and transport of hazardous and nonhazardous samples will comply with Department of Transportation (DOT) and International Air Transport Association (IATA) regulations. For additional information regarding sample handling procedures refer to ERT/SERAS SOP #2003, Sample Storage, Preservation, and Handling.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

12.0 REFERENCES

U.S. EPA, Guide to Management of Investigation Derived Wastes, OERR Directive 9345.3.03FS, January 1992.

U.S. EPA, Management of Investigations - Derived Wastes During Site Inspections, OERR Directive 9345.3-02, May 1991.

Code of Federal Regulations (CFR), Title 40, Part 261, Section 23, Section 11 (a) (3), and Section 24 (a) (b).

CFR Proposed Criteria: 51 FR 21685, June 30, 1986 and 51 FR 21450, May 20, 1992.

DESCRIPTION AND IDENTIFICATION OF SOILS

CONTENTS

DESCRIPTION AND IDENTIFICATION OF SOILS

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) outlines the description and identification of soils in the field using a modified Burmister System. The intent of this SOP is to establish a consistent method for describing oils that are to be sampled and analyzed in the course of a site investigation. Soil descriptions and identifications provide key information when investigating hazardous waste sites. More precise engineering parameters may be determined in a laboratory using industry-recognized methods such as those published by the American Society for Testing and Materials (ASTM).

"Soil", as used in this SOP and in the environmental field in general, is considered to be any unconsolidated natural material composed of solid particles, with the pore spaces occupied by water, gas, or liquid. The term encompasses the engineering and geological properties of the material and is not limited by depth below ground surface (bgs) or the origin of the material. According to this usage, "soils" may therefore include formal or informal geologic units and material that may also be classified as "sediments", thus implying an origin. The more traditional use of the term "soil" was generally limited to the near-surface material that serves as a medium for plant growth.

2.0 METHOD SUMMARY

Major attributes of a representative soil sample to be identified in the field include soil type or lithology (sand, silt, clay), color, texture as determined by major and minor particle sizes, and sorting. Other characteristics that may be recorded include structure, cementation, moisture content, density, the presence of accessory minerals, foreign material, odor, and hydrochloric acid (HCl) reaction. Other critical parameters of the sample collected include method of collection, location, and depth.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Because field identification of soil is a learned skill, results may vary due to experience, weather conditions, and type of sampling. Determining if a sample is representative of native soil may also present difficulties. During borehole investigations, "fallback" of material in the hole is common, particularly in loose sediment, and thus it may be difficult to identify native soil. Sampling or drilling methods other than coring may segregate size fractions so that finer-grained portions of the samples may be lost or not recognized. Soils containing large gravel or cobbles may be difficult to core consistently.

5.0 EQUIPMENT/APPARATUS

Standard materials and equipment required for soil classification are:

- Pocket knife or small spatula,
- Hand magnification lens,
- Tape measure or ruled scale,
- Grain size chart,
- Munsell color charts
- Soil boring log or field logbook

6.0 REAGENTS

- Dilute 10 percent (%) hydrochloric acid
- Water; city, non-potable or any other natural source

7.0 PROCEDURES

The following items are typically determined and recorded for soil classification.

7.1 Soil Sample Origin

A soil sample should be representative of the stratum from which it was obtained using an industry-recognized procedure (e.g., ASTM D-1581). The sample is identified by soil boring number, location, and depth. This information is recorded in a field logbook or on soil boring logs (Figure 1, Appendix B) so that the origin of the sample can be readily ascertained away from the field. An example of a completed soil boring log is presented in Figure 2, Appendix B.

7.2 Soil Name or Type

The bulk soil type should be described by a generic name such as gravel, sand, silt, or clay. This is the primary descriptor with confirming or more detail added by the identification of major and minor particle sizes.

7.3 Color

The general color of the whole sample, preferably while it is moist, is described in the field. It is preferable that the Munsell Soil Color Charts be used for the soil color determination. The Munsell system provides a field standard for classifying soil color. It embodies three aspects of color - hue, value, and chroma. The hue documents the spectral color. The value is the lightness of the color. The chroma is the degree of departure from a specific color (e.g., weak or vivid). When using the Munsell description, the order for recording color is hue, value/chroma followed by the description. For example, 5YR 5/6 describes the hue as 5YR, yellowish-red with a value of 5 and a chroma of 6. Half values can also be used for colors falling halfway between chips (e.g. 5YR 5.5/6 yellowish-red). It should be noted if the Munsell Color Charts are not used for soil color descriptions.

Soil colors may be associated with certain soil attributes and environmental conditions. Yellow to reddish soil color may be indicative of the presence of oxidized iron (Fe^{+3}) and well-aerated soils.

The terms redoximorphic or mottling are used when several colors are present within a soil. These features are described using the following terms:

- size (small, medium, large),
- shape (round, semi-round, angular),
- edge contrast (smooth, sharp, distinct),
- density/abundance (frequent, infrequent).

7.4 Soil Density Classification

Density is determined through standard penetration resistance. Resistance in granular (cohesionless) soils is referred to as relative density while resistance in cohesive soils is referred to as soil consistency.

In the field, standard penetration resistance is the number of blows required to drive a standard two-inch outer diameter (OD) split-spoon sampler 12 inches into the soil column using a 140-pound hammer falling freely through 30 inches. The sampler is driven in three six-inch intervals for a total of 18 inches. The number of blows is recorded for each 6-inch interval. The N value is the number of blows required for the last 12 inches. This test demonstrates the compactness of granular soils, while it demonstrates the consistency of cohesive (silt and clay) soils on a shearing strength basis (Table 1, Appendix A).

7.5 Soil Structure Classification

Record soil structure attributes, as applicable, using the criteria described in Table 2, Appendix A.

7.6 Identification and Description of Soil Components.

7.6.1 Major and Minor Components

Examine the soil sample to determine the following components:

- Amount of sorting in the sediment (Figure 3, Appendix B),
- Size distribution (gravel, sand, silt, clay) (Tables 3 and 4, Appendix A),
- Major and minor components,
- Predominating grain shape (roundness) (Figure 4, Appendix B),
- Degree of compaction.

7.6.2 Other Components

Examine the soil sample to identify other components that may be present:

- Roots and root mass,
- Vegetation, peat, organic matter,
- Shells or fossils,
- Accessory minerals such as mica, gypsum, and magnetite,
- Slag, cinder or charcoal, trash, rubbish, fill, bricks, glass.

7.6.3 Recording Modified Burmister Soil Descriptions

Use the following guidelines when recording soil descriptions:

- If major component comprises more than 50% of the soil, than fully capitalize the major component descriptor (e.g., SAND);

- If the major component comprises less than 50% of the soil, capitalize the descriptor (e.g., Sand);
- Place a comma after the major and minor component descriptors;
- Place size qualifiers such as coarse, medium, or fine before the major component descriptors (Table 1, Appendix A);
- Describe the minor component with the first letter capitalized, preceded by the size descriptor (e.g., Fine Sand);
- Use these adjectives when describing the minor fraction(s):
  and = 35 to 50%
  some = 20 to 35%
  little = 10 to 20%
  trace = <10%
- Record formal or informal geological names for soil bodies when probable identification can be made from the literature or local experience.

Some examples of modified Burmister soil descriptions are:

- Gray medium to fine GRAVEL and coarse to fine Sand, trace silt;
- 2.5YR 5/4 reddish brown coarse to medium SAND, little Clayey Silt, some medium to fine Gravel; layered, occasional lens coarse Sand;
- Wet, Very loose grey 3/1 dark gray to black, fine to coarse SAND, little rounded fine to coarse Gravel, trace Silt, some debris (wood, organics, cinders)(fill).

7.7 Soil Moisture

Note the moisture content as dry, moist or wet. Dry refers to the absence of moisture, dusty, dry to the touch; moist is damp with no visible water; wet has visible free water and the soil sample is usually collected below the water table. The top of the capillary fringe should be recorded, if it can be identified, and the date noted on the soil boring log or in the field logbook.

7.8 Soil Odor

Soil odor may be classified as organic or chemical. Some decaying organic soils may exhibit a rotten egg or vegetable odor; whereas, contaminated soils may have a petroleum or chemical smell. Caution should be used and soil odors should not be inhaled directly if contaminants are suspected.

7.9 Photoionization/Flame Ionization Detectors

Photoionization detectors (PIDs) and/or flame ionization detectors (FIDs) may be used to identify areas of contamination. Detectors are sensitive to particular compounds, depending on the type of detector. Weather conditions, temperature, and moisture content of the sample may affect the

readings. When measured, these readings are recorded on the soil boring logs or in the field logbook along with location and any other descriptors (i.e., discoloration between laminations or in fill).

7.10 Hydrochloric Acid Reaction

Reaction to a drop or two of dilute HCl is noted as strong, weak, or none. Strong refers to a violent reaction, with bubbles forming immediately; weak is some reaction, with the slow formation of bubbles; and none is any visible reaction. This test identifies the presence of carbonates, either in the cement (if present) or the soil matrix. Caution must be exercised when handling acids.

7.11 Cementation

Cementation is an indicator of cohesiveness and should be recorded as strong, moderate, or weak. Intact soils that will not crumble or break with finger pressure are classified as strong. Moderate refers to intact soils that crumble or break with considerable finger pressure and weak refers to those that crumble or break with handling or little finger pressure. Cement type can often be recognized. Common cement types are iron and carbonate (effervesces with dilute hydrochloric acid).

8.0 CALCULATIONS

This section not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

All data must be documented on soil boring logs or in field logbooks.

10.0 DATA VALIDATION

If additional analyses (e.g., sieve analyses or other engineering tests) are required by a laboratory, the results will be reviewed prior to release. All soil boring logs will become part of a deliverable package and will be reviewed in accordance with SERAS Administrative Procedure (AP) #22, *Peer Review of SERAS Deliverables.*

11.0 HEALTH AND SAFETY

General field safety practices must be followed. Waste samples should be handled with care and disposed of in accordance with SERAS SOP #2049, *Investigation-Derived Waste Management*. Refer to the specific material safety data sheet (MSDS) for any chemical or reagent utilized in this procedure. All excess samples, used samples, and waste material generated during any additional analysis not covered in this SOP must be disposed in accordance with SERAS SOP #1501, *Hazardous Waste Management.*

When working with potentially hazardous materials, follow United States Environmental Protection Agency (U.S. EPA), Occupational Safety and Health Administration (OSHA), and corporate health and safety procedures.

12.0 REFERENCES

American Society of Testing and Materials (ASTM). 2000. *Annual Book of ASTM Standards*, Designation D2488 - 00: Description and Identification of Soils (Visual-Manual Procedure).

13.0 APPENDICES

A - Tables
B - Figures

APPENDIX A
Tables
SOP #2074
February 2004

TABLE 1. Relative Density and Consistency of Soils

Compactness of Cohesionless Soils

Relative Density	*Standard Penetration Resistance*, (bpf) blows per foot
very loose	0-4
loose	5-10
medium dense	11-30
dense	31-50
very dense	>50

> = greater than

Consistency of Cohesive Soils

Consistency	*Unconfined Compressive Strength*, (tons per ft^2)	*BPF*	*Field Identification*
very soft	<0.25	0-2	Easily penetrated several inches with fist.
soft	0.25-0.50	3-4	Easily penetrated several inches with thumb.
medium stiff	0.50-1.0	5-8	Penetrated several inches with thumb under moderate pressure.
stiff	1.0-2.0	9-15	Readily indented with thumb, but penetrated with great effort.
very stiff	2.0-4.0	16-30	Readily indented with thumbnail.
hard	>4.0	>30	Indented with difficulty with thumbnail.

ft^2 = foot squared, < = less than

TABLE 2. Soil Structures

Examples of Soil Structures

Description	*Criteria*
Stratified	alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	alternating layers of varying material less than 6 mm thick, note thickness
Massive	no visible layers
Stringers	layers or different material or color
Lenses	small pockets of different material or color; note thickness and extent.
Homogeneous	same color and appearance throughout.
Heterogeneous	non-uniform color and appearance throughout.

mm = millimeters

Bedding Thickness

Thickness (English)	*Thickness (Metric)*	*Bedding Classification*
>3.3'	>1m	v. thickly bedded
1'-3.3'	30cm-1m	thickly bedded
4"-1'	10cm-30cm	medium bedded
1"-4"	3cm-10cm	thinly bedded
2/5"-1"	1cm-3cm	v. thinly bedded
1/8"-2/5"	3mm-1cm	laminated
1/32"-1/8"	1mm-3mm	thinly laminated
< 1/32"	<1mm	microlaminated

m = meters, cm = centimeters, mm= millimeters, > = greater than, < = less than, v. = very, ‘ = inches

TABLE 3. Grain Size and Type Definitions

Component	*Definition*	*Fractions*	*Upper Sieve Limit*	*Lower Sieve Limit*
boulders	lithified material > 9 inches			9 inch
cobbles	lithified material < 9 inched but > 3 inches		9 inch	3 inch
gravel	material passing through the 3 inch sieve and retained on the no. 10 (2000-micron) sieve	Coarse Medium Fine	3 inch 1 inch 1/8 inch	1 inch 1/8 inch No. 10
sand	material passing the No. 10 sieve and retained on the No. 200 (74 micron) sieve	Coarse Medium Fine	No. 10 (2000 micron) No. 30 (590 Micron) N0. 60 (250 micron)	No. 30 N0. 60 No. 200
silt	Material passing the 200 sieve that is non-plastic in character and exhibits little or no strength when air dried	Coarse Fine	No. 200 (74 micron) 0.02 mm	0.02 mm
clay	Material passing the No. 200 sieve which can be made to exhibit plasticity and clay qualities within a certain range of moisture content, and which exhibits considerable strength when air dried.			

< = less than, > = greater than, mm = miliimeters

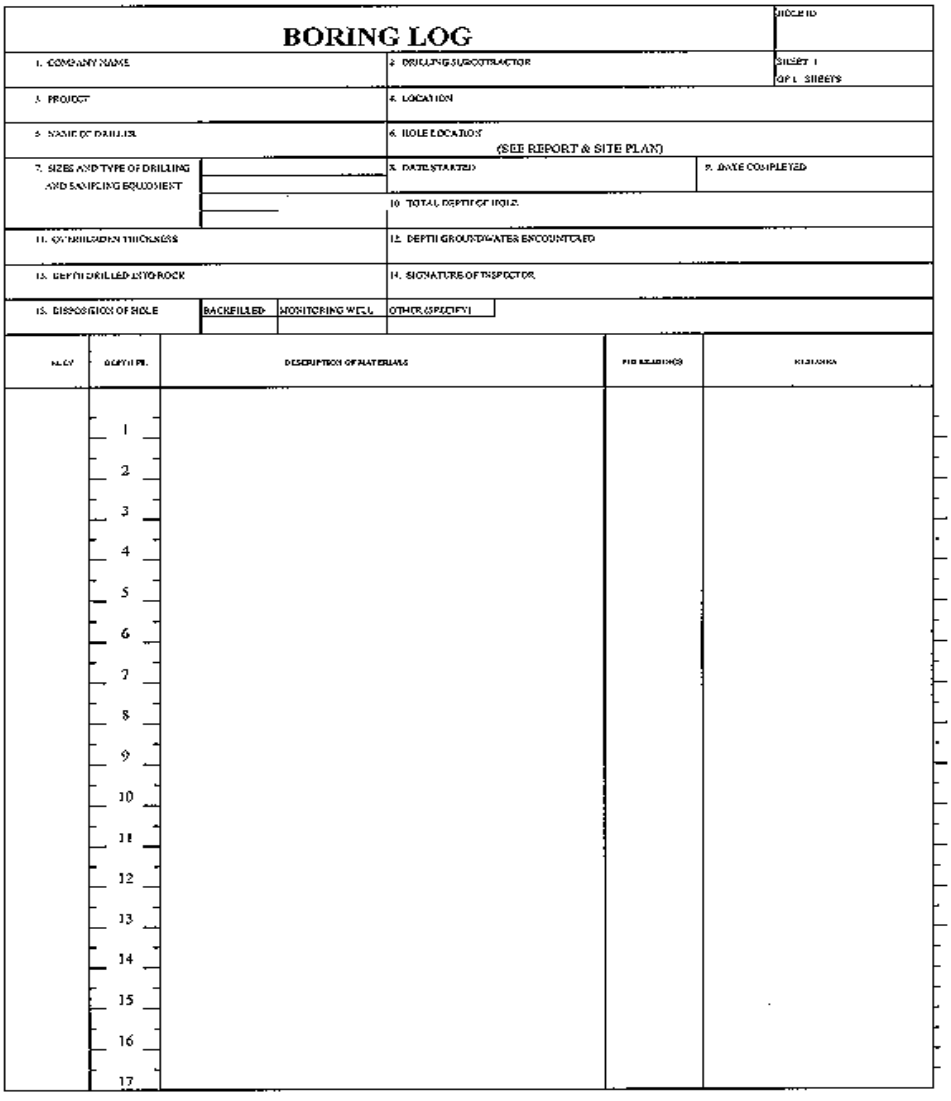
TABLE 4. Field Identification of Silt and Clay Component Ratio

Component	*Smallest Diameter of Rolled Thread*	*Plasticity Index*	*Plasticity*
silt	none	0	Non-plastic
clayey silt	thread crumbles at1/4"	1 to 5	slight
silt and clay	thread crumbles at 1/8"	5 to 10	Low
clay and silt	thread crumbles at 1/16"	10 to 20	medium
silty clay	thread crumbles at 1/32"	20 to 40	High
clay	thread crumbles at 1/64"	>40	very high

" = inches, > = greater than

APPENDIX B
Figures
SOP #2074
February 2004

FIGURE 1. Example Soil Boring Log



BORING LOG

HOLE ID

1. COMPANY NAME
2. DRILLING SUBCONTRACTOR
SHEET 1 OF 1 SHEETS
3. PROJECT
4. LOCATION
5. NAME OF DRILLER
6. HOLE LOCATION (SEE REPORT & SITE PLAN)
7. SIZES AND TYPE OF DRILLING AND SAMPLING EQUIPMENT
8. DATE STARTED
9. DATE COMPLETED
10. TOTAL DEPTH OF HOLE
11. OVERBURDEN THICKNESS
12. DEPTH GROUNDWATER ENCOUNTERED
13. DEPTH DRILLED INTO ROCK
14. SIGNATURE OF INSPECTOR
15. DISPOSITION OF HOLE: BACKFILLED | MONITORING WELL | OTHER (SPECIFY)

ELEV.	DEPTH FT.	DESCRIPTION OF MATERIALS	PID READINGS	REMARKS
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			
	14			
	15			
	16			
	17			

FIGURE 2. Completed Soil Boring Log

FIGURE 3. Soil Boring Log

BORING LOG

1. COMPANY NAME: Locked Martin (REAC)	2. DRILLING SUBCOTRACTOR: GROTZK DRILLING. CO	HOLE ID: MCB-3 / SHEET 1 OF 1 SHEETS
3. PROJECT: Bosta Site	4. LOCATION: Interior Building	
5. NAME OF DRILLER: Mark	6. HOLE LOCATION: (SEE REPORT & SITE PLAN)	
7. SIZES AND TYPE OF DRILLING AND SAMPLING EQUIPMENT: acetate sleeves	8. DATE STARTED: 5/9/2003	9. DATE COMPLETED: 9-May-03
GEOPROBE	10. TOTAL DEPTH OF HOLE: 16 FT.	
11. OVERBURDEN THICKNESS	12. DEPTH GROUNDWATER ENCOUNTERED: DRY	
13. DEPTH DRILLED INTO ROCK	14. SIGNATURE OF INSPECTOR: Gary Newhart	
15. DISPOSITION OF HOLE: BACKFILLED x; MONITORING WELL; OTHER (SPECIFY)		

ENVIRONMENTAL SAMPLES	DEPTH FT.	DESCRIPTION OF MATERIALS BURMISTER SYSTEM	PID READINGS	REMARKS UNIFIED SYSTEM
	1	Med. To fine SAND,some fine gravel (fill)		
0-4 FT	2			rec. only 6inches SW
	3			
	4	Brown, f.SILT & Clay organic peat stringers		Marsh deposit very wet
	5			
	6			rec. 42 in. OL
	7			
	8	f.to coarse SAND,some f.to med.gravel,some silt		Fluvial deposit saturated SW
	9			
	10			
	11			
	12	v.dk. Brown med(+) to coarse SAND &med.GRAVEL,,little silt		SW Fluvial deposit heavily stained
	13	Green Saprolite/Residual Clay DRY		
	14			severly weathered
	15			
	16	E.O.B. @ 16FT.		
	17			

Figure 3 Soil Sorting

poorly sorted moderately sorted well-sorted

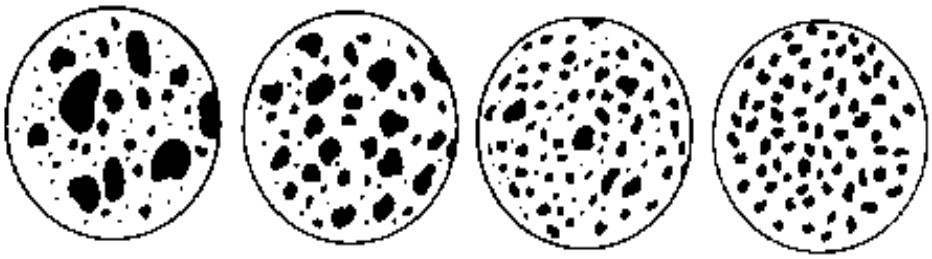


FIGURE 4. Grain Shape Diagram

well-rounded rounded sub-rounded sub-angular angular

STANDARD OPERATING PROCEDURES

pH/mV/ORP DETERMINATION USING A COLE-PARMER DIGI-SENSE METER

CONTENTS

REPLACES: SOP #2077, Revision 0.0; 12/19/96. U.S. EPA Contract EP-W-09-031.

pH/mV/ORP DETERMINATION USING A COLE-PARMER DIGI-SENSE METER

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the measurement of pH in aqueous media using a COLE-Palmer Digi-Sense digital pH/mV/ORP meter.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

The electromotive force (EMF) produced in the glass electrode system varies linearly with pH. This linear relationship is described by plotting the measured EMF against the pH of different buffers. Sample pH is determined by extrapolation[1].

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING and STORAGE

No preservation is necessary. Samples should be stored in glass or polyethylene bottles, maintained at 4^{o}C and analyzed immediately. Analyses are typically performed at room temperature. All samples and calibration buffers should be allowed to equilibrate to ambient temperature prior to analysis.

The amount of the sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest, and are discussed in ERT/SERAS SOP #2003, *Sample Storage, Preservation and Handling* for water matrices.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The combination electrode is relatively free from interference from color, turbidity, colloidal matter, oxidants, reductants, and high salinity, except for a sodium error at pH >10[1].

Measurements of pH are affected by temperature in two ways: mechanical effects that are caused by changes in the properties of the electrodes, and chemical effects caused by equilibrium changes. Standard pH buffers have a specific pH at indicated temperatures.

5.0 EQUIPMENT/APPARATUS

The following are standard materials and equipment required for testing:

- pH meter, Model No. 5938-00

- Combination pH electrode
- Magnetic stir plate
- Magnetic stir bars
- Thermometer
- 9V battery

6.0 REAGENTS

At least two standard known pH buffers are needed to calibrate the meter. The three most common are pH 4.00, 7.00, and 10.00 buffers. The buffers selected should bracket the pH of the samples. A saturated aqueous potassium chloride (KCl) solution is used for filling the combination electrode. If separate glass and reference electrodes are used, the reference electrode is filled with saturated aqueous KCl. Deionized or distilled water should be used for rinsing the probe between samples.

7.0 PROCEDURE

7.1 pH Calibration Procedure

1. Press ON/OFF key to turn meter on.
2. Connect the pH probe to the meter.
3. Immerse the probe in buffer 7.00.
4. Press the pH/mV key to select pH.
5. Adjust temp EC control to the temperature of buffer 7.00.
   Note: Both buffers should be at the same temperature.
6. Adjust the standardize control to read 7.00 pH on the display.
7. Rinse the pH probe with deionized or distilled water and blot dry.
8. Immerse the probe in the second buffer (4.00 or 10.00)
9. Adjust the temp EC control to the temperature of the second buffer.
10. Allow the reading to stabilize, and then adjust the SLOPE control to the value of the second buffer.
11. Rinse probe with deionized or distilled water. Calibration is now complete.

The pH meter should be calibrated at the beginning of every eight-hour operating period, and the calibration must be checked at least once during every subsequent eight-hour period.

7.2 Operation

1. Push the ON/OFF key to turn the meter on.

2. Push the pH/mV key until the annunciators indicate the desired mode.

For millivolt or ORP (oxidation-reduction potential) measurement: Press the pH/mV key until the display shows millivolts. Verify the probe connection, then rinse the probe with distilled water and blot dry. Immerse the probe in the sample to be measured. Allow the displayed reading to stabilize, then take the reading.

7.3 Temperature Compensation

Temperature compensation can be set manually by the temperature ^{o}C adjustment over a range of 0^{o} to 100^{o}C.

7.4 Sample Measurement

1. Measure the temperature of the sample to be measured

2. Rinse the probes with distilled or deionized water. Blot dry. With the meter on, place the electrode in the sample solution to be measured, which is being magnetically stirred.

3. If the meter is calibrated using pH 4.00 and pH 7.00 buffers and the sample reading is >7.00, the meter will be recalibrated using pH 7.00 and 10.00 buffers. Adjust the temp EC control the match the sample solution temperature. The sample pH will be displayed. Record the reading once the meter has stabilized.

For millivolt or ORP measurement: Press the pH/mV key until the display show millivolts. Verify the probe connection, then rinse the probe with distilled water and blot dry. Immerse the probe in the sample to be measured. Allow the display reading to stabilize, then take the reading.

7.5 Battery Replacement

The pH meter uses a 9 volt battery with a life of 2000 hours. If the low battery indicator is on, stop operation and replace the internal battery with a new 9 volt battery.

7.6 Cleaning the Probe

The glass bulb is the sensitive part of the probe, it should always be kept clean. Rinse the probe with deionized or distilled water after use. Before storage, rinse the probe with tap or distilled water, shake dry and place the probe in the protective cap, which should be filled with a KCl solution or equivalent probe storage solution.

If KCl or equivalent storage solution is not available, use a 4.00 pH buffer, 7.00 pH buffer, or tap water. Distilled water should never be used.

8.0 CALCULATIONS

The value displayed is read directly as pH. The temperature of the samples and calibration buffers should be identical to assure accuracy. Record sample temperature with pH value.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

All data must be documented on field data sheets or within site or laboratory notebooks.

All instrumentation must be operated in accordance with the manufacturer's instructions. Equipment check-out procedures and calibration activities must be performed. (See section 7.1).

Duplicate samples should be processed with the frequency of one in twenty samples. Duplicate samples will be used to determine precision.

10.0 DATA VALIDATION

By careful use of a laboratory pH meter with good electrodes, a precision of ±0.02 pH unit and accuracy of ± 0.05 pH unit can be achieved. However ±0.1 pH unit represents the limit of accuracy under normal conditions, especially for measurement of water and poorly buffered solutions[(1)].

11.0 HEALTH AND SAFETY

General laboratory safety practices should be followed. Waste samples should be handled with care due to the uncertainty of the properties and contents involved. Refer to the specific material safety data sheet (MSDS) for the hazardous properties of any chemical or reagent utilized in this analysis. All excess samples, used samples, and waste material generated during analysis must be disposed in accordance with ERT/SERAS SOP #1501, *Hazardous Waste Management.*

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and Lockheed Martin health and safety procedures. More specifically, refer to ERT/SERAS SOP #3013, *Laboratory Safety Program.*

12.0 REFERENCES

[(1)] American Public Health Association (APHA). 1992. *Standard Methods for the Examination of Water and Wastewater*, 18th Edition. Baltimore, Maryland: Port City Press.

[(2)] Cole-Parmer Instrument Co. *Digi-Sense Digital pH/mV/ORP Meter Operator's Manual*, A-1299-297, Edition 2692.

13.0 APPENDIX

A - Digi-Sense Digital pH/mV/ORP Operator's Manual

APPENDIX A
Digi-Sense® Digital pH/mV/ORP Meter Operator's Manual
SOP #2077
November 2000

pH/mV/ORP DETERMINATION USING A COLE-PARMER DIGI-SENSE METER

OPERATOR'S MANUAL

Digi-Sense®

Digital

pH / mV / ORP Meter

MODEL NO.
5938-00

Cole-Parmer Instrument Co.
7425 N. Oak Park Avenue
Niles, Illinois 60714

(708) 647-7600
1-800-323-4340

A-1299-297
Edition 2692

TABLE OF CONTENTS

pH/mV/ORP DETERMINATION USING A COLE-PARMER DIGI-SENSE METER

GENERAL DESCRIPTION

This portable, Digital pH Meter is designed with solid state electronics providing highly reliable operation. The LCD display enables you to read even under bright ambient conditions. It is designed for pH (manual), millivolt and ORP determination.

OPERATING TIPS

For fast response, the glass bulb of the probe should always be kept moist. A rubber cap is supplied with the probe to store a small amount of solution and to cover the glass bulb.

Before use, remove the cap. If the cap has been left off and the tip of the probe is dry, dip the probe in KCL solution for 30 minutes or soak in tap water for 2 hours.

When the electrode is not in use, replace the cap which should be filled with KCL or equivalent probe storage solution. If a solution is not available, use tap water.

NOTE: Do not use distilled or deionized water for storing, under any circumstances.

Front Panel Controls

The features on the front panel are:

1. ON/OFF key
2. (pH/mV) key
3. SLOPE adjustment
4. Manual temperature adjustment
5. Standardize control
6. pH probe input
7. LCD display

pH Calibration

Calibration with manual temperature compensation.

1. Press ON/OFF key to turn meter on.
2. Connect the pH probe to the meter.
3. Immerse the probe in buffer 7.00.
4. Press the pH/mV key to select pH.
5. Adjust temp °C control to the temperature of buffer 7.00.

NOTE: A separate thermometer is needed to measure the temperature of the buffers. Both buffers should be at the same temperature.

6. Adjust the standardize control to read 7.00 pH on the display.
7. Rinse the probe with distilled water and blot dry.
8. Immerse the probe in the second buffer (4.00 or 10.00).
9. Adjust the temp °C control to the temperature of the second buffer.
10. Allow the reading to stabilize, then adjust the SLOPE control to the value of the second buffer.
11. Rinse the probe with distilled water.

Calibration is now complete.

OPERATION

1. Push the ON/OFF key to turn the meter on.
2. Push the pH/mV key until the annunciators indicate the desired mode.

For pH measurement: Rinse the probes with distilled water, then immerse the probe in the solution to be measured. The pH value will stabilize after a few seconds. Do not rub the bulb as this will cause static build-up on the bulb resulting in faulty readings.

Temperature Compensation

Temperature compensation can be set manually by the temperature °C adjustment over a range of 0° to 100° C.

For millivolt or ORP measurement: Press the pH/mV key until the display shows millivolts. Verify the probe connection, then rinse the probe with distilled water and blot dry. Immerse the probe in the sample to be measured. Allow the displayed reading to stabilize, then take the reading.

pH/mV/ORP DETERMINATION USING A COLE-PARMER DIGI-SENSE METER

Battery Replacement

The pH meter uses a 9 volt battery with a life of 2000 hours. If the low battery indicator is on, stop operation and replace the internal battery with a new 9 volt battery.

Cleaning the Probe

The glass bulb is the sensitive part of the probe. It should always be kept clean. Rinse the probe with distilled water after use. Before storage, rinse the probe with tap or distilled water, shake dry and place the probe in the protective cap which should be filled with a KCL solution or equivalent probe storage solution.

If KCL or equivalent storage solution is not available, use a 4.00 pH buffer, 7.00 pH buffer or tap water.

NOTE: Distilled or deionized water should never be used.

TROUBLESHOOTING GUIDE

SYMPTOMS	PROBLEM	POSSIBLE SOLUTION
Meter will not calibrate or gives erroneous readings	Defective pH probe, bad buffer, or incompatible sample	1. Change buffer 2. Check chemical compatibility 3. Replace pH probe
Unit gives slow response or erroneous readings	Dry electrode or clogged reference junction in pH probe	1. Clean the probe 2. Replace pH probe
Meter will not accept second buffer	Defective pH probe or bad buffer	1. Change buffers 2. Clean probe 3. Replace probe
Reading drift on display	Bad pH probe or incompatible sample being measured	1. Clean probe 2. Check chemical compatibility of sample with probe 3. Replace probe
Lo Bat indicator is lit	Low Battery	Replace battery

SPECIFICATIONS

Ranges:		
	pH:	0.00 to 14.00
	mV:	-1999 to +1999
Resolution:		
	pH:	0.01
	mV:	1. mV
Accuracy:		
	pH:	±0.01 pH
	mV:	±1 mV
Temp Compensation:		Manual, from 0° to 100° C
Battery:		9 volt (included) battery life: 2000 hrs.
Display:		4 digit LCD, 1/2" high
Input Impedance:		Greater than 10^{12} ohms
Dimensions:		6 5/8" L x 3"W x 29/32"D

WARRANTY

We warrant this product to be free from defects in material and workmanship for the period noted in the enclosed Warranty Card. If repair or adjustment is necessary, which has not been the result of abuse or misuse within the warranty period, please return, freight prepaid. Correction of the defect will be made without charge. (See Return of Items below.)

For your protection, items being returned must be *carefully* packed to prevent damage in shipment. Also *insure* against possible damage or loss. We will not be responsible for damage resulting from careless or improper packing.

Out-of-warranty products will be repaired for a nominal charge.

RETURN OF ITEMS

Authorization must be obtained from your Dealer before returning items for any reason. When applying for authorization, please include the reason the items are to be returned.

pH/mV/ORP DETERMINATION USING A COLE-PARMER DIGI-SENSE METER

TECHNICAL ASSISTANCE

Technical information and advice concerning the use of the product in specific applications may be obtained. Modifications can often be made to adapt the unit to special applications. Contact your Dealer for information.

The manufacturer reserves the right to make improvements in design, construction and appearance of the product without notice.

CONSTRUCTION AND INSTALLATION OF PERMANENT SUB-SLAB SOIL GAS WELLS

CONTENTS

CONSTRUCTION AND INSTALLATION OF PERMANENT SUB-SLAB SOIL GAS WELLS

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) outlines the procedure used for the construction and installation of permanent sub-slab soil gas wells. The wells are used to sample the gas contained in the interstitial spaces beneath the concrete floor slab of dwellings and other structures.

Soil gas monitoring provides a quick means of detecting volatile organic compounds (VOCs) in the soil subsurface. Using this method, underground VOC contamination can be identified and the source, extent and movement of pollutants can be traced.

2.0 METHOD SUMMARY

Using an electric Hammer Drill or Rotary Hammer, an inner or pilot hole is drilled into the concrete slab to a depth of approximately 2" with the d" diameter drill bit. Using the pilot hole as the center, an outer hole is drilled to an approximate depth of 1d" using the 1" diameter drill bit. The 1" diameter drill bit is then replaced with the d" drill bit. The pilot hole is drilled through the slab and several inches into the sub-slab material. Once drilling is completed, a stainless steel probe is assembled and inserted into the pre-drilled hole. The probe is mounted flush with the surrounding slab so it will not interfere with pedestrian or vehicular traffic and cemented into place. A length of Teflon tubing is attached to the probe assembly and to a sample container or system.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

3.1 SUMMA Canister Sampling

After the sub-slab soil gas sample is collected, the canister valve is closed, an identification tag is attached to the canister and the canister is transported to a laboratory under chain of custody for analysis. Upon receipt at the laboratory, the data documented on the canister tag is recorded. Sample holding times are compound dependent, but most VOCs can be recovered from the canister under normal conditions near the original concentration for up to 30 days. Refer to SERAS SOP #1704, *SUMMA Canister Sampling* for more details.

3.2 Tedlar Bag Sampling

Tedlar bags most commonly used for sampling have a 1-liter volume capacity. After sampling, the Tedlar bags are stored in either a clean cooler or an opaque plastic bag at ambient temperature to prevent photodegradation. It is essential that sample analysis be undertaken within 24 to 48 hours following sample collection since VOCs may escape or become altered. Refer to SERAS SOP #2102, *Tedlar Bag Sampling* for more details.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The thickness of a concrete slab may vary from structure to structure. A structure may also have a single slab where the thickness varies. A slab may contain steel reinforcement (REBAR). Drill bits of various sizes and cutting ability will be required to penetrate slabs of varying thicknesses or those that are steel-reinforced.

5.0 EQUIPMENT/APPARATUS

- Hammer Drill or Rotary Hammer
- Alternating current (AC) extension cord
- AC generator, if AC power is not available on site
- Hammer or Rotary Hammer drill bit, d" diameter
- Hammer or Rotary Hammer drill bit, 1"diameter
- Portable vacuum cleaner
- 1 - ¾" open end wrench or 1-medium adjustable wrench
- 2 - 9/16" open end wrenches or 2-small adjustable wrenches
- Hex head wrench, ¼"
- Tubing cutter
- Disposable cups, 5 ounce (oz)
- Disposable mixing device (i.e., popsicle stick, tongue depressor, etc.)
- Swagelok SS-400-7-4 Female Connector, ¼" National Pipe Thread (NPT) to ¼" Swagelok connector
- Swagelok SS-400-1-4 Male Connector, ¼"NPT to ¼" Swagelok connector
- ¼" NPT flush mount hex socket plug, Teflon-coated
- ¼" outer diameter (OD) stainless steel tubing, pre-cleaned, instrument grade
- ¼" OD Teflon tubing
- Teflon thread tape
- 1/8 ” OD stainless steel rod, 12” to 24” length
- Swagelok Tee, optional (SS-400-3-4TMT or SS-400-3-4TTM)

6.0 REAGENTS

- Tap water, for mixing anchoring cement
- Anchoring cement
- Modeling clay

7.0 PROCEDURES

7.1 Probe Assembly and Installation

1. Drill a d" diameter inner or pilot hole to a depth of 2" (Figure 1, Appendix A).

2. Using the d" pilot hole as your center, drill a 1" diameter outer hole to a depth of 1d". Vacuum out any cuttings from the hole (Figure 2, Appendix A).

3. Continue drilling the d inner or pilot hole through the slab and a few inches into the sub-slab material (Figure 3, Appendix A). Vacuum out any cuttings from the outer hole.

4. Determine the length of stainless steel tubing required to reach from the bottom of the outer hole, through the slab and into the open cavity below the slab. To avoid obstruction of the probe tube, ensure that it does not contact the sub-slab material. Using a tube cutter, cut the tubing to the desired length.

5. Attach the measured length (typically 12O) of ¼" OD stainless tubing to the female connector

(SS-400-7-4) with the Swagelok nut. Tighten the nut.

6. Insert the ¼" hex socket plug into the female connector. Tighten the plug. **Do not over tighten**. If excessive force is required to remove the plug during the sample set up phase, the probe may break loose from the anchoring cement.

7. Place a small amount of modeling clay around the stainless steel tubing adjacent to the Swagelok nut, which connects the stainless steel tubing to the female connector. Use a sufficient amount of modeling clay so that the completed probe, when placed in the outer hole, will create a seal between the outer hole and the inner hole. The clay seal will prevent any anchoring cement from flowing into the inner hole during the final step of probe installation.

8. Place the completed probe into the outer hole. The probe tubing should not contact the sub-slab material and the top of the female connector should be flush with the surface of the slab and centered in the outer hole (Figure 4, Appendix A). If the top of the completed probe is not flush with the surface of the slab, due to the outer hole depth being greater than 1d", additional modeling clay may be placed around the stainless steel tubing adjacent to the Swagelok nut, which connects the stainless steel tubing to the female connector. Use a sufficient amount of clay to raise the probe until it is flush with the surface of the slab while ensuring that a portion of the clay will still contact and seal the inner hole.

9. Mix a small amount of the anchoring cement. Fill the space between the probe and the outside of the outer hole. Allow the cement to cure according to manufacturers instructions before sampling.

7.2 Sampling Set-Up

1. Wrap one layer of Teflon thread tape onto the NPT end of the male connector (SS-400-1-4). Refer to Figure 5, Appendix A.

2. Remove the ¼" hex socket plug from the female connector (SS-400-7-4). Refer to Section 7.3 if the probe breaks loose from the anchoring cement during this step.

3. To ensure that the well has not been blocked by the collapse of the inner hole below the end of the stainless steel tubing, a stainless steel rod, 1/8” diameter, may be passed through the female connector and the stainless steel tubing. The rod should pass freely to a depth greater than the length of the stainless steel tubing, indicating an open space or loosely packed soil below the end of the stainless steel tubing. Either condition should allow a soil gas sample to be collected.

   If the well appears blocked, the stainless steel rod may be used as a ramrod in an attempt to open the well. If the well cannot be opened, the probe should be reinstalled or a new probe installed in an alternate location.

4. Screw and tighten the male connector (SS-400-1-4) into the female connector (SS-400-7-4). **Do not over tighten**. This may cause the probe to break loose from the anchoring cement during this step or when the male connector is removed upon completion of the sampling

event. Refer to Section 7.3 if the probe breaks loose from the anchoring cement during this step.

5. If a collocated sub-slab sample or split sample is desired, a stainless steel Swagelok Tee (SS-400-3-4TMT or SS-400-3-4TTM) may be used in place of the Swagelok male connector (SS-400-1-4).

6. Attach a length of ¼"OD Teflon tubing to the male connector with a Swagelok nut. The Teflon tubing is then connected to the sampling container or system to be used for sample collection.

7. After sample collection remove the male connector from the probe and reinstall the hex socket plug. **Do not over tighten** the hex socket plug. If excessive force is required to remove the plug during the next sampling event the probe may break loose from the anchoring cement. Refer to Section 7.3 if the probe breaks loose from the anchoring cement during this step.

7.3 Repairing a Loose Probe

1. If the probe breaks loose from the anchoring cement while removing or installing the hex head plug or the male connector (SS-400-1-4), lift the probe slightly above the surface of the concrete slab.

2. Hold the female connector (SS-400-7-4) with the ¾" open end wrench.

3. Complete the step being taken during which the probe broke loose, following the instructions contained in this SOP (i.e., **Do not over tighten** the hex socket plug or male connector).

4. Push the probe back down into place and reapply the anchoring cement.

5. Modeling clay may be used as a temporary patch to effect a seal around the probe until the anchoring cement can be reapplied.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

An additional collocated soil gas well is installed with the frequency of 10 percent (%) or as specified in the site-specific Quality Assurance Project Plan (QAPP). The following general Quality Assurance (QA) procedures apply:

1. A rough sketch of the area is drawn where the ports are installed with the major areas noted on the sketch. This information may be transferred to graphing software for incorporation into the final deliverable.

2. A global positioning system (GPS) unit may be used to document coordinates outside of a structure as

a reference point.

3. Equipment used for the installation of sampling ports should be cleaned by heating, inspected and tested prior to deployment.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA) and Lockheed Martin corporate health and safety procedures. All site activities should be documented in the site-specific health and safety plan (HASP).

12.0 REFERENCES

This section is not applicable to this SOP.

13.0 APPENDICES

A - Figures

APPENDIX A
Soil Gas Installation Figures
SOP #2082
March 2007

FIGURE 1

INNER or PILOT HOLE

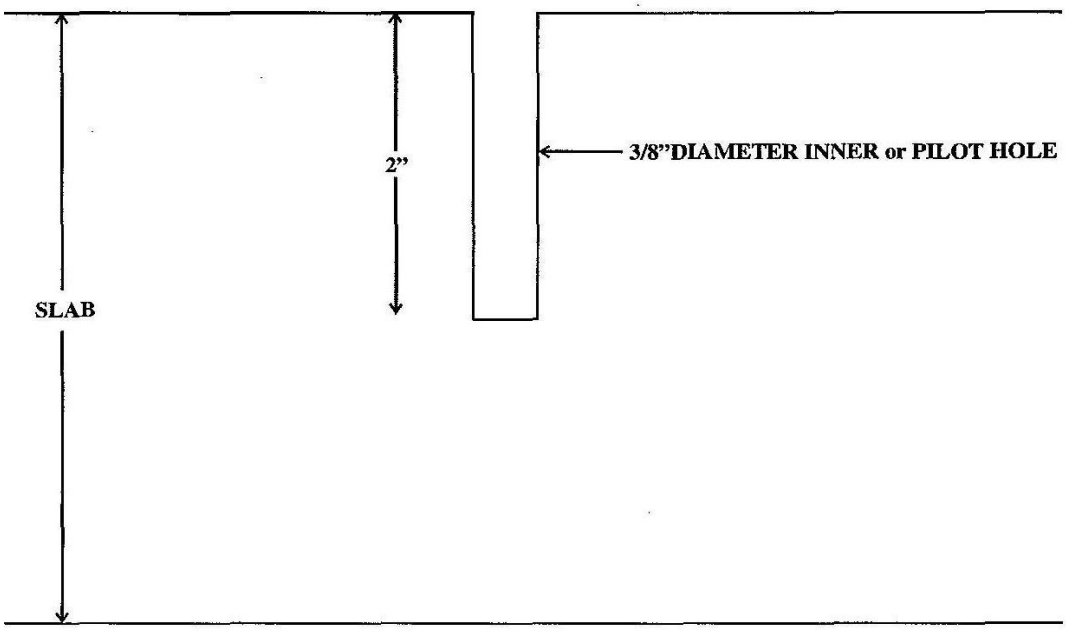


FIGURE 2

OUTER HOLE

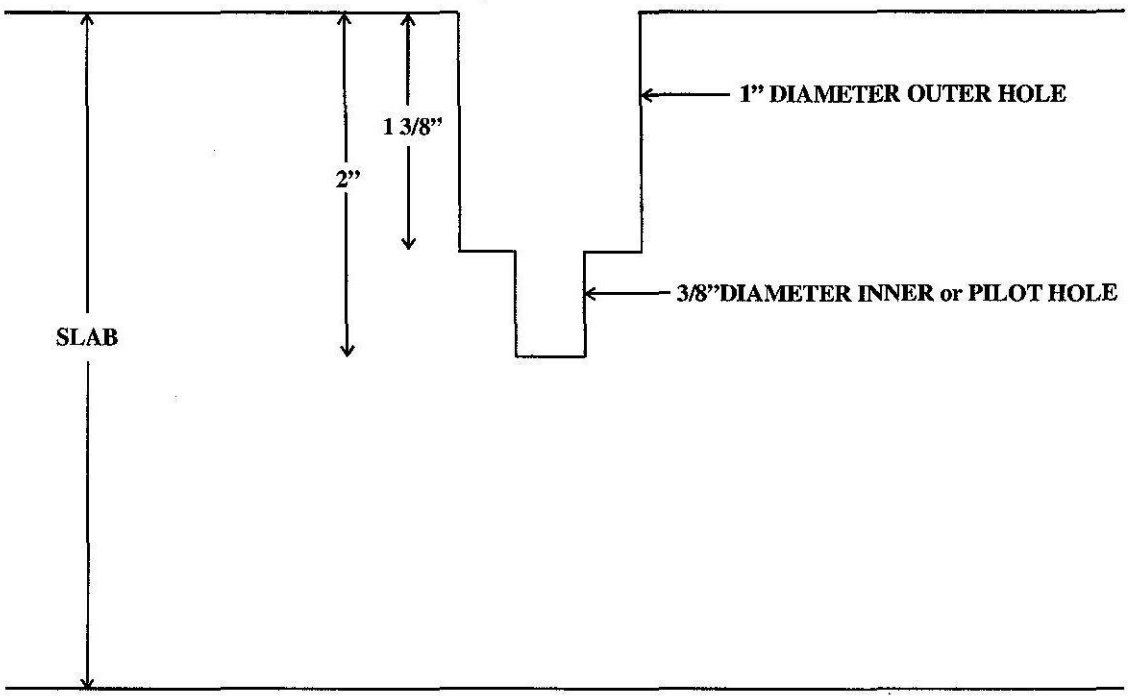


FIGURE 3

COMPLETED HOLE PRIOR to PROBE INSTALLATION

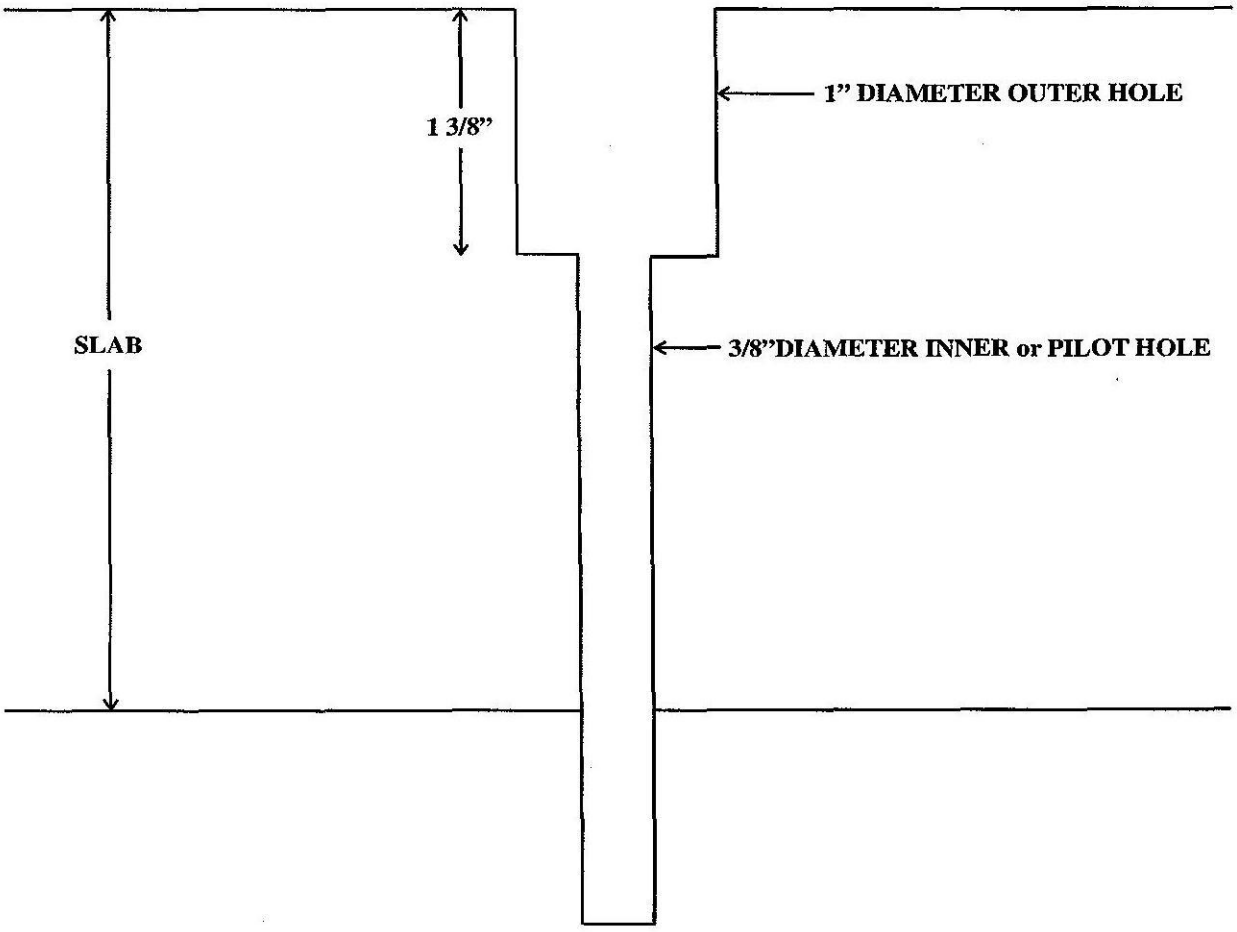


FIGURE 4

SOIL GAS PROBE INSTALLED

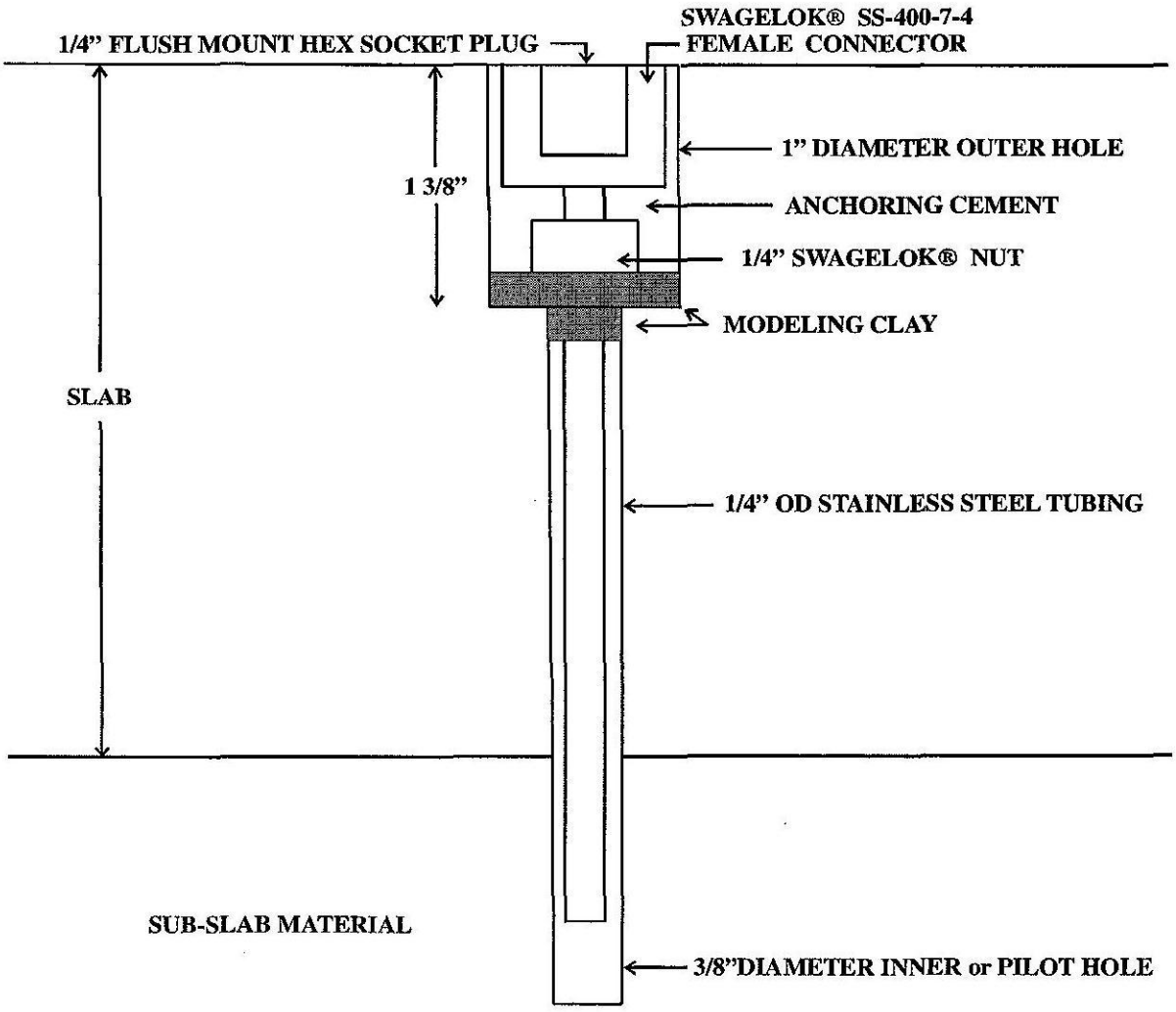


FIGURE 5
SOIL GAS PROBE PREPARED FOR SAMPLING

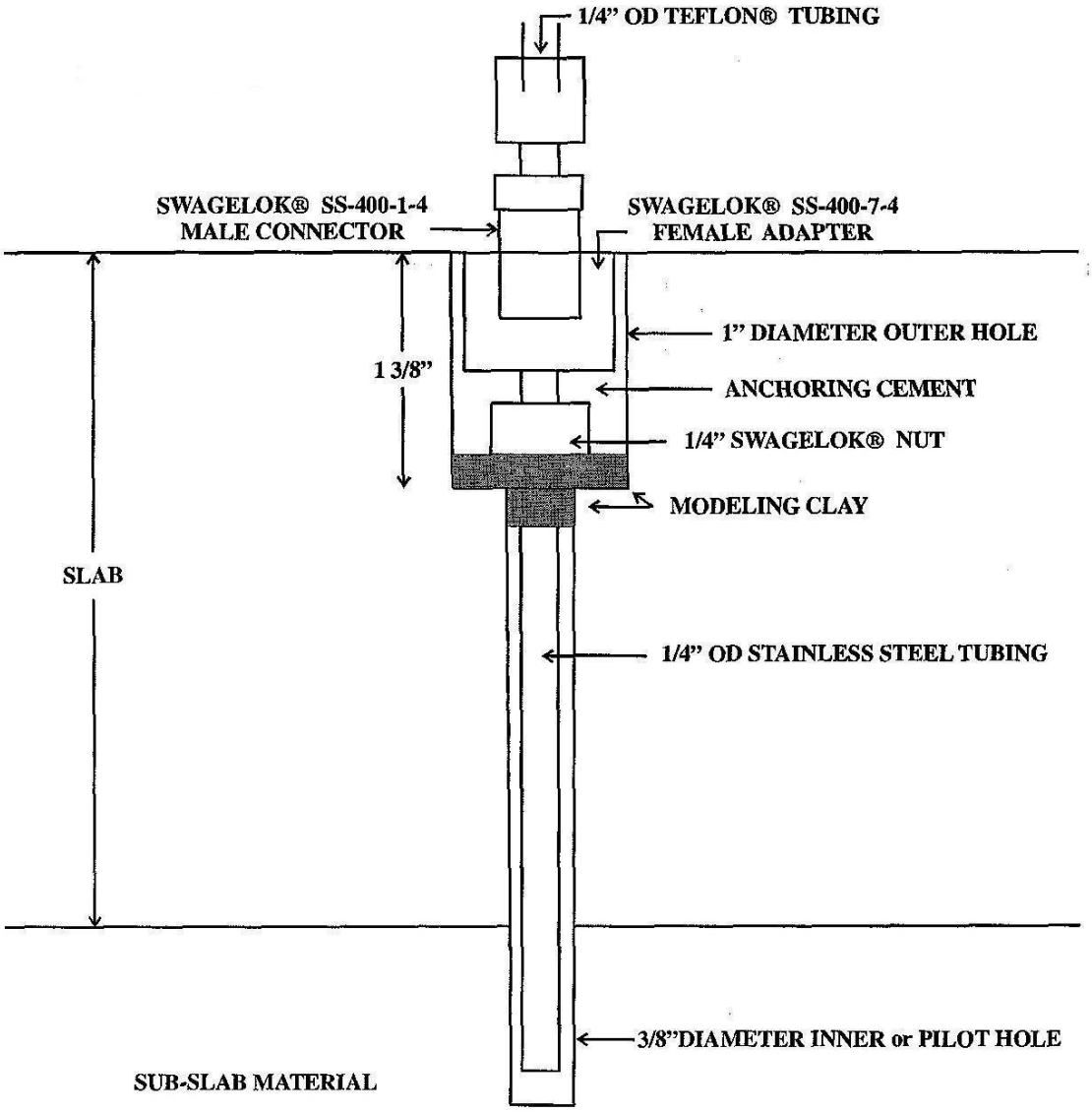
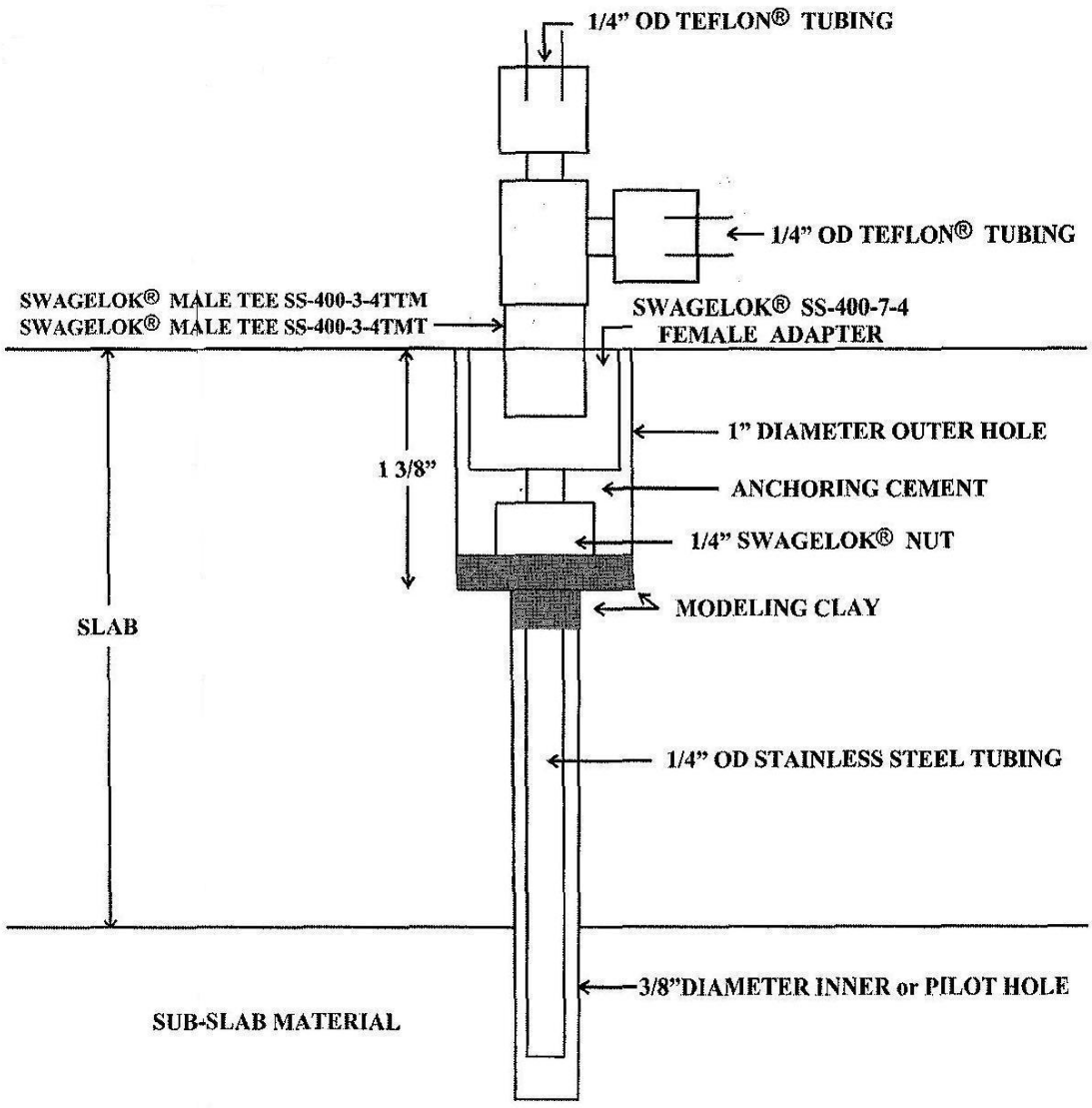


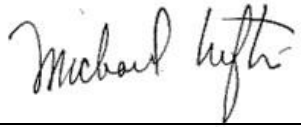
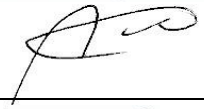
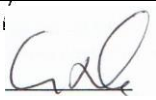
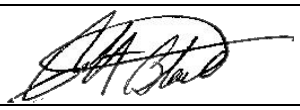
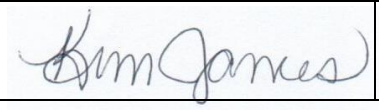
FIGURE 6
SOIL GAS PROBE PREPARED FOR SAMPLING



QUALITY MANUAL

for

Integrated Analytical Laboratories, LLC
273 Franklin Road
Randolph, New Jersey 07869
Phone: 973-361-4252 Fax: 973-989-5288
www.ialonline.com

Name	Function (Unit)	Signatures	Date
Dr. Michael Leftin	Laboratory Director		10.10.2017
Lauren Jenkins	Quality Assurance Director Air Manager		10.10.2017
Jimmy Shen	Organics Manager		10.10.2017
En Ma	Metals Manager		10.10.2017
Robert Blank	Wet Chemistry Manager Microbiology Manager		10.10.2017
Kimberly James	Senior Project Manager		10.10.2017

Revision Number:	**29**	**Effective Date:**	**October 10, 2017**
Document Number:	**QM.29.10.10.2017**		

Section 2: TABLE OF CONTENTS

Section 3:
INTRODUCTION AND SCOPE

The purpose of this *Quality Manual* is to outline the management system for Integrated Analytical Laboratories, LLC (IAL). The *Quality Manual* defines the policies, procedures, and documentation that assure analytical services continually meet a defined standard of quality that is designed to provide clients with data of known and documented quality and, where applicable, demonstrate regulatory compliance.

The *Quality Manual* sets the standard under which all laboratory operations are performed, including the laboratory's organization, objectives, and operating philosophy. The *Quality Manual* has been prepared to assure compliance with the 2009 TNI Environmental Laboratory Sector Standard – Volume 1 **–** Management and Technical Requirements for Laboratories Performing Environmental Analysis (EL-V1-M1, M2, M4, M5-ISO-2009). This Standard is consistent with ISO/IEC 17025:2005 requirements that are relevant to the scope of environmental testing services and thus, the laboratory operates a quality system in conformance with ISO/IEC 17025:2005(E). In addition, the policies and procedures outlined are compliant with the various accreditation and certification programs listed in Appendix E.

3.1 Scope of Testing

The laboratory's scope of analytical testing services includes items listed on its NJDEP Annual Certified Parameters List. Other services may be provided without certification. Clients must be notified in writing that certification is not held and/or is not available.

3.2 Table of Contents, References and Appendices

The Table of Contents is in Section 2 and Appendices are in Section 28.

This *Quality Manual* uses the references included in Modules 1, 2, 4, 5 in the 2009 TNI Environmental Laboratory Sector Standard – Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, EPA Clean Water Act Methods, EPA Clean Air Act Methods and Standard Methods for the Examination of Water and Wastewater.

3.3 Glossary and Acronyms Used

Quality control terms are generally defined within the Section that describes the activity.

3.3.1 Glossary

The *Terms and Definitions* Section of Modules 1, 2, 4, 5 in the 2009 TNI Environmental Laboratory Sector Standard – Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis. A glossary of terms can be found in Appendix J.

3.3.1.1 **The TNI Standard:** Modules 1, 2, 4, 5 in the 2009 TNI Environmental Laboratory Sector Standard – Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis (EL-V1, M1, M2, M4 & M5, ISO-2009).

3.3.2 Acronyms

A list of acronyms used in this document and their definitions are:

AB	–	Accrediting Body
ANSI	–	American National Standards Institute
ASTM	–	American Society for Testing and Materials
°C	–	degrees Celsius
cal	–	calibration
CAS	–	Chemical Abstract Service
CCV	–	Continuing calibration verification
COC	–	Chain of custody
DO	–	Dissolved oxygen
DOC	–	Demonstration of Capability
EPA	–	Environmental Protection Agency
GC/MS	–	gas chromatography/mass spectrometry
ICC	–	Initial Calibration Curve
ICP-MS	–	inductively coupled plasma-mass spectrometry
ICV	–	Initial calibration verification
IDOC	–	Initial Demonstration of Capability
ISO/IEC	–	International Organization for Standardization/International Electrochemical Commission
ISTD	-	Internal Standard
LCS	–	Laboratory control sample
LFB	–	Laboratory fortified blank
LOD	-	Limit of Detection
LOQ	-	Limit of Quantitation
MDL	–	method detection limit
mg/Kg	–	milligrams per kilogram
mg/L	–	milligrams per liter
mg/m^3	–	milligrams per cubic meter (air)
MS	–	matrix spike
MSD	–	matrix spike duplicate
NELAC	–	National Environmental Laboratory Accreditation Conference
NELAP	–	National Environmental Laboratory Accreditation Program
NIST	–	National Institute of Standards and Technology
ppb	–	parts per billon
ppbv	–	parts per billion by volume (air)
ppm	–	parts per million
ppmv	–	parts per million by volume (air)
ppt	–	can either be parts per THOUSAND or TRILLION. Context of use must be verified before use.
PQL	-	Practical Quantitation Limit
PT	–	Proficiency Test(ing)
QA	–	Quality Assurance
QC	–	Quality Control
QL	-	Quantitation Limit

QM	–	*Quality Manual*
RL	–	Reporting Limit
RPD	–	Relative percent difference
RSD	–	Relative standard deviation
SOPs	–	Standard operating procedures
std	–	standard
TNI	-	The NELAC Institute
µg/kg	–	micrograms per kilogram
µg/L	–	micrograms per liter
$\mu g/m^3$	–	micrograms per cubic meter (air)
µg/mL	–	micrograms per milliliter
VOC	–	Volatile organic compound

3.4 Management of the *Quality Manual*

The Quality Assurance Manager is responsible for maintaining the currency of the *Quality Manual*.

The *Quality Manual* is reviewed annually by the Quality Assurance Manager and laboratory personnel to ensure it still reflects current practices and meets the requirements of any applicable regulations or client specifications. Sections of the manual are updated by making a change to the Section and then increasing the revision number by one. The cover sheet of the *Quality Manual* (Section 1) must be re-signed and the Table of Contents (Section 2) is updated whenever a Section is updated.

The *Quality Manual* is considered confidential within IAL and may not be altered in any way except by approval of the Laboratory Director and Quality Assurance Manager. If it is distributed to external users, it is for the purpose of reviewing IAL's management system and may not be used for any other purpose without written permission.

Section 4:
ORGANIZATION

The laboratory is a legally identifiable organization. The laboratory is responsible for carrying out testing activities that meet the requirements of the TNI Standard, the ISO/IEC 17025 Standard, and that meet the needs of the client. Through application of the policies and procedures outlined in this Section and throughout the *Quality Manual*:

- The laboratory assures that it is impartial and that personnel are free from undue commercial, financial, or other undue pressures that might influence their technical judgment.

- Management and technical personnel have the authority and resources to carry out their duties and have procedures to identify and correct departures from the laboratory's management system.

- Personnel understand the relevance and importance of their duties as related to the maintenance of the laboratory's management system.

- Ethics and data integrity procedures (see Appendix A, Section 5.5 – "Ethics and Data Integrity System" and Section 18 – "Data Integrity Investigations") ensure personnel do not engage in activities that diminish confidence in the laboratory's capabilities.

- Confidentiality is maintained.

4.1 Organization

The laboratory is a commercial environmental testing laboratory. IAL's Tax ID# is 22-3498363. The laboratory operates in Randolph, New Jersey.

The laboratory's organization chart can be found in Appendix B. Additional information regarding responsibilities, authority and interrelationship of personnel who manage, perform or verify testing is included in Section 5 –"Management" and Section 19 – "Personnel". These Sections also include information on supervision, training, technical management, job descriptions, quality personnel, and appointment of deputies for key managerial personnel.

The laboratory has the resources and authority to operate a management system that is capable of identifying departures from that system and from procedures during testing, and initiates actions to minimize or prevent departures.

4.2 Conflict of Interest and Undue Pressure

The organizational structure indicated above minimizes the potential for conflicting or undue interests that might influence the technical judgment of analytical personnel. In addition, procedures are in place to prevent outside pressures or involvement in activities that may affect competence, impartiality, judgment, operational integrity, or the quality of the work performed at the laboratory.

Section 5:
MANAGEMENT

The laboratory maintains a management system that is appropriate to the scope of its activities.

5.1 Management Requirements

Top management includes the Laboratory Director, Department Managers, Customer Service Manager and the Quality Assurance Manager.

Management's commitment to good professional practice and to the quality of its products is defined in the Quality Policy statement, Section 5.4.

Management has overall responsibility for the technical operations and the authority needed to generate the required quality of laboratory operations. Management ensures communication within the organization to maintain an effective management system and to communicate the importance of meeting customer, statutory, and regulatory requirements. Management assures that the system documentation is known and available so that appropriate personnel can implement their part. When changes to the management system occur or are planned, managers ensure that the integrity of the system is maintained.

Management is responsible for carrying out testing activities that meet the clients' needs, the requirements of the TNI Standard and the ISO/IEC 17025 Standard.

Managers implement, maintain, and improve the management system, and identify noncompliance with the management system of procedures. Managers initiate actions to prevent or minimize noncompliance.

Management ensures technical competence of personnel operating equipment, performing tests, evaluating results, or signing reports, and limits authority to perform laboratory functions to those appropriately trained and/or supervised. Management is responsible for defining the minimal level of education, qualifications, experience, and skills necessary for all positions in the laboratory and assuring that technical staff have demonstrated capabilities in their tasks. The TNI standard must also be consulted for certain positions in the lab, which have specific educational requirements.

Training is kept up to date as described in Section 19 – "Personnel" by periodic review of training records and through employee performance review.

Management bears specific responsibility for maintenance of the Management system. This includes defining roles and responsibilities to personnel, approving documents, providing required training, providing a procedure for confidential reporting of data integrity issues, and periodically reviewing data, procedures, and documentation. The assignment of responsibilities, authorities, and interrelationships of the personnel who manage, perform, or verify work affecting the quality of environmental tests is documented in Section 19 of this manual.

Designated deputies are appointed by management during the absence of the Laboratory Manager, Department Manager or the Quality Manager, and always if the absence is more than 15 days.

5.2 Management Roles and Responsibilities

5.2.1 Laboratory Director

The Laboratory Director is responsible for the overall quality, safety, financial, technical and service performance of the laboratory. The Laboratory Director provides the resources necessary to implement and maintain an effective quality and data integrity program.

5.2.1.1 Responsibilities

The Laboratory Director is responsible for:

a. Ensuring that personnel are free from any commercial, financial and other undue pressures that might adversely affect the quality of their work.
b. Ensuring that all analysts, supervisors and managers have the appropriate education and training to properly carry out their duties.
c. Ensuring the appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external audits.
d. Reviews and approves all SOPs and policies prior to their implementation and ensures all approved SOPs and policies are provided to laboratory personnel and are adhered to.
e. Serving as the Chemical Hygiene Officer.

5.2.2 Quality Assurance Manager

The Quality Assurance Manager (or designee) is responsible for the oversight and review of quality control data. In addition, it is the responsibility of the Quality Assurance Manager to uphold the standards, rules, and requirements dictated by TNI, ISO/IEC 17025:2005, and state regulatory authorities. The Quality Manager's training and proof of experience in QA/QC procedures, knowledge of analytical methods, and the laboratory's management system are available in the employee's file.

If the Quality Assurance Manager is absent for fifteen (15) calendar days or more, a deputy (see Table 5-1 below) with appropriate qualifications will perform the Quality Assurance Manager's duties. Beyond a thirty-five (35) calendar day absence, management will notify the primary accreditation body in writing of the absence of the Quality Assurance Manager and the appointment of the deputy.

5.2.2.1 Responsibilities

The Quality Assurance Manager is responsible for:

a. serving as a focal point for QA/QC;
b. notifying management of deficiencies, and monitoring corrective actions;
c. oversight and review of quality control data;
d. arranging or conducting internal audits

e. monitoring corrective actions;
f. ensuring that the management system related to quality is implemented and followed at all times;
g. monitoring and maintaining laboratory certifications
h. Proficiency Testing Program
i. keeping this *Quality Manual* current.

5.2.3 Department Manager

The Department Manager (or designee) is a full-time laboratory staff member and supervises laboratory operations and data reporting. The Department Manager's proof of experience in the fields of accreditation may be found in the employees file.

If the Department Manager is absent for fifteen (15) calendar days or more, a deputy (see Table 5-1 below) with appropriate qualifications will perform the Department Manager's duties. Beyond a thirty-five (35) calendar day absence, management will notify the primary accreditation body in writing of the absence of the Department Manager and the appointment of the deputy.

The Department Manager is not the technical manager of more than one accredited environmental laboratory.

5.2.3.1 Responsibilities

The Department Manager is responsible for:

a. meeting the general and education requirements and qualifications found in Sections 4.1.7.2 and 5.2.6.1 of the TNI Standard - EL-V1M2-2009;
b. ensuring personnel are properly trained to perform their duties
c. possess full knowledge in all analytical procedures and methods used within the department
d. overseeing the flow of work through the department, ensuring hold times, analysis times and client due dates are met

5.2.4 Laboratory Key Personnel Deputies

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

Table 5-1: Key Personnel and Designated Deputies

Key Personnel	Deputy
Laboratory Director	QA Manager
QA Manager	QA Deputy
Organics Manager	Team Leaders
Metals Manager	Team Leader
Wet Chemistry / Microbiology Manager	Team Leaders
Air Manager	Team Leader
Sample Receiving Manager	Team Leader
Senior Project Manager	Project Manager

5.3 Management Reviews

All members of the IAL Management participate in a monthly meeting on the second Tuesday of each month at 11:00am. The meeting agenda is established by the IAL Laboratory Director and the QA Manager.

Documentation of Management Meeting minutes will be made by the designated member of the staff. Previous meeting minutes are reviewed from the prior meeting. All items as required by the TNI Standards are addressed as needed during each meeting. These items include the following:

a. The suitability of company policies and procedures,
b. Reports, comments and concerns of each staff member,
c. The outcome of recent internal audits,
d. Corrective and preventative actions,
e. Results and assessments by outside auditors,
f. Proficiency testing schedules and results,
g. Work volume, capacity and types of current in-house workloads,
h. Client feedback
i. Complaints
j. Recommendations for improvement
k. Instrument and staffing problems, capacity, efficiency, vacations, workloads, etc.

An annual review will also be conducted for the above listed items. The annual review shall cover all relevant issues over a twelve month period. The most recent sent of audit findings will be reviewed annually to ensure all issues have been addressed.

Findings and follow-up actions from management reviews are recorded. Management will determine appropriate completion dates for action items and ensure they are completed within the agreed upon time frame.

5.4 Quality Policy

Management's commitment to quality and to the management system is stated in the Quality Policy below, which is upheld through the application of related policies and procedures described in the laboratory's *Quality Manual*, SOPs and policies.

IAL is committed to the production of analytical data of the highest quality, to comply with the TNI standards and to continuous improvement in all areas of our operation. Only procedures and techniques meeting the highest standards will be used. Because of having a focus on environmental analyses, an emphasis is placed on timeliness of work, exacting quality, and dependable, legally defensible data. Each operation maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality. Under the guidance of this quality assurance manual, a level of quality, which is acceptable on a national scale, is upheld in all IAL operations.

The corporate goal for all segments of IAL operations is for quality of the highest caliber. The process of achieving this goal entails continuous evaluation and action. IAL Management requires documentation of existing practices and improvement action

plans at every stage in the improvement process. Management follows this documentation process in order to demonstrate control of the laboratory operations.

A spirit of innovation is an essential element to the success of IAL in solving the complicated analytical problems encountered in environmental samples. This spirit, combined with the discipline and attention to detail required to provide the level of service expected by our customers, is what makes IAL stand out among others in this field. This same spirit is what drives the continuous striving for quality improvement and is the keystone to the IAL quality program.

The laboratory ensures that personnel are free from any commercial, financial or other undue pressures, which might adversely affect the quality of work. This policy is implemented and enforced through the commitment of management, at all levels, to the Quality Assurance (QA) principles and practices outlined in this manual. However, the primary responsibility for quality rests with each individual within the laboratory organization. Every employee must ensure that the generation and reporting of qualify analytical data is a fundamental priority. Every laboratory employee is required to familiarize themselves with the Quality Assurance Manual and to implement the policies and procedures in their work. All employees are trained annually on ethical principles and procedures surrounding the data that is generated. The laboratory maintains a strict policy of client confidentiality. On each employee's first day at IAL, a confidentiality statement was signed. These confidentiality statements are kept in each employee's file.

5.5 Ethics and Data Integrity System

The laboratory has an Ethics and Data Integrity policy that is included in Appendix A. The laboratory's Ethics and Data Integrity program, training and investigations are discussed in Section 18 – "Data Integrity Investigations".

Ethics and Data Integrity training will be conducted annually. New employees must complete training prior to the completion of their probationary period.

5.6 Documentation of Management/Quality System

The management system is defined through the policies and procedures provided in this *Quality Manual* and written laboratory Standard Operating Procedures (SOPs) and policies.

5.6.1 Quality Manual

The *Quality Manual* contains the following required items:

5.6.1.1 document title;

5.6.1.2 laboratory's full name and address;

5.6.1.3 name, address (if different from above), and telephone number of individual(s) responsible for the laboratory;

5.6.1.4 identification of all major organizational units which are to be covered by this quality manual and the effective date of the version;

5.6.1.5 identification of the laboratory's approved signatories;

5.6.1.6 the signed and dated concurrence (with appropriate names and titles), of all responsible parties including the quality manager(s), technical manager(s), and the agent who is in charge of all laboratory activities, such as the laboratory director or laboratory manager;

5.6.1.7 the objectives of the management system and contain or reference the laboratory's policies and procedures;

5.6.1.8 the laboratory's official quality policy statement, which shall include management system objectives and management's commitment to ethical laboratory practices and to upholding the requirements of this Standard; and

5.6.1.9 a table of contents, and applicable lists of references, glossaries and appendices.

This *Quality Manual* contains or references all required elements as defined by the TNI Standard - V1:M2, Section 4.2.8.4.

5.6.2 Standard Operating Procedures (SOPs)

Standard Operating Procedures (SOPs) represent all phases of current laboratory operations (they include an effective date, revision number, and signature of the approving authorities (Laboratory Director, QA Manager and Technical Manager) and are available to all personnel. They contain sufficient detail such that someone with similar qualifications could perform the procedures. There are two types of SOPs used in the laboratory: 1) test method SOPs, which have specific requirements as outlined below, and 2) general use SOPs which document general procedures.

Each accredited analyte or method has an SOP. Sometimes an SOP is a copy of a method, and any additions are clearly described. The laboratory's test method SOPs include the following topics, where applicable:

i. identification of the method;
ii. applicable matrix or matrices;
iii. limits of detection and quantitation;
iv. scope and application, including parameters to be analyzed;
v. summary of the method;
vi. definitions;
vii. interferences;
viii. safety;
ix. equipment and supplies;
x. reagents and standards;
xi. sample collection, preservation, shipment and storage;
xii. quality control;
xiii. calibration and standardization;
xiv. procedure;
xv. data analysis and calculations;
xvi. method performance;
xvii. pollution prevention;
xviii. data assessment and acceptance criteria for quality control measures;
xix. corrective actions for out-of-control data;

xx. contingencies for handling out-of-control or unacceptable data;
xxi. waste management;
xxii. references; and
xxiii. any tables, diagrams, flowcharts and validation data.
xxiv. a log of changes for each revision

If IAL deviates from a SOP with regards to any procedural changes or non-conformance, it is carefully documented in a case narrative for each project affected.

5.6.3 Order of Precedence

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

- Quality Assurance Manual
- SOP and Policies, Memos, Internal instruction documents
- Method referenced

Section 6:
DOCUMENT CONTROL

This section describes how the laboratory establishes and maintains a process for document management. Procedures for document management include controlling, distributing, reviewing, and accepting modifications. The purpose of document management is to preclude the use of invalid and/or obsolete documents.

Documents can be SOPs, policy statements, specifications, calibration tables, charts, textbooks, posters, notices, memoranda, software, drawings, plans, etc. These may be on various media, whether hard copy or electronic, and they may be digital, analog, photographic or written.

The laboratory manages three types of documents: 1) controlled, 2) approved, and 3) obsolete.

A controlled document is one that is uniquely identified, issued, tracked, and kept current as part of the management system. Controlled documents may be internal documents or external documents.

An approved document means it has been reviewed, and either signed and dated, or acknowledged in writing or by secure electronic means by the issuing authority(ies).

Obsolete documents are documents that have been superseded by more recent versions or are no longer needed.

6.1 Controlled Documents

Documents will be reviewed, revised (as appropriate) and approved for use by the Department Managers, QA Manager and Laboratory Director prior to issue. Documents are reviewed at least every two years to ensure their contents are suitable and in compliance with the current management systems requirements, and accurately describe current operations.

Approved copies of documents are available to staff at all locations where operations are essential to the effective functions of the laboratory.

Controlled internal documents are uniquely identified with:

1) a unique name or number identification
2) date of issue
3) revision identification
4) page number
5) the signatures of the issuing authority (i.e. management).

A master list of controlled internal documents is maintained that includes distribution, location, and revision dates. The controlled document list is maintained by the Quality Assurance Manager or designee.

6.1.1 Laboratory Notebooks

All Laboratory notebooks are maintained under the supervision of the Department Manager/Supervisor. Each manager/supervisor must maintain a log book of laboratory notebooks. The location of the laboratory notebooks, date started and completed, and authors/users of the notebooks must be documented.

The inside cover or first page of each laboratory notebook must have:

1) Department manager name and signature
2) Analyst name(s) and signature(s)
3) Method name(s) and number(s) (if applicable)
4) Date notebook begins
5) Date notebook ends

All notebooks are permanently bound and paginated. If notebook is generated from loose-leaf paper, the pages may be kept in a 3-ring binder until full. Once full, the pages must immediately be paginated, bound, and returned to the department manager.

All entries are dated and signed by the analyst. Entries of pertinent data include instrument conditions, weights, proper units, volumes, dilutions, and calculations as required in the analytical SOP.

Notebooks are maintained as permanent records of in-house maintenance logs for the analytical balances, temperature control logs, and fume hoods. Notebooks are reviewed during annual inspections by the QA Department. Completed notebooks are cataloged, boxed, and stored in a secured storage area of the laboratory for a minimum of five (5) years. The Quality Assurance Manager and Office Manager share responsibility for the key and access log for the secured storage area.

All data are physically destroyed before disposal.

6.2 Obsolete Documents

All invalid or obsolete documents are removed from general distribution, or otherwise prevented from unintended use.

Obsolete documents retained for legal use or historical knowledge preservation are appropriately marked and retained by the Quality Assurance Manager. Hardcopy documents shall be scanned after five (5) years for storage on IAL's server. Once scanned, the hardcopy will be shredded or otherwise destroyed.

Section 7:
REVIEW OF REQUESTS, TENDERS AND CONTRACTS

The review of all new work assures that oversight is provided so that requirements are clearly defined, the laboratory has adequate resources and capability, and the test method is applicable to the customer's needs. This process assures that all work will be given adequate attention without shortcuts that may compromise data quality.

Contracts for new work may be formal bids, signed documents, verbal, or electronic. The client's requirements, including the methods to be used, must be clearly defined, documented and understood. Requirements might include target analyte lists, project specific reporting limits (if any), project specific quality control requirements (if any), turnaround time, and requirements for data deliverables. The review must also cover any work that will be subcontracted by the laboratory.

7.1 Procedure for the Review of Work Requests

The Laboratory Director, Department Managers and Quality Assurance Manager determine if the laboratory has the necessary accreditations, resources, including schedule, equipment, deliverables, and personnel to meet the work request.

The Senior Project Manager or Account Manager 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 the complete the work satisfactorily.

The client is informed of any deviation from the contract including the test method or sample handling processes. All differences between the request and the final contract are resolved and recorded before any work begins. It is necessary that the contract be acceptable to both the laboratory and the client. The Account Manager submits the bid and formal quote to the client.

For routine projects a review by the Project Manager is considered adequate. The Project Manager and Quality Assurance Manager, when needed, confirms that the laboratory has any required certifications, that it can meet the client's data quality and reporting requirements, and that the lab has the capacity to meet the client's turn around needs.

For new and/or complex projects, the Laboratory Director, Quality Assurance Manager and Department Managers will evaluate such items as: method capabilities, analyte lists, reporting limits, quality control limits, turnaround time feasibility, reporting requirements and electronic deliverable requirements. This process is detailed in SOP 1.2300 - 'New Projects, Tests, Parameters, and Demo Jobs' and is used to evaluate the lab's ability to perform the project and to implement the project.

The review process is repeated when there are amendments to the original contract, before or after the commencement of work. The participating personnel are given copies of the amendments. The amendments are maintained in IAL's LIMS and in a revised version of the formal bid and quote. The revised bid and quote are prepared by the Account Manager and sent to the client. IAL will log all information pertaining to the amendments into the LIMS and a confirmation of changes will be sent to the

client for review. All laboratory personnel have department-specific access to the LIMS, where they can review the initial request and applicable amendments once a project is logged-in. Final changes will be communicated to the laboratory via email.

7.2 Documentation of Review

Records are maintained for every contract or work request, when appropriate. This includes 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. This information is recorded in emails, phone logs and quotes.

Records of all project-related communication with the client (including emails, fax, telephone conversation etc.) are documented in the notes section of the Project Information sheet which is included in the final report.

Section 8:
SUBCONTRACTING OF ENVIRONMENTAL TESTS

A subcontract laboratory is defined as a laboratory external to this laboratory, or at a different location than the address indicated on the front cover of this manual, that performs analyses for this laboratory.

When subcontracting analytical services, the laboratory assures work requiring accreditation is placed with an appropriately accredited laboratory or one that meets applicable statutory and regulatory requirements for performing the tests.

8.1 Procedure

IAL's LIMS system maintains a list of subcontractors and their applicable certification identification numbers. A copy of the certificate and analyte list from subcontractors is maintained as evidence of compliance. This information is maintained by the Quality Assurance Manager.

The certificate and analyte list are reviewed by the Quality Assurance Manager or Senior Project Manager to ensure the subcontracting laboratory has the appropriate accreditation to do the work. Project Management notifies the client of the intent to subcontract the work either in writing or verbally. The laboratory shall advise the customer of the arrangement in writing and, when appropriate, gain the approval of the customer, preferably in writing.

The laboratory performing the subcontracted work is identified in the final report. The laboratory assumes responsibility to the client for the subcontractor's work, except in the case where a client or a regulating authority specified which subcontractor is to be used.

Refer to SOP 1.4100 - Subcontracted Analyses to Outside Sources.

Section 9:
PURCHASING SERVICES AND SUPPLIES

The laboratory ensures that purchased supplies and services that affect the quality of environmental tests are of the required or specified quality, by using approved suppliers and products.

The laboratory has procedures for purchasing, receiving, and storage of supplies that affect the quality of environmental tests.

9.1 Procedure

When an item needs to be purchased, the department will contact the IAL Purchasing Manager. The Purchasing Manager will correlate the necessary information for purchase. This includes item, vendor, catalog number, amount, etc. Orders are placed either by phone or internet. If items are on back-order or otherwise out of stock, the department is informed and determines the next course of action. The Purchasing Manager will be directed to an alternate supplier or notified if the wait will be acceptable.

All items are requested to be shipped via FedEx, UPS, or US Mail. Upon receipt at the laboratory, the Purchasing Manager will notify the appropriate personnel to receive their items from the reception area. The person receiving their item from the Purchasing Manager must sign and date the packing slips/purchasing documents after thorough inspection of them item. Suppliers of critical consumables, supplies and services which affect the quality of testing results will also be evaluated by the section Supervisor. The supplies received are inspected for breakage, leaks or any other damage. The supplies received are stored according to manufacturer's recommendations, laboratory SOPs or test method specifications.

The purchased supplies and reagents that affect the quality of the tests are not used until they are inspected or otherwise verified as complying with requirements defined in the test method.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality by signing packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describes the services and supplies ordered. The description may include type, class, grade, identification, specifications or other technical information.

Any documents received with the supplies and services including specifications, certificates of analyses, warranties, maintenance records, calibration records etc. are kept on file within each department.

All materials must be labeled and stored in accordance with IAL SOP1.4400.

9.2 Approval of Suppliers

The Department Managers review and approve the supplier of services and supplies and approves technical content of purchasing documents prior to initial ordering. The Office/Purchasing Manager maintains a list of approved suppliers and suppliers that have been deemed unacceptable. 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 of their products, the overall quality of their services, their past history and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations and proof of historical compliance with similar programs for other clients. To ensure that quality-critical consumables and equipment conform to specified requirements, all purchases from vendors are approved by a member of the management staff.

Section 10:
SERVICE TO THE CLIENT

The laboratory collaborates with clients and/or their representatives in clarifying their requests and in monitoring laboratory performance related to their work. Each request is reviewed to determine the nature of the request and the laboratory's ability to comply with the request within the confines of prevailing statutes and/or regulations without risk to the confidentiality of other clients.

10.1 Client Confidentiality

The laboratory confidentiality policy is to not divulge or release any information to a third party without proper authorization. To ensure the agreements of confidentiality that IAL has with its clients, all employees are required to sign a confidentiality statement at the beginning of their employment. This statement explains the ethical and legal responsibilities of an IAL employee as well as procedures for insure confidentiality. Third party requests for data and information are referred to the client. Data and records identified as proprietary, privileged, or confidential are exempt from disclosure.

All electronic data (storage or transmissions) are kept confidential, based on technology and laboratory limitations, as required by client or regulation.

A confidentiality statement is included on all emails, documents and transmitted (fax) information by using the following confidentiality statement:

ATTENTION: This message and any attachments are intended only for the named recipient(s), and may contain information that is confidential, privileged, attorney work product, or exempt or protected from disclosure under applicable laws and rules. If you are not the intended recipient(s), you are notified that the dissemination, distribution, or copying of this message and any attachments is strictly prohibited. If you receive this message in error, or are not the named recipient(s), please notify the sender at either the email address or by calling IAL. at (973) 361-4252 and delete this message and any of its attachments from your computer and/or network. Receipt by anyone other than the named recipient(s) is not a waiver of any attorney-client, work product, or other applicable privilege, protection, or doctrine.

This message and any attachments are covered by the Electronic Communications Privacy Act, 18 U.S.C SS 2510-2521.'

10.2 Client Support

The management of IAL stresses communication at all levels and strives to maintain an atmosphere of excellence, which our customers deserve. IAL is continually upgrading our operations to remain current with the latest technical advances in instrumentation and procedures, as well as, the latest rules and regulations.

Communication with the client, or their representative, is maintained to provide proper instruction and modification for testing. Technical staff is available to discuss any technical questions or concerns the client may have.

The client, or their representative, may be provided reasonable access to laboratory areas for witnessing testing.

Delays or major deviations to the testing are communicated to the client immediately by Customer Service through a phone call and/or email notification.

The laboratory will provide the client with all requested information pertaining to the analysis of their samples. An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

10.3 Client Feedback

The laboratory seeks both negative and positive feedback following the completion of projects and periodically for ongoing projects. Feedback provides acknowledgement, corrective actions where necessary, and opportunities for continuous improvement. Clients have the ability to supply direct feedback by completing the Customer Survey on the IAL website.

Section 11:
COMPLAINTS

The purpose of this Section is to assure that customer complaints are addressed and corrected. This includes requests to verify results or analytical data. Requests to verify data, the investigation and the resolution are documented in the 'Client Data Inquiry' form.

Complaints provide the laboratory an opportunity to improve laboratory operation and client satisfaction. Complaints by customers or other parties are reviewed by management and an appropriate action is determined. All customer complaints are documented by the person receiving the complaint and addressed to the responsible manager.

If it is determined that the complaint has merit, the procedures outlined below and in Section 14 – Corrective Action are utilized. If it is determined that a complaint is without merit, it is documented, and the client is contacted by a Project or Account Manager.

11.1 Client Complaints

When legitimate complaints are lodged by clients, this prompts an internal investigation. The person receiving the complaint must fill out a Client Inquiry Form found at J:\Client Data Inquiry. All data inquiry forms will be logged, numbered, and saved. Once/if it is deemed necessary, a corrective action report will be filled out by or in cooperation with the QA Manager. See Section 14 – "Corrective Action"

Section 12:
CONTROL OF NON-CONFORMING ENVIRONMENTAL TESTING WORK

Non-conforming work is work that does not meet acceptance criteria or requirements. Non-conformances can include departures from standard operating procedures or test methods or unacceptable quality control results (see Section 26 – "Quality Assurance for Environmental Testing"). Identification of non-conforming work can come through customer complaints, quality control, instrument calibration, evaluating consumable materials, staff observation, final report review, management reviews and internal and external audits.

12.1 Exceptionally Permitting Departures from Documented Policies and Procedures

Requests for departures from laboratory procedures are approved by the Laboratory Director and documented. Planned departures from procedures or policies do not require audits or investigations. If a client requests a departure from laboratory procedures, it is not considered a non-conformance that requires a corrective action. However, the non-conformance must be documented in the final report.

12.2 Non-Conforming Work

The laboratory policy for control of non-conforming work is to identify the non-conformance, determine if it will be permitted, and take appropriate action. All employees have the authority to stop work on samples when any aspect of the process does not conform to laboratory requirements.

The responsibilities and authorities for the management of non-conforming work are detailed below. The procedure for investigating and taking appropriate corrective actions of non-conforming work are described in Section 14 – "Corrective Actions". Section 14.3 describes procedures for Technical Corrective Actions. Formal corrective action procedures must be followed for non-conforming work that could reoccur (beyond expected random QC failures) or where there is doubt about the laboratory's compliance to its own policies and procedures.

Occasionally, a situation may present itself that would require a more intensive evaluation and resolution. Under these circumstances, the Department Manager in conjunction with the Quality Assurance Manager and Laboratory Director evaluate the significance of the non-conforming work and take corrective action immediately. The customer is notified if their data has been impacted. The laboratory allows the release of non-conforming data only with approval by the appropriate Department Manager or designee on a case-by-case basis. Non-conforming data is clearly identified in the final report (see Section 27 – "Reporting the Results").

12.2.1 Notifying Clients

The discovery of a non-conformance for results that have already been reported to the customer must be immediately evaluated for significance of the non-conformance, its acceptability to the customer, and determination of the appropriate corrective action.

The following procedure is followed for transmitting results and notifying clients of dubious findings:

12.2.1.1 If results have been faxed, phoned, or emailed to a client and not identified as Preliminary, the results should be considered by the client to be "true and valid". Only results that have NOT been reviewed by the QC Department will be labeled as Preliminary.

12.2.1.2 Upon completion of the hardcopy data report, a full review of the entire report is performed by the QC Department. If during this evaluation, a change or modification of the original faxed results is determined, the client will be notified in the following manner:

a. A revised copy of results, corrected for the change, will be faxed or emailed to the client with a full explanation of the revision.

b. The client will be notified by a follow-up phone call from the IAL person sending the revised fax or email.

12.2.1.3 Erroneous findings in a hardcopy report are either discovered after being received by the client or an IAL employee will detect a problem. All client contact regarding in-house projects is either through an IAL Client Manager or an Account Manager. Client questions of problems in a hardcopy report will be handled in the following manner:

a. Assess the problem. Identify if the error is typographical, e.g. the misspelling of a name, or if the problem arises from analytical data.

b. Address minor errors, typos, etc., by first documenting the situation on the IAL LIMS, including person spoken with. Initial and date all comments made in the IAL LIMS.

c. Distribute paperwork to appropriate personnel (lab analysts, report generation personnel, etc.)

d. Re-send corrected material to client in shortest time frame possible (preferably less than 10 days).

e. If problems are of an analytical nature (data results are incorrect, dilution errors, calculation problems, etc.) direct the situation to the QA Officer.

f. Problems of an analytical nature will require a full evaluation by the QA Manager and Department Manager to assess the validity of the situation.

g. The QA Manager will respond to the client within 72 hours of the complaint either in writing, or over the phone, or both.

h. All information will be documented in a written correspondence letter to the client by the QA Manager.

i. Corrective Action may need to be taken, as described in Section 14 – "Corrective Actions".

The investigation and associated corrective actions of non-conforming work involving alleged violations of the company's Ethics and Data Integrity policies must follow the procedures outlined in Section 18 – "Data Integrity Investigations".

12.3 Stop Work Procedures

Personnel notify the appropriate Department Manager of a non-conformance beyond the expected random QC non-conformance. The Department Manager reviews the significance of the non-conformance and develops a course of action. If data are questionable, the Quality Assurance Manager may be involved in the review. When an investigation of non-conformance indicates that the cause of the non-conformance requires a method be restricted or not used until modifications are implemented, the Laboratory Director and Quality Assurance Manager will immediately notify personnel of the suspension/restriction. The lab will hold all relevant reports to clients pending review. The Quality Assurance Manager must be involved in the resolution of the issue and must verify that the issue is resolved before work may resume. Personnel are notified by the Department Manager as to when work can resume. The Department Manager and Quality Assurance Manager will document the issue, root cause and resolution using the corrective action procedures described in Section 14 – "Corrective Action". The reporting on nonconforming work involving alleged violations of the company's Ethic and Data Integrity policies must be reported to the Quality Assurance Manager.

Section 13:
IMPROVEMENT

Improvement in the overall effectiveness of the laboratory management system is a result of the implementation of the various aspects of the laboratory's management system: quality policy and objectives (Section 5 – "Management"); internal auditing practices (Section 17 – "Internal Audits"); the review and analysis of data (Section 26 – "Quality Assurance for Environmental Testing"); the corrective action (Section 14 – "Corrective Action") and preventative action (Section 15 – "Preventative Action") process; and the annual management review of the quality management system (Section 5.3 – "Management Reviews") where the various aspects of the management/quality system are summarized, and evaluated and plans for improvement are developed.

On time delivery, PT performance, number and type of corrective actions, audit performance, client complaints, and customer feedback provide the information which allows for improvement. The Problem Tracking program is available to all personnel and is used to document non-conformances and monitor the performance of the laboratory. The Problem Tracking program is reviewed by the Laboratory Director and Quality Assurance Manager monthly. Corrective actions are implemented as necessary.

Section 14:
CORRECTIVE ACTION

Corrective action is the action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence.

Deficiencies cited in external assessments, internal quality audits, data reviews, customer feedback/complaints, control of nonconforming work or managerial reviews are documented and require corrective action. Corrective actions taken are appropriate for the magnitude of the problem and the degree of risk.

14.1 General Procedure

The laboratory uses corrective action forms to document and track corrective actions.

The Quality Assurance Department is responsible for initiating corrective action on routine data reviews where a non-conformance is found that could reoccur (beyond expected random QC failures) or where there is doubt about the compliance of the laboratory to its own policies and procedures. The Quality Assurance Manager is responsible for monitoring and recording the corrective action.

All deficiencies are investigated and a corrective action plan is developed and implemented if determined necessary. The implementation is monitored for effectiveness.

14.1.1 Cause Analysis

When failures due to systematic errors have been identified, the first step of the corrective action process starts with the initial investigation and determination of root cause(s) of the problem. Records are maintained on the Corrective Action form of non-conformances requiring corrective action to show that the root cause(s) was investigated, and includes the results of the investigation.

Where there may be non-systematic errors and as such the initial cause is readily identifiable or expected random failures (e.g. failed quality control), a formal root cause analysis is not performed and the process begins with selection and implementation of corrective action (also see Section 14.3 "Technical Corrective Actions").

14.1.2 Selection and Implementation of Corrective Actions

Where uncertainty arises regarding the best approach for analysis of the cause of exceedances that require corrective action, appropriate personnel will recommend corrective actions that are appropriate to the magnitude and risk of the problem and that will most likely eliminate the problem and prevent recurrence
Under these circumstances, the Department Manager, in conjunction with the Quality Assurance Manager and Laboratory Director, will evaluate the significance of the non-conforming work and take corrective action immediately. The Quality Assurance Manager ensures that corrective actions are discharged within the agreed upon time frame.

14.1.3 Monitoring of Corrective Action

The Quality Assurance Manager will monitor implementation and documentation of the corrective action to assure that the corrective actions were effective. This may be achieved through internal auditing and regular data review. IAL's Corrective Action procedures are as follows:

14.1.3.1 Corrective Action Forms

14.1.3.1.1 Are initiated by the QA Manager or designee for any of the following:

a. Deviations from Standard Operating Procedures, the Quality Manual and/or the applicable test method
b. Proficiency Test Failure
c. When a legitimate complaint is lodged by a client

14.1.3.1.2 Identify the root cause of the problem, short term action, long term action, verification of effectiveness

14.1.3.1.3 Corrective action forms and a corrective action log are stored to: Q:\Corrective Action. Corrective action forms must contain the following information:

a. Control #
b. Initiated by
c. Date Issued
d. Date Due
e. Statement of Problem/Issue
f. Cause
g. Corrective/Preventative Action
h. Signatures of all personnel involved. Must always include the QA Manager and the Lab Manager
i. QA follow up with date, comments, and signature

14.1.3.1. An annual review of the corrective action forms issued for the year will occur during the annual managerial review as referenced in Section 5.3 – "Management Reviews".

14.2 Additional Audits

Where the identification of non-conformances or departures from normal lab procedures cast doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with the TNI Standard, the laboratory ensures that the appropriate areas of activity are audited in accordance with Section 17 – "Internal Audits" as soon as possible.

In many cases, the additional audits are follow-ups after the corrective action has been implemented to ensure it is effective. These are done when a serious issue or risk to the laboratory have been identified.

14.3 Technical Corrective Action

Sample data associated with a failed quality control are evaluated for the need to be reanalyzed or qualified. Unacceptable quality control results are documented, and if the evaluation requires cause analysis, the cause and solution are recorded (also see Section 12 – "Control of Nonconforming Environmental Testing Work"*).*

Analysts routinely implement corrective actions for data with unacceptable QC measures. First level correction may include re-analysis without further assessment. If the test method SOP addresses the specific actions to take, they are followed. If the situation could cause a deviation from standard operating procedures, the analyst is required to inform the Department Manager immediately. The Department Manger will determine the best course of action. If the Department Manager cannot establish a corrective action within the guidelines of the standard operating procedure, he/she will consult with the Quality Assurance Manager for the appropriate corrective action.

Corrective action for non-systematic errors or expected random failures is documented in run logs, laboratory notebooks and the case narrative of the final report. Corrective actions for non-conformances that may reoccur (beyond expected random QC failures) or where there is concern that the laboratory is not in compliance with its own policies and procedures require that a corrective action form be completed (see Section 14.1). If the data reported are affected adversely by the non-conformance, the affected data is clearly identified in the report and the customer is notified.

Section 15:
PREVENTATIVE ACTION

Preventative action is a pro-active process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints. Preventative action includes, but is not limited to: review of QC data to identify trends, monthly Managers meetings, review of Proficiency Testing results (See Appendix I – "Proficiency Testing"), annual managerial reviews, scheduled instrument maintenance (See Table 22-5, "Preventative Maintenance") and other actions to prevent problems.

When improvement opportunities are identified or if preventative action is required, action plans are developed, implemented and monitored to reduce the likelihood of the occurrence of nonconformities.

Procedures for preventative actions include the initiation of such actions and subsequent monitoring to ensure that they are effective.

All personnel have the authority to offer suggestions for improvements and to recommend preventative actions, however management is responsible for implementing preventative action.

Section 16:
CONTROL OF RECORDS

Records are a subset of documents, usually data recordings that include annotations, such as daily refrigerator temperatures posted to a laboratory form, lists, spreadsheets, or analyst notes on a chromatogram. Records may be on any form of media, including electronic and hard copy. Records allow for the historical reconstruction of laboratory activities related to sample-handling and analysis.

The laboratory maintains a record system appropriate to its needs, records all laboratory activities, and complies with applicable standards or regulations as required. Records of original observations and derived data are retained to establish an audit trail. Records help establish factors affecting the uncertainty of the test and enable test repeatability under conditions as close as possible to the original.

16.1 Records Maintained

Records of all procedures to which a sample is subjected while in the possession of the laboratory are kept. The laboratory retains all original observations, calculations and derived data (with sufficient information to produce an audit trail), calibration records, personnel records and a copy of the test report for a minimum of five years from generation of the last entry in the records. At a minimum, the following records are maintained by the laboratory to provide the information needed for historical reconstruction:

i) all raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' worksheets and data output records (chromatograms, strip charts, and other instrument response readout records);
ii) a written description or reference to the specific method(s) used; a copy of all pertinent Standard Operating Procedures;
iii) laboratory sample ID;
iv) date of analysis;
v) time of analysis is required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., extractions and incubations);
vi) instrument identification and instrument operating conditions/parameters (or reference to such data);
vii) all manual calculations (including manual integrations);
viii) analyst's or operator's initials/signature or electronic identification;
ix) sample preparation, including cleanup, separation protocols, incubation periods or subculture, volumes, weights, instrument printouts, meter readings, calculations, reagents;
x) test results (including a copy of the final report);
xi) standard and reagent origin, receipt, preparation, and use;
xii) calibration criteria, frequency and acceptance criteria;
xiii) archive records;
iv) quality control protocols and assessment;
xv) electronic data security, software documentation and verification, backups, and records of any changes to automated data entries;

xvi) method performance criteria including expected quality control requirements;
xvii) proficiency test results;
xviii) records of demonstration of capability for each analyst;
xix) a record of names, initials, and signatures for all individuals who are responsible for signing or initialing any laboratory record;
xx) correspondence relating to laboratory activities for a specific project;
xxi) corrective action reports;
xxiii) copies of internal and external audits including audit responses;
xxiv) copies of all current and historical laboratory SOPs, policies and *Quality Manual*s;
xxv) sample receiving records;
xxvii) data review and verification records;
xxviii) personnel qualification, experience and training records;
xxviv) management reviews.

16.2 Records Management and Storage

The laboratory maintains a record management system for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage, and reporting. Data is recorded immediately and legibly in permanent ink (data generated by automated data collections systems is recorded electronically.) Corrections are initialed and dated with the reason noted for corrections other than transcription errors. A single line strikeout is used to make corrections so that the original record is not obliterated.

Records, including electronic records, are easy to retrieve, legible, and protected from deterioration or damage; held secure and in confidence; and are available to accrediting bodies for a minimum of five years or as required by regulation or contract. Records that are stored only on electronic media are supported by the hardware and software necessary for their retrieval.

Additional information regarding control of data is included in Section 21.5 – "Control of Data".

In the event that the laboratory transfers ownership or goes out of business, records are maintained or transferred according to client instructions. Appropriate regulatory and state legal requirements concerning laboratory records shall be followed.

16.3 Legal Chain of Custody Records

Evidentiary sample data are used as legal evidence. These samples are treated in the same manner as standard samples received at the laboratory. Procedures for sample handling can be found in IAL SOP1.0800.

Section 17:
AUDITS

Audits measure laboratory performance and verify compliance with accreditation/ certification and project requirements. Audits specifically provide management with an on-going assessment of the management system. They are also instrumental in identifying areas where improvement in the management/quality system will increase the reliability of data. Audits are of four main types: internal, external, performance, and system. Section 17.5 discusses the handling of audit findings.

17.1 Internal Audits

Annually, the laboratory prepares a schedule of internal audits to be performed during the year. All areas of the laboratory must be audited annually. These audits verify compliance with the requirements of the management/quality system, including analytical methods, SOPs, the *Quality Manual*, ethics policies, data integrity, other laboratory policies, and the TNI Standard.

It is the responsibility of the Quality Assurance Manager to plan and organize audits as required by the schedule and requested by management. The schedule prepared must be followed without exception. These audits are carried out by trained and qualified personnel who are, wherever resources permit, independent of the activity to be audited. Check lists, which will be maintained by the Quality Assurance Manager, will be provided to the designated in-house auditors.

All documentation, check lists, paperwork, copies of logbooks, etc. which were reviewed or produced during the internal audit must be submitted to the Quality Assurance Manager. The area audited, the audit findings, and corrective actions are recorded. Audits are reviewed after completion to assure that corrective actions were implemented and effective. All staff involved in an audit and area audited must sign off on the final report.

In addition to the scheduled internal audits, it may sometimes be necessary to conduct special audits as a follow-up to corrective actions, PT results, complaints, regulatory audits or alleged data integrity issues. These audits address specific issues.

17.2 External Audits

It is the laboratory's policy to cooperate and assist with all external audits, whether performed by clients or an accrediting body. Management ensures that all areas of the laboratory are accessible to auditors as applicable and that appropriate personnel are available to assist in conducting the audit.

17.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, on-site 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.

17.3 Performance Audits

Performance audits may be Proficiency Test Samples, internal single-blind samples, double-blind samples through a provider or client, or anything that tests the performance of the analyst and method.

Proficiency Test Samples are discussed in Section 26 – "Quality Assurance for Environmental Testing" and Appendix I – "Proficiency Testing".

17.4 System Audits

The Laboratory's management system is audited though annual management reviews. Refer to Section 5.3 – "Management Reviews" for further discussion of management reviews.

17.5 Handling Audit Findings

Internal or external audit findings are responded to within the time frame agreed to at the time of the audit. The response may include action plans that could not be completed within the response time frame. A completion date is established by management for each action item and included in the response. Ideally, all corrective actions will be resolved within 30 days unless this time frame is impractical or causes undue hardship to the laboratory. For example, this may be due to the need for extensive programming or the need to purchase costly equipment.

The responsibility for developing and implementing corrective actions to findings is the responsibility of the Quality Assurance Manager and Laboratory Director. Corrective actions are documented through the corrective action process described in Section 14 – "Corrective Actions"

Audit findings that cast doubt on the effectiveness of the laboratory operation to produce data of known and documented quality or that question the correctness or validity of sample results must be investigated. Corrective action procedures described in Section 14 – "Corrective Action" must be followed. Clients must be notified in writing if the investigation shows the laboratory results have been negatively affected and the clients' requirements have not been met. The client must be notified within 48 hours after the laboratory discovers the issue. Laboratory management will ensure that this notification is carried out within the specified time frame.

All investigations that result in findings of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. See Section 18 – "Data Integrity Investigation" for additional procedures for handling inappropriate activity.

Section 18:
DATA INTEGRITY INVESTIGATIONS

In addition to covering data integrity investigations, this Section covers all topics related to ethics and data integrity policies, procedures and training.

IAL is committed to ensuring the integrity of its data and providing valid data of known and documented quality to its clients. The elements in IAL's Ethics and Data Integrity program include:

- An Ethics and Data Integrity Policy signed by all management and staff annually during the annual data integrity training.
- Annual data integrity training.
- Procedures for confidential reporting of alleged data integrity issues.
- An audit program that monitors data integrity (see Section 17 – "Audits") and procedures for handling data integrity investigations and client notifications.

18.1 Ethics and Data Integrity Procedures

The Ethics and Data Integrity Policy provides an over view of the program. Written procedures that are considered part of the Ethics and Data Integrity program include:

- Ethics and Data integrity Policy
- Manual Integrations Procedure
- Corrective Action procedures
- Data Integrity training

Management reviews data integrity procedures yearly and updates these procedures as needed.

18.2 Training

Data integrity training is provided as a formal part of new employee orientation and a refresher is given annually for all employees. Employees are required to understand that any infractions of the laboratory data integrity procedures shall result in a detailed investigation that could lead to very serious consequences including immediate termination, debarment, and/or civil/criminal prosecution. This is discussed in the Ethics and Data Integrity Policy that every employee is required to sign after initial training is conducted. Attendance for required training is monitored through a signature attendance sheet.

Data integrity training emphasizes the importance of proper written narration on the part of the analyst with respect to those cases where analytical data may be useful, but are in one sense or another partially deficient. The following topics and activities are covered:

- organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting;
- how and when to report data integrity issues;

- record keeping;
- training, including discussion regarding all data integrity procedures;
- data integrity training documentation;
- in-depth data monitoring and data integrity procedure documentation; and
- specific examples of breaches of ethical behavior such as improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards.
- Consequences of data integrity infractions.

When contracted technical or support personnel are used, the Department Manager is responsible for ensuring that they are trained to the laboratory's management system and data integrity procedures, competent to perform the assigned tasks, and appropriately supervised.

Topics covered are provided in writing and provided to all trainees.

18.3 Confidential Reporting of Ethics and Data Integrity Issues

Confidential reporting of data integrity issues is assured through the use of confidential email. All employees have the ability to report unethical issues anonymously using IAL's "Contact Us" form on the website (http://www.ialonline.com/Contact_US.cfm) which is monitored by the Quality Assurance Manager or through IAL's suggestion box. Upon receipt of information regarding unethical behavior, the Quality Assurance Manager will notify the Laboratory Director and a detailed investigation will be performed.

18.4 Investigations

All investigations resulting from data integrity issues are conducted confidentially. They are documented and notifications are made to clients who received any negatively affected data that did not meet the client's data quality requirements. Procedures for investigation are as follows:

a. Information is gathered through interviews and review of all records related to the issue reported or found.
b. Interviews shall be conducted with staff involved. All investigations are conducted privately & confidentially
c. Formal report conclusion is written based on findings
    i. No Action: Data integrity issue not verified
    ii. Further Action: Corrective Action – See Section 14, "Corrective Action"
d. If necessary, clients must be notified of any dubious findings – See Section 12.2.1 – "Notifying Clients"
e. A report is issued to Lab Director for final review and/or action
f. Reports are archived for five years

Section 19:
PERSONNEL

IAL employs competent personnel based on education, training, experience and demonstrated skills as required. The laboratory's organization chart can be found in Appendix B.

19.1 Overview

All personnel are responsible for complying with all quality and data integrity policies and procedures that are relevant to their area of responsibility.

All personnel who are involved in activities related to sample analysis, evaluation of results or who sign test reports, must demonstrate competence in their area of responsibility. Appropriate supervision is given to any personnel in training and the trainer is accountable for the quality of the trainees work. Personnel are qualified to perform the tasks they are responsible for based on education, training, experience and demonstrated skills as required for their area of responsibility.

Training needs are identified at the time of employment and when personnel are moved to a new position or new responsibilities are added to their job responsibilities. Ongoing training, as needed, is also provided to personnel in their current jobs. The effectiveness of the training must be evaluated before the training is considered complete.

Contracted personnel, when used, must meet the same competency standards and follow the same policies and procedures that laboratory employees must meet.

19.2 Job Descriptions

Job descriptions are available for all positions that manage, perform, or verify work affecting data quality. An overview of top management's responsibilities is included in Section 5 – "Management". Job descriptions include the specific tasks, minimum education and qualifications, skills, and experience required for each position.

19.3 Training

All personnel are appropriately trained and competent in their assigned tasks before they contribute to functions that can affect data quality. It is Management's responsibility to assure personnel are trained. Training records are used to document management's approval of personnel competency. The date on which authorization and/or competence is confirmed is included.

Training records are maintained by the Quality Assurance Manager and include Initial & Annual Demonstration of Capability Certification(s), documentation that the Quality Assurance Manual and the applicable Standard Operating Procedure (SOP) has been read and understood.

19.3.1 Training for New Staff

New staff members are given the following training:

- The new employee is given an orientation by the Office Manager upon arrival.
- The new employee is given Ethics and Data Integrity training by the Quality Assurance Manager.
- The new employee is required to read the Quality Assurance Manual.
- The new employee is required to view a Safety video presentation.
- The new employee is relinquished to the department manager and is required to read applicable SOPs for the tasks he/she will be trained on.
- The new employee will work under the direct supervision of the manager, supervisor or senior personnel. During this time, the trainee may sign laboratory notebooks, logbooks, etc. but they must be co-signed by the trainer who is responsible for the data generated.
- The trainee must successfully demonstrate competency in the new task before he/she can operate independently. Competency is demonstrated by a Demonstration of Capability as defined in Section 21 – "Environmental Methods and Method Validation".
- All steps of the training process are documented. Documentation is maintained by the Quality Assurance Director.

19.3.2 Ongoing Training

Staff members are given the following ongoing training:

- All employees are given refresher Ethics and Data Integrity training annually.
- All employees are required to show continued proficiency in each method he/she performs as defined in Section 21- "Environmental Methods and Method Validation".
- All employees are required to read, understand and agree to perform the most recent SOP.
- All ongoing training is documented. Documentation is maintained by the Quality Assurance Manager.

Section 20:
ACCOMODATIONS AND ENVIRONMENTAL CONDITIONS

20.1 Environmental

Laboratory operations are conducted in a 20,000 square foot facility, designed to meet production demands easily and efficiently. Environmental conditions are monitored to ensure that conditions do not invalidate results or adversely affect the required quality of any measurement. Such environmental conditions include temperature, light and biological sterility. If the laboratory environment is required to be controlled by a method or regulation, the adherence is recorded. Environmental tests are stopped when the environmental conditions jeopardize the results.

20.2 Work Areas

Work areas may include access and entryways to the laboratory, sample receipt area, sample storage area, sample process area, instrumental analysis area, chemical and waste storage area and data handling and storage area.

Access to, and use of, areas affecting the quality of the environmental tests is controlled by restriction of areas to authorized personnel only. See Section 20.4 below.

The laboratory work spaces are adequate for their use, and appropriately clean to support environmental testing and ensure an unencumbered work area.

Laboratory space is arranged to minimize cross-contamination between incompatible areas of the laboratory. The Volatile Organic laboratories have a separate air system from the rest of the lab. Electronic balances are located away from drafts. Biological sterility is monitored according to SOPs for bacteriological test methods.

20.3 Floor Plan

A floor plan can be found in Appendix C.

20.4 Building Security

The laboratory is kept secure during off hours with an alarm system.

A Visitor's Logbook is maintained for every visitor to sign in and out. Visitors must be accompanied by laboratory personnel when in secure areas.

Section 21:
ENVIRONMENTAL METHODS AND METHOD VALIDATION

Methods and/or procedures are available for all activities associated with the analysis of the samples including preparation and testing. For purposes of this Section, "method" refers to both the sample preparation and determinative methods.

Before being put into use, a test method is confirmed by a demonstration of capability or method validation process.

All methods are published or documented. Deviations from the methods are allowed only if the deviation is documented, technically justified, authorized by management and accepted by the customer

21.1 Method Selection

A reference method is a method issued by an organization generally recognized as competent to do so. When a laboratory is required to analyze a parameter by a specified method due to a regulatory requirement, the parameter/method combination is recognized as a reference method.

The laboratory will use methods that meet the needs of the customer. Such methods will be based on the latest edition of the method unless it does not meet the needs of the customer.

The laboratory selects methods that are appropriate to the customer needs. When the regulatory authority mandates or promulgates methods for a specific purpose, only those methods will be used.

If a method proposed by a customer is considered to be inappropriate or out-of-date, the customer is informed and the issue resolved before proceeding with analysis of any samples (see Section 7 – Review of Requests, Tenders and Contracts).

If a method is not specified by the customer, an appropriate method will be selected based on mandated by the applicable regulatory authority. The customer will be informed of the selected method and must approve its use before being used to report data. All communications between the laboratory and the customer are documented.

When a method is not specified by the customer, or the proposed method is inappropriate, the laboratory will select a method that is appropriate to the end use of the data:

- If the data are to be submitted to a regulatory agency, the method(s) specified by the regulatory agency will be used.
- For drinking water samples, a method will be selected from those specified in 40 CFR Part 141 or the applicable state regulations.
- For NPDES permits, the method will be selected from those specified in 40 CFR Part 136.

- If the end use of the data is not regulatory or if the regulatory agency does not specify a method, the laboratory will determine the method in terms of reporting limit requirements in conjunction with laboratory capabilities and capacity. The laboratory will select an appropriate method based on the following hierarchy:
    - Resources from published standards
    - Methods published by other technical organizations such as ASTM or Standard Methods.
    - Methods developed by the instrument manufacturer.
    - Laboratory developed methods.

21.2 Laboratory-Developed Methods

If the laboratory develops a method, the process of designing and validating the method is carefully planned and documented. All personnel involved in the method design, development and implementation will be in constant communication during all stages of development. Methods developed by IAL will be named "IAL001, IAL002, IAL003…" SOPs must be written for laboratory developed methods

21.3 Method Validation

Validation is the confirmation, by examination and objective evidence, that the particular requirements for a specific intended use are fulfilled.

At a minimum, reference methods are validated by performing an initial demonstration of capability. Additional requirements are discussed for each technology.

All methods that are not reference methods are validated before use. The validation is designed so that the laboratory can demonstrate that the method is appropriate for its intended use. All records (e.g., planning, method procedure, raw data and data analysis) shall be retained while the method is in use.

Method validation and Demonstration of Capability procedures can be found in:

- Appendix G - Chemistry
- Appendix H – Microbiology

21.4 Estimation of Analytical Uncertainty

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.

When requested, the laboratory will provide an estimate of the analytical uncertainty.

21.5 Control of Data

To ensure that data are protected from inadvertent changes or unintentional destruction, the laboratory uses procedures to check calculations and data transfers (both manual and automated).

21.5.1 Computer and Electronic Data Requirements

The laboratory assures that computers, user-developed computer software, automated equipment, or microprocessors used for the acquisition, processing, recording, reporting, storage, or retrieval of environmental test data are:

- documented in sufficient detail and validated as being adequate for use;
- protected for integrity and confidentiality of data entry or collection, data storage, data transmission and data processing;
- maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of environmental test data; and
- held secure including the prevention of unauthorized access to, and the unauthorized amendment of, computer records. Data archive security is addressed in Section 16 – "Control of Records" and building security is addressed in Section 20- "Accommodations and Environmental Conditions".

The laboratory controls access to all programs that are used to acquire, process, record and report data. All programs are password protected. Each employee is granted access only to those programs that he or she uses.

21.5.2 Data Reduction

As part of the management system, the laboratory ensures that manual calculations and data transfers (data entry, transcribing raw or calculated data, etc.) are checked for accuracy by the Quality Assurance department.

The analyst calculates final results from raw data or appropriate computer programs provide the results in a reportable format. The test methods provide required concentration units, calculation formulas and any other information required to obtain final analytical results.

The laboratory has manual integration procedures that must be followed when integrating peaks during data reduction. See IAL SOP1.3400.

All raw data must be retained electronically on IAL's server or as bound hardcopy in each department. Data are maintained as described in Section 16 – "Control of Records".

21.5.3 Data Review Procedures

Data review procedures are located in Section 22.4 – "Data Review".

Section 22:
CALIBRATION REQUIREMENTS

22.1 General Equipment Requirements

The laboratory provides all the necessary equipment required for the correct performance of the scope of environmental testing performed by the laboratory.

All equipment and software used for testing and sampling are capable of achieving the accuracy required for complying with the specifications of the environmental test methods as specified in the laboratory SOPs.

Equipment is operated only by authorized and trained personnel (see Section 19 – "Personnel").

The laboratory has procedures for the use, maintenance, handling and storage of equipment and they are readily available to laboratory. Manuals provided by the manufacturer of the equipment provide information on use, maintenance, handling and storage of the equipment. The laboratory maintains an equipment list that includes additional information on storage location. The laboratory also has a table to summarize planned equipment maintenance. These procedures ensure proper functioning of the equipment and prevent contamination or deterioration.

All equipment is calibrated or verified before being placed in use to ensure that it meets laboratory specifications and relevant standard specifications. One to two bound laboratory notebooks are kept for each piece of equipment. One notebook is for maintenance, the other notebook contains a record of analysis, calibration, sample analysis and QC performed. These notebooks can and will be combined, when necessary. Each notebook is assembled chronologically by instrument and stored together as a laboratory working record.

Test equipment, including hardware and software, are safeguarded from adjustments that would invalidate the test result measurements by limiting access to the equipment and using password protection where possible (see Section 21.5 – "Control of Data").

Equipment that has been subject to overloading, mishandling, given suspect results, or shown to be defective or outside specifications is taken out of service. The equipment is isolated to prevent its use or clearly labeled as being out of service until it has been shown to function properly. If it is shown that previous tests are affected, then procedures for nonconforming work are followed and results are documented (see Section 12 – "Control of Nonconforming Environmental Testing Work" and Section 14 – "Corrective Action").

Each item of equipment and software used for testing and significant to the results is uniquely identified. Records of equipment and software are maintained. This information includes the following:

- identity of the equipment and its software;
- manufacturer's name, type identification, serial number or other unique identifier;
- checks that equipment complies with specifications of applicable tests;

- current location;
- manufacturer's instructions, if available, or a reference to their location;
- dates, results and copies of reports and certificates of all calibrations, adjustments, acceptance criteria, and the due date of next calibration;
- maintenance plan where appropriate, and maintenance carried out to date; documentation on all routine and non-routine maintenance activities and reference material verifications;
- any damage, malfunction, modification or repair to the equipment;
- date received and date placed in service, if available.

A complete list of equipment can be found in Table 22-1.

22.2 Support Equipment

Support Equipment includes, but is not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices, volumetric dispensing devices, and thermal/pressure sample preparation devices. All support equipment is maintained in proper working order. Records are kept for all repair and maintenance activities, including service calls.

All raw data records are retained to document equipment performance. These records include logbooks, data sheets, or equipment computer files.

22.2.1 Support Equipment Maintenance

Regular maintenance of support equipment, such as balances is conducted at least annually. Maintenance of support equipment is outlined in Table 22-2.

Maintenance on other support equipment, such as ovens, refrigerators, and thermometers is conducted on an as needed basis.

Records of maintenance to support equipment are documented in Instrument Maintenance Logs. Each piece of support equipment does not necessarily have its *own* logbook but must be documented. Maintenance logbooks may be shared with equipment that is housed in the same laboratory area.

Table 22.1 - Laboratory Equipment			
Name - Unique Identifier	**Location**	**Brand/Model**	**Serial Number**
Air			
AA	Unit 4	Agilent (7890A)	US10831002
	Unit 4	Agilent(5975C XL)	US81839848
	Unit 4	Markes (Unity 2)	U21921
	Unit 4	Markes (CIA Advantage)	GB00H10120
AC	Unit 4	Dionex(CD 20)	980708890
	Unit 4	Agilent (1100)	DE11109587
	Unit 4	Agilent (G1323B) - autosampler	DE82206436
	Unit 4	Agilent (G1323B) - controller	CN40413267
AD	Unit 4	Waters(616)	MX5NM5096M
	Unit 4	Waters(600S)	SX5MM0173M
	Unit 4	Thermosci.(UV1000)	035/13716-5
	Unit 4	Gastorr(153)	5345H13
	Unit 4	Waters (717PLUS,WAT078563)	MX4EM839M
AG	Unit 4	Agilent(6890N)	US10217045
Can Cleaner	Unit 4	ESC (ESC 4 C-9501)	Not provided
Heating Jacket	Unit 4	Restek(24123)	1080
Heating Jacket	Unit 4	Restek(24123)	1070
Heating Jacket	Unit 4	Restek(24123)	1071
Heating Jacket	Unit 4	Restek(24123)	1119
Heating Jacket	Unit 4	Restek(24123)	1054
Heating Jacket	Unit 4	Restek(24123)	1067
Heating Jacket	Unit 4	Restek(24123)	1053
Heating Jacket	Unit 4	Restek(24123)	1097
Pump	Unit 4	Edwards(RV3)	986059523
Balance	Unit 4	OHAUS(G160D)	2461
Mass Flow Controller	Unit 4	Alicat(MC200SCCMD)	47694
Flow Meter	Unit 4	Alicat(M10SCCMD30PSIA)	33295
Flow Meter	Unit 4	Alicat(M10SCCMD30PSIA)	34023
Flow Meter	Unit 4	Alicat(M200SCCMD30PSIA)	90332
Metals			
Hot Plate	Unit 9	VWR(12365-504)	90930001
Hot Block	Unit 9	Env. Express (SC100)	HB01
Hot Block	Unit 9	Env. Express (SC154)	424CEC0561
Hot Block	Unit 9	Env.Expresss (SC100)	HB03
Stir Plate	Unit 9	VWR (SPO1)	SP01
Balance	Unit 9	Mettler Toledo (PL602-S/03)	6428230019
ICP-MS	Unit 8	Agilent (7500cx)	JP51202480
ICP-MS	Unit 8	Agilent (7900)	JP17321968
FIMS	Unit 8	Perkin Elmer (FIMS)	101S7061401
Chiller for Agilent	Unit 8	PolyScience (3370P9QT1B)	109A00485
Chiller for Elan	Unit 8	Thermo (Merlin M110)	108164034
Autosampler -Agilent	Unit 8	CETAC (ASX500)	099501ASX
Autosampler - Elan	Unit 8	CETAC (ASX520)	080803A520
Autosampler -FIMS	Unit 8	Perkin Elmer (AS-91)	10157061401
Extractions			

Table 22.1 - Laboratory Equipment			
Name - Unique Identifier	**Location**	**Brand/Model**	**Serial Number**
Turbovap 2	Unit 9	Caliper (103187/0)	TV0708N13599
Turbovap 2	Unit 9	Zymark (46368/0)	TV9828N8218
Turbovap LV	Unit 9	Zymark (43750/24)	TV9716N7451
Ultrasonic Cleaner Bath	Unit 9	VWR (550D)	18DS34106
Sonic Disruptor	Unit 9	Tekmar (TM600-2)	11601
Sonic Horn	Unit 9	Tekmar (V1A)	V9828
Sonic Horn	Unit 9	Tekmar (V1A)	V9779
Sonic Disruptor	Unit 9	Tekmar (TM500)	7057
Sonic Horn	Unit 9	Tekmar (CV17)	V12564
Sonic Horn	Unit 9	Tekmar (CV17)	V12276
ASE	Unit 9	Dionex (200)	99040607
Gilson Seperator	Unit 9	Gilson (GX274 ASPEC)	
Microbiology			
Vertical Clean Bench	Unit 5	Labconco (3750000)	030226857E
Incubator 1	Unit 5	VWR (5025T)	1201402
Incubator 2	Unit 5	VWR (5025B)	1201402
Incubator 3	Unit 5	Fisher (146E)	401N0018
Incubator 4	Unit 5	Raven (120)	4088
Autoclave 1	Unit 5	Gettinge (Novus 1)	I90004
Steam Generator	Unit 5	Sussman Automatic (HP30A)	SS-86118-R2000
Balance 1	Unit 5	Mettler (PL202-S)	1202470409
Quebec Darkfield Counter	Unit 5	Reichert-Jung (3325)	10764-0
Microwave Oven	Unit 5	Emerson (MW8985W)	360-70502008
ElecPress Steril	Unit 5	All American (25X-1)	4599
Refrigerator 1	Unit 5	Frigidaire (FRU17B2JW5)	WA32900496
Refrigerator 2	Unit 5	Kenmore (253.68802011)	BA03829026
Hand Tally 1	Unit 5	VWR (23609-102)	NA
Phase Contrast Microscope	Unit 5	Olympus (BHB)	222966
Air Sampler Quicktake 30	Unit 5	SKC (228-9530)	678088
pH Meter	Unit 5	Beckman (340)	2755
Vortexer	Unit 5	VWR (VM-300)	26574
Thermometer/ Hygrometer	Unit 5	Fisher (11-661-7D)	111830554
Water Bath, Fecal Coliform	Unit 5	VWR (1285PC)	1000101
Pump, Digital	Unit 5	Microflex (7523-60)	E06004919
Incubator	Unit 5	Bellco (Walk-in)	BRP0801
Microscope, dissection	Unit 5	Southern Precision (1891)	NA
Ultraviolet Light, longwave	Unit 5	Entech (UVL28)	95-0248-1
Autoclave 2	Unit 5	Napco (9000D)	6-86-2170-69
Utraviolet sterilizer	Unit 5	Millipore (xx6370000)	NA
UV measuring meter	Unit 5	Blak-ray (J-2225)	NA
StirrerHot Plat 7 x 7	Unit 5	Corning (PC-420)	4.10504E+11
Stirre Hot Plate7 x 7	Unit 5	Corning (PC-420)	4.10505E+11
Balance 2	Unit 5	Sartorius (CP153)	13502134

Table 22.1 - Laboratory Equipment			
Name - Unique Identifier	**Location**	**Brand/Model**	**Serial Number**
Organics: Gas Chromatography			
GC-H	Unit 6	Agilent(6890+)G1530A	US00021502
	Unit 6	Agilent(7683B)G2613A	CN33832630
	Unit 6	Agilent(Tray)G2614A	CN33626283
GC-I	Unit 6	Agilent(6890+)G1530A	US00041327
	Unit 6	Agilent(7683)G2913A	US01212322
	Unit 6	Agilent(7683)G2913A	CN13922395
	Unit 6	Agilent(Tray)G2614A	CN42329162
GC-M	Unit 6	Agilent(6890N)G1530N	US10342036
GC-N	Unit 6	Agilent(6890N)G1530N	US00033045
	Unit 6	Agilent(7683)G2913A	CN21024254
	Unit 6	Agilent(7683)G2913A	US92307651
	Unit 6	Agilent(Tray)G2614A	US81100463
GC-O	Unit 6	Agilent(6890N) G13530N	US10643023
	Unit 6	Agilent(7683)G2613A	CN63835828
	Unit 6	Agilent(Tray)G2614A	CN52534562
GC-P	Unit 6	Agilent(6890+)G1530A	US00037974
	Unit 6	Agilent(7683)G2613A	US81200576
	Unit 6	Agilent(Tray)G2614A	US21014539
GC-Q	Unit 6	Agilent(7890A)G3440A	CN10719100
	Unit 6	Agilent(7683B)G2913A	CN82249705
	Unit 6	Agilent(7683B)G2913A	CN71640149
	Unit 6	Agilent(Tray)G2614A	CN71643708
GC-R	Unit 6	Agilent(6890) G13530A	US00026210
	Unit 6	Agilent(7683)G2613A	US92407809
	Unit 6	Agilent(Tray)G2614A	US90704201
GC-T	Unit 6	Agilent(6890N)G1530N	CN10439002
	Unit 6	Agilent(7683)G2913A	CN22225570
	Unit 6	Agilent(7683)G2913A	US01813243
	Unit 6	Agilent(Tray)G2614A	CN22020720
GC-U	Unit 6	Agilent(6890N)G1530N	CN10532015
	Unit 6	Agilent(7683)G2913A	US93008445
	Unit 6	Agilent(7683)G2913A	US93408874
	Unit 6	Agilent(Tray)G2614A	US15113907
GC-V	Unit 6	Agilent(6890N) G13530N	US10643020
	Unit 6	Agilent(7683)G2613A	CN63835826
	Unit 6	Agilent(Tray)G2614A	CN63941269
GC-W	Unit 6	Agilent(6890) G13530A	US00023119
	Unit 6	Agilent(7683)G2613A	US8300171A
	Unit 6	Agilent(Tray)G2614A	US81006371
GC-X	Unit 6	Agilent(6890+)G1530A	US00024186
	Unit 6	Agilent(7683)G2913A	CN52425814
	Unit 6	Agilent(Tray)G2614A	CN82248798
GC-Y	Unit 6	Agilent(6890N) G13530N	CN10525059
	Unit 6	Agilent(7683)G2613A	CN63835828
	Unit 6	Agilent(Tray)G2614A	CN63941271
GC-Z	Unit 6	Agilent(6890N)G1530N	CN10615009

Table 22.1 - Laboratory Equipment			
Name - Unique Identifier	**Location**	**Brand/Model**	**Serial Number**
	Unit 6	Agilent(7683)G2913A	CN13922395
	Unit 6	Agilent(7683)G2913A	US94409987
	Unit 6	Agilent(Tray)G2614A	US01407940
Refrigerator #3	Unit 6	Kenmore 253.60721	WA12700429
Refrigerator #10	Unit 6	Kelvinator VC26RMS10300	247670
Refrigerator X	Unit 6	Kelvinator VC26RMS10300	242801
Freezer #11	Unit 6	FGI Industries EVF-1100	1198
Refrigerator-ECD	Unit 6	Thermo 47747-222	144009083265
Refrigerator FID	Unit 6	Thermo 47747-222	144009083266
Organics: Volatiles			
MSD_F	Unit 8	Agilent(5975A)G6172A	US52430245
	Unit 8	Agilent(6890N)G1530N	CN10527008
	Unit 8	Archon(Auto-sampler)	US 11300003
	Unit 8	OI Analytical(Purge Trap)4660	D819466192P/E
MSD_J	Unit 8	Agilent(5973N)G2579A	US90460028
	Unit 8	Agilent(6890+)G1530A	US00033194
	Unit 8	Archon(Auto-sampler)	13226
	Unit 8	OI Analytical(Purge Trap)4560	M948460721
MSD_L	Unit 8	Agilent(5973A)G1098A	US71191378
	Unit 8	Agilent(6890)G1530A	US00009383
	Unit 8	Archon(Auto-sampler)	12280
	Unit 8	OI Analytical(Purge Trap)4660	G124466864P/E
MSD_E	Unit 8	Agilent(5973A)G1099A	US71191371
	Unit 8	Agilent(6890)G1530A	US00021420
	Unit 8	Archon(Auto-sampler)	14629
	Unit 8	OI Analytical(Purge Trap)4660	D624466014PEE
MSD_G	Unit 8	Agilent(5973I)G2579A	US33220152
	Unit 8	Agilent(6890N)G1530N	CN10344011
	Unit 8	Archon(Auto-sampler)	14301
	Unit 8	OI Analytical(Purge Trap)4660	D738466409P/E
MSD_K	Unit 8	Agilent(5973N)G1088A	US71191274
	Unit 8	Agilent(6890+)G1530A	US00024098
	Unit 8	OI Analytical(Auto-sampler)	A435410212
	Unit 8	OI Analytical(Purge Trap)4660	B448466253P/E
GC-S	Unit 8	Agilent(6890N)G1530N	US10238139
	Unit 8	Agilent(7683)G2613A	US04516115
	Unit 8	Agilent(Auto-sampler)2614A	CN43130194
	Unit 8	Tekmar(7000)14-4400-000	93092005
Refrigerator #5	Unit 8	Frigidaire Explosion Proof	
Refrigerator #6	Unit 8	Kenmore 546.942564	50948111
Freezer #7	Unit 8	Frigidaire FKFH21	F7HWA
Freezer #8	Unit 8	Kenmore	WB8224831
Balance B3	Unit 8	OHAUS SCOUT II	SC4010
Organics: BNA			
MSD_A	Unit 3	Agilent (5975)G3172A	US71236043
	Unit 3	Agilent (7890A)G3440A	CN10719081
	Unit 3	Agilent (7683B)G2913A	CN71640236

Table 22.1 - Laboratory Equipment			
Name - Unique Identifier	**Location**	**Brand/Model**	**Serial Number**
	Unit 3	Agilent (Tray)G2614A	CN71743797
MSD_B	Unit 3	Agilent (5973N)G2579A	US03950351
	Unit 3	Agilent (6890A)G1530A	US00039814
	Unit 3	Agilent (7383)G2613A	US05316949
	Unit 3	Agilent (Tray)G2614A	US05110250
MSD_C	Unit 3	Agilent (5973N)G2579A	US10452229
	Unit 3	Agilent (6890A)G1530A	US10205018
	Unit 3	Agilent (7383)G2613A	CN14523014
	Unit 3	Agilent (Tray)G2614A	US20314099
Refrigerator	Unit 3	Kenmore 253.688	BA04506281
Wet Chemistry			
LACHAT - Quick Chem	Unit 9	LACHAT (QC8500 Series 2)	140400001674
LACHAT - Auto Sampler	Unit 9	LACHAT (ASX260)	140400002225
LACHAT/ISMATEC - Reagent Pump	Unit 9	LACHAT (RP-150 / ISM1135)	529577-3
pH Meter	Unit 9	Hach(HQ440d_	1.10101E+11
Balance,Analytical	Unit 9	Mettler(AB104-S/Fact)	1126460848
Balance	Unit 9	Mettler(PL202-S/03)	6428100003
Balance	Unit 9	Mettler(PL202-S/01)	1126380390
Balance	Unit 9	Mettler(PL202-S/03)	6428100004
Oven, Isotemp	Unit 9	Fisher(650B)	212NO212
Oven	Unit 9	Blue M(OV-12A)	KAA-6898
Muffle Furnace	Unit 9	Barnstead(f62735)	1.27602E+12
Glass Crusher	Unit 9	Prodeva(95-6)	12812
Sieve Shaker	Unit 9	WS Tyler(RX-86)	102907
Sieve Shaker, Rototap	Unit 9	WS Tyler(RX-29)	3889
Flashpoint Tester, Closed-Cup	Unit 9	Boekel(152800)	NA
Bomb Calorimeter	Unit 9	Parr(NA)	5191
Midi Cyanide Distillation Apparatus	Unit 9	Andrews(10 position) Glass	NA
Midi Phenol Distillation Apparatus	Unit 9	Kontes(10 position)	NA
Dissolved Oxygen Meter	Unit 9	YSI(5100)	03G0973
Spec.Conduct.Mtr	Unit 9	YSI (3100)	00K0498
TOC Analyzer Phoenix 8000	Unit 9	Tekmar (14-7045-200)	US01211011
TOC Boat Splr	Unit 9	Tekmar-Dohrman (183)	US01107001
IR, Fixed WL	Unit 9	Foxboro (Miran 1FF)	2300
Turbidity Meter	Unit 9	Hach (2100Q)	11120C014830
Spec. Genesys 20	Unit 9	Thermospectronic (4001/4)	3SGK292009
COD Reactor	Unit 9	Hach (45600)	891201541
BOD Incubator	Unit 9	Kenmore (253.60722007)	WA94100495
Incutrol BOD Inc.	Unit 9	Hach (2597-00)	2030001027
TCLP Tumbler 1	Unit 9	Analytical Testing (12 position)	0685BRFC0044
TCLP Tumbler 2	Unit 9	Associated Design (3740-12-BRE)	NA
Hot plate 10 x 10	Unit 9	Fisher (10x10)	11-100-100H
Hot plate, 7x 7	Unit 9	Fisher (7x7)	C1892101142701

Table 22.1 - Laboratory Equipment			
Name - Unique Identifier	**Location**	**Brand/Model**	**Serial Number**
Hot plate, 3 x 3	Unit 9	Fisher (3x3)	C1928110622899
Hot plate, 3 x 3	Unit 9	Fisher (3x3)	C1928110622982
Hot Plate 30 x12	Unit 9	Thermolyne (2200)	NA
Colorimeter	Unit 9	Hach (28700-00)	A7123
pH Meter, Field	Unit 9	Mettler (SevenGo)	1230515951
pH Meter, Field	Unit 9	Mettler (SevenGo)	1231155159
Colorimeter(Fe2+)	Unit 9	Hanna Instruments (29677)	8322410
Digestors, Micro	Unit 9	Labconco (60300-00)	9912923125
Digestors, Micro	Unit 9	Labconco (6030-00)	NA
Refrigerator Walk-in	Unit 9	Jordan Scientific (D-7-89)	1672238JI
Refrigerator Metals	Unit 9	General Electric (TAXSNYBWH)	STO87630
Refrigerator WC Chem	Unit 9	General Electric (TAXSNYBWH)	STO87619
Refrigerator WC Chem	Unit 9	Revco Technologies (LR445A0)	T15L-534691-UL
Refrigerator WC Chem	Unit 9	Head Exchange Assembly (LR450A20)	W25M-600738
TOX Analyzer	Unit 9	Mitsubishi (TOX-10-R)	75R02192
TOX Drip Board	Unit 9	Mitsubishi (TXA02)	75A21202
Freeze Dryer	Unit 9	Thermo Savant (MicroModulyo115)	1G290017-1

Table 22-2 Summary of Support Equipment Calibration And Maintenance			
Instrument	**Activity**	**Frequency**	**Documentation**
ASTM Class 1 Weights	1. Only use for the intended purpose 2. Use plastic forceps to handle 3. Keep in case 4. Re-calibrate	Every year if weight is used for daily checks.	Keep certificate
Balance	1. Clean 2. Check alignment 3. Service Contract	1. Before use 2. Before use 3. Annually	Worksheet/log book; Post annual service date on balance
DO electrometer	Calibrate as specified in SOP	Before use	Worksheet/log book
DO probe	Maintenance as specified by manufacturer	As needed	Worksheet/log book
Mass flow meter	Maintenance as specified by manufacturer	As needed	Keep certificate
Microbiological incubators, and water baths	1. Thermometers in each unit are immersed in liquid to the appropriate immersion line 2. The thermometers will be graduated in increments of 0.5°C (0.2°C increments for tests which are incubated at 44.5°C) or less	Temperature of incubators and water baths will be recorded twice a day for each day in use with readings separated by at least four hours	Worksheet/log book
pH electrometers	Calibration: 1. pH buffer aliquot are used only once 2. Buffers used for calibration will bracket the pH of the media, reagent, or sample tested.	Before use	Worksheet/log book
pH probe	Maintenance: Use manufacturer's specifications	As needed	Worksheet/log book
Photometer	1. Keep cells clean 2. Check wavelength settings with color standards	Annually	Post service date on balance
Refrigerators, Freezers, and BOD incubators	1. Thermometers are immersed in liquid to the appropriate immersion line 2. The thermometers are graduated in increments of 1°C or less	Temperatures are recorded each day in use	Worksheet/log book
Sterilizer (autoclave)	1. Use a maximum-temperature-registering thermometer or a continuous recording device. 2. Use spore strips or ampoules. 3. In house maintenance of autoclave.	1. Each cycle 2. One sterilizing cycle per month. 3. Once per year	Worksheet/log book
Thermometer, NIST Traceable	Accuracy determined by A2LA-accredited weights and measurement laboratory.	Every 5 years	Keep certificate

Table 22-2 Summary of Support Equipment Calibration And Maintenance			
Instrument	**Activity**	**Frequency**	**Documentation**
Thermometers: 1. Glass and electronic 2. Dial thermometers 3. IR thermometer	Check at the temperature used, against a reference NIST certified thermometer	1. Annually for glass and electronic 2. Quarterly for dial and IR thermometers	Calibration factor and date of calibration on thermometer and worksheet/log book
Working Standard Weights	Used to check balances before their use.	Annually	Worksheet / logbook

22.2.2 Support Equipment Calibration

Calibration requirements for analytical support equipment are found in Tables 22-3 and 22-4.

All support equipment is calibrated or verified annually over the entire range of use using NIST traceable references where available. The results of the calibration of support equipment are within specifications or (1) the equipment is removed from service until repaired, or (2) records are maintained of correction factors to correct all measurements. If correction factors are used this information is clearly marked on or near the equipment.

Support equipment such as balances, ovens, refrigerators, freezers, and water baths are verified with a NIST traceable reference if available, each day prior to use, to ensure operation is within the expected range for the application for which the equipment is to be used

Volumetric dispensing devices (except Class A glassware and Glass microliter syringes) are checked for accuracy on a quarterly basis.

For microbiology analyses records for autoclaves used in the laboratory are required for the following:

- initial performance of the autoclave functional properties (supplied by the installer);
- temperature demonstration of sterilization continuous monitoring device or maximum registering temperature;
- for every cycle, record date, contents, maximum temperature reached, pressure, time in sterilization mode, total run time, and analysts initials;
- quarterly check of autoclave timing device against a stopwatch; and
- annual maintenance check to include a pressure check and calibration of temperature device.

Table 22-3 Calibration Acceptance Criteria for Support Equipment				
Equipment	**Type of Calibration/ Number of Standards**	**Frequency**	**Acceptance Limits**	**Corrective Action**
Analytical Balance	Accuracy determined using A2LA-accredited NIST weights. Minimum of 2 standards bracketing the weight of interest. Inspected and calibrated by A2LA accredited personnel annually.	Daily	± 0.2%	Clean, check level, insure lack of drafts, and that unit is warmed up, recheck. If fails, call service.
Thermometer	Against NIST-traceable thermometer	Yearly at appropriate temperature range for intended use	± 1.2°C	Replace
Minimum-Maximum Thermometers	Against NIST-traceable thermometer	Yearly	± 1.5°C	Replace
InfraRed Temperature Guns	Against NIST-traceable thermometer	Quarterly at appropriate temperature range for intended use	± 1.5°C	Repair/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.	Quarterly	± 2% Calculate accuracy by dividing weight by stated volume times 100 for percent.	Adjust or Replace.

Table 22-4 Acceptance Criteria for Support Equipment		
Equipment Identification	**Use**	**Acceptance Criteria**
Refrigerator	Sample storage, other than micro	1 to 6°C
Refrigerator	Sample storage, micro	1.1 to 3.9°C
Refrigerator	Reagent / media storage	1 to 6°C
Freezer	Ice packs, reagent storage	-20°C to -30°C
Freezer	Sample storage – volatile soils per SW-846 5035	<-7°C

22.3 Analytical Equipment

22.3.1 Maintenance for Analytical Equipment

All equipment is properly maintained, inspected, and cleaned.

Maintenance of analytical instruments and other equipment may include regularly scheduled preventative maintenance or maintenance on an as-needed basis. Instrument malfunction is documented in Instrument Maintenance Logs which become part of the laboratory's permanent records. A description of what was done to repair the malfunction and proof of return to control are also documented in the log. See Table 22-5, "Analytical Equipment Maintenance".

22.3.2 Instrument Calibration

Information on instrument calibration can be found in Appendix H and I.
Initial instrument calibration and continuing instrument calibration verification are an important part of ensuring data of known and documented quality. If more stringent calibration requirements are included in a mandated method or by regulation, those calibration requirements override any requirements outlined here or in laboratory SOPs. Generally, procedures and criteria regarding instrument calibrations are provided in test methods.

Table 22-5 Analytical Equipment Maintenance		
Instrument	**Procedure**	**Frequency**
Auto Analyzers	Clean sampler	Daily
	Check all tubing	Daily
	Clean inside of colorimeter	Daily
	Clean pump well and pump rollers	As required
	Clean wash fluid receptacle	As required
	Oil rollers/chains/side rails	Annually
	Clean optics and cells	As required
Balances	Class "1" traceable weight check	Daily, when used
	Clean pan and check if level	Daily
	Field service	At least annually
BOD Incubator	Temperature monitoring	Twice daily
	Coil and incubator cleaning	As needed
BOD/DOC Probe	Replace probe membrane	As required
	Calibrate	Weekly
	Check gold cathode for tarnish	Monthly
Conductivity Meter	0.01 M KCl calibration	Daily
	Conductivity cell cleaning	As required
Drying Ovens	Temperature monitoring	Twice daily
	Temperature adjustments	As required
ICP/MS	Check pump tubing	Daily
	Check liquid argon supply	Daily
	Check fluid level in waste container	Daily
	Check filters	Weekly
	Clean or replace filters	As required
	Check torch	Daily
	Check sample spray chamber for debris	Monthly
	Clean and align nebulizer	Monthly
	Check entrance slit for debris	Monthly
	Change printer ribbon	As required
	Replace pump tubing	As required
Gas Chromatograph	Compare standard response to previous day or since last initial calibration	Daily
	Check carrier gas flow rate in column	Daily via use of known compound retention
	Check temp. of detector, inlet, column oven	Daily
	Clean syringes	Daily
	Septum replacement	As required
	Glass wool replacement	As required
	Check system for gas leaks with SNOOP	with cylinder change as required
	Check for loose/fray wires and insulation	Monthly
	Bake injector/column	As required
	Change/remove sections of guard column	As required
	Replace connectors/liners	As required
	Change/replace column(s)	As required
GC Electron Capture Detector (ECD)	Detector wipe test (Ni-63)	Semi-annually
	Detector cleaning	As required
GC Flame Ionization Detector (FID)	Detector cleaning	As required

Table 22-5 Analytical Equipment Maintenance		
Instrument	**Procedure**	**Frequency**
GC Mass Spectrometer (GC/MS)	Ion gauge tube degassing Pump oil-level check Pump oil changing Check PFTBA volume Autotune Clean ion source Analyzer bake-out Analyzer cleaning Resolution adjustment	As required Monthly Semi-annually Quarterly As required As required As required As required As required
GC/MS Air Autosamplers	Change Trap Leak Test System	As required Daily
GC/MS Purge & Trap	Change Trap	As required
HPLC	Change guard columns Change lamps Change pump seals Replace tubing Change fuses in power supply Filter all samples and solvents Change autosampler rotor/stator Check pump rates	As required As required Semi-annually or as req'd As required As required Daily As required Daily
IR, Fixed Wavelength	Calibrate	Quarterly
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
pH/Specific Ion Meter	Calibration/check slope Clean electrode	Daily As required
Photoionization Detector (PID)	Change O-rings Clean lamp window	As required As required
Refrigerators/ Freezers	Temperature monitoring Warning system checked Temperature adjustment Defrosting/cleaning	Twice daily Monthly As required 6 months
Turbidimeter	Check light bulb	Daily, when used
UV-Vis Spectrophotometer	Calibration Wavelength verification check	Quarterly Annually
Vacuum Pumps/ Air Compressor	Drained Belts checked Lubricated	Semi-annually Semi annually Semi annually
Water Baths	Temperature monitoring Water replaced	Twice daily Monthly or as needed

Section 23:
MEASUREMENT TRACEABILITY

Measurement quality assurance comes in part from traceability of standards to certified materials.

All equipment used affecting the quality of test results are calibrated prior to being put into service and on a continuing basis (see Section 22 – "Calibration Requirements"). These calibrations are traceable to national standards of measurement where available.

If traceability of measurements to SI units is not possible or not relevant, evidence for correlation of results through interlaboratory comparisons, proficiency testing, or independent analysis is provided.

23.1 Reference Standards

Reference standards are standards of the highest quality available at a given location, from which measurements are derived.

Reference Standards, such as ASTM Class 1 weights, are used for calibration only and for no other purpose.

Reference standards, such as ASTM Class 1 weights, are calibrated by an entity that can provide traceability to national or international standards. The following reference standards are sent out to be calibrated to a national standard as indicated in Section 22 – "Calibration Requirements".

- Class 1 weights.
- NIST traceable reference thermometers.

23.2 Reference Materials

Reference materials are substances that have concentrations that are sufficiently well established to use for calibration or as a frame of reference.

Reference materials, where commercially available, are traceable to national standards of measurement, or to Certified Reference Materials, usually by a Certificate of Analysis.

Purchased reference materials require a Certificate of Analysis where available. If a reference material cannot be purchased with a Certificate of Analysis, it is verified by analysis and comparison to a certified reference material and/or demonstration of capability for characterization.

Internal reference materials, such as working standards or intermediate stock solutions, are checked as far as is technically and economically practical. Working standards are checked against a second source. When a second source is not available, a vendor certified different lot is accepted as a second source. In most cases, the analysis of an Initial Calibration Verification (ICV) standard or Laboratory Control Sample (LCS) can be used as a second source confirmation. Working

standards and intermediate stock solutions are given expiration dates when they are prepared and are used up or disposed of by the expiration date.

23.3 Transport and Storage of Reference Standards and Materials

The laboratory handles and transports reference standards and materials in a manner that protects the integrity of the materials. Reference standard and material integrity is protected by separation from incompatible materials and/or minimizing exposure to degrading environments or materials.

Reference standards and materials are stored according to manufacturer's recommendations, method SOP requirements and separately from samples.

23.4 Labeling of Reference Standards, Reagents, and Reference Materials

The laboratory has procedures for purchase, receipt and storage of standards, reagents and reference materials. Purchase procedures are described in Section 9 – "Purchasing Services and Supplies".

Expiration dates can be extended if the reference standard or material's integrity is verified. The extended date may not be beyond the expiration date of the referenced standards used to re-verify.

Reagent quality is verified during routine blank analysis.

23.4.1 Stock Standards, Reagents, Reference Materials and Media

Records for all standards, reagents, reference materials, and media include:

- the manufacturer/vendor name (or traceability to purchased stocks or neat compounds)
- the manufacturer's Certificate of Analysis or purity (if supplied)
- recommended storage conditions

If the original container does not have an expiration date provided by the manufacturer or vendor it is not required to be labeled with an expiration date. If an expiration date is provided, it must be labeled with the expiration date. The date the container was opened shall also be labeled.

In methods where the purity of reagents is not specified, analytical reagent grade is used. If the purity is specified, that is the minimum acceptable grade. Purity is verified and documented according to Section 9 – "Purchasing Services and Supplies".

23.4.2 Prepared Standards, Reagents, Reference Materials and Media

Records for standards, reagents, reference materials, and media preparation include:

- traceability to purchased stock or neat compounds
- reference to the method of preparation
- date of preparation

- an expiration date after which the material shall not be used (unless its reliability is verified by the laboratory)
- preparer's initials (if prepared)

All containers of prepared standards, reagents, or materials are labeled with a unique ID and an expiration date.

Prepared reagents are verified to meet the requirements of the test method through blank analyses.

Section 24:
COLLECTION OF SAMPLES

24.1 Sampling Containers

The laboratory offers clean sampling containers for use by clients. Sample containers are obtained from manufacturers that supply clean bottle certificates.

24.1.1 Preparing Container Orders

Containers (containing any required preservatives) are provided to the client upon request. A bottle order form is generated by Client Services and given to the sample receiving/shipping department. The process is outlined in SOP 1.1300 – 'Sample Container Preparation and Shipment'.

24.1.2 Sampling Containers, Preservation Requirements, Holding Times

Sampling container, preservation and holding time requirements can be found in Table 24.1 – "Sampling Container, Preservation and Holding Time Requirements". If preservation or holding time requirements are not met, the procedures in Section 12 – "Control of Nonconforming Environmental Testing Work" are followed.

24.2 Sampling Plan

IAL provides sampling services. The laboratory uses sampling plans provided by clients or prepared in consultation with the client. The plan must include any factors that must be controlled to ensure the validity of the test. Sampling plans and written sampling procedures are used for sampling substances, materials or products for testing. The plan and procedures are made available at the sampling location.

The laboratory's procedures for dealing with non-conformances are used when the client requests any deviations from the sampling plan or sampling procedures. The requests are documented and included in the final test report.

24.3 Sampling Records

The following relevant sampling data are recorded: sampling procedure used, the date and time of sampling, the identification of the sampler, environmental conditions (if relevant), the sampling location, and the statistics upon which the sampling procedures are based.

Table 24-1a Summary of Sampling Container, Preservation and Holding Time Requirements				
Aqueous				
Parameter Group	**Available Method(s)**	**Container**	**Preservation**	**Holding Time**
Acidity	SM 2310 B-11	250 mL glass or plastic	Cool ≤6°C	14 Days
Alcohols	SW-846 8015D	2 x 40mL GTLS VOA Vials	Cool ≤6°C	7 Days
Alkalinity	SM 2320 B-11	500 mL glass or plastic	Cool ≤6°C	14 Days
Ammonia	SM 4500-NH_3 B+G	500 mL glass or plastic	H_2SO_4 to pH <2, Cool ≤6°C	28 Days
Base Neutral / Acids	EPA 625/625.1 SW-846 8270D	2 x 1 L Amber GTLC	$Na_2S_2O_3$, Cool ≤6°C	7 Days extract/ 40 Days analyze
Biochemical Oxygen Demand (BOD)	SM 5210 B-11	1 L plastic or glass	Cool ≤6°C	48 Hours
Bromide	EPA 300.0 SW-846 9056A	250 mL plastic or glass	None required	28 Days
Carbonaceous Biochemical Oxygen Demand (CBOD)	SM 5210 B-11	500 mL plastic or glass	Cool ≤6°C	48 Hours
Chemical Oxygen Demand (COD)	HACH 8000	250 mL plastic or glass	H_2SO_4 to pH<2, Cool ≤6°C	28 Days
Chloride	SM 4500-Cl B-97 SM 4500-Cl E-11 EPA 300.0 SW-846 9056A	250 mL plastic or glass	Cool ≤6°C	28 Days
Chlorine, Residual	SM 4500-Cl G-11	250 mL plastic or glass	None required	Analyze immediately (15 minutes)
Color	SM 2120 B-11	250 mL plastic or glass	Cool ≤6°C	24 Hours DW / 48 Hours WW
Conductance, Specific	SM 2510 B-11	250 mL plastic or glass	Cool ≤6°C	28 Days
Cyanide, Amenable	SM 4500-CN G-11 & EPA 335.4	250 mL plastic or glass	NaOH to pH>12, Cool ≤6°C, Ascorbic acid for DW	14 Days
Cyanide, Total	EPA 335.4 SW-846 9012B	250 mL plastic or glass	NaOH to pH>12, Cool ≤6°C, Ascorbic acid for DW	14 Days
Cyanide, Total	EPA 335.4 SW-846 9012B	250 mL plastic or glass	NaOH to pH>12, Cool ≤6°C, Ascorbic acid for DW	14 Days
Diesel Range Organics	SW-846 8015D	2 x 1 L Amber GTLC	Cool ≤6°C	7 Days extract/ 40 Days analyze
1,4-Dioxane only	SW-846 8270D	2 x 1 L Amber GTLC	Cool ≤6°C	7 Days extract/ 40 Days analyze
Dissolved Organic Carbon (DOC)	SM 5310 C-11	250 mL plastic or glass	HCl or H_2SO_4 to pH<2, Cool ≤6°C	28 Days

Key:

HNO_3 – Nitric Acid
H_2SO_4 – Sulfuric Acid
GTLC - Glass, Teflon lined cap
GTLS - Glass, Teflon lined septum
$(NH_4)_2SO_4$ – ammonium sulfate
NaOH - Sodium Hydroxide
$Na_2S_2O_3$ - Sodium Thiosulfate
ZHS - Zero Headspace

Table 24-1a Summary of Sampling Container, Preservation and Holding Time Requirements

Aqueous

Parameter Group	Available Method(s)	Container	Preservation	Holding Time
Dissolved Oxygen	SM 4500-O C-11	300 mL glass DO bottle	Azide modification– ask for assistance	8 Hours
Dissolved Oxygen	SM 4500-O G-11	300 mL glass DO bottle	None required	Analyze immediately (15 minutes)
Extractable Petroleum Hydrocarbons	NJ EPH Method 10.08 Rev 3	2 x 1 L Amber GTLC	HCl to pH<2, Cool ≤6°C	14 Days extract/ 40 Days analyze
Flashpoint	SW-846 1010A	250 mL plastic or glass	None required	None stated
Fluoride	SM 4500-F B+C-11	500 mL glass or plastic	None required	28 Days
Formaldehyde	SW-846 8315A	2 x 1 L Amber GTLC	Cool ≤6°C	72 hours extract/ 72 hours analyze
Gasoline Range Organics	SW-846 8260C Modified	2 x 40 mL GTLS VOA Vials	HCl to pH<2, Cool ≤6°C	14 Days
Glycols	SW-846 8015D-M	2 x 40mL GTLS VOA Vials	Cool ≤6°C	7 Days
Hardness	SM 2340 C-11	250 mL plastic or glass	HNO_3 to pH<2	180 days
Herbicides	SW-846 8151A	2 x 1 L Amber GTLC	Cool ≤6°C	7 Days extract/ 40 Days analyze
Hexavalent Chromium	SM 3500-Cr B-11	250 mL plastic or glass	$(NH_4)_2SO_4$ to pH 9.3-9.7, Cool ≤6°C	28 Days
Hexavalent Chromium	SW-846 7196A	250 mL plastic or glass	Cool ≤6°C	24 Hours
Iron, Ferrous	SM 4500-Fe B-11	250 mL plastic or glass	Cool ≤6°C	Analyze immediately (15 minutes)
Microextractables: EDB, DBCP, & TCP	EPA 504.1	2 x 40 mL GTLS Vials	$Na_2S_2O_3$ / ZHS / Cool ≤6°C	14 Days
Microextractables: EDB, DBCP, & TCP	SW-846 8011	2 x 40 mL GTLS Vials	HCl pH<2 / ZHS / Cool ≤6°C	14 Days
Mercury	EPA 245.1 SW-846 7470A	250 mL plastic	HNO_3 to pH<2	28 Days
Metals (except Mercury)	EPA 200.8 SW-846 6020A/B	250 mL plastic	HNO_3 to pH<2	180 Days
Methane, Ethane, Ethene, Propane	RSK-175	2 x 60 mL GTLS Vials	HCl pH<2/ ZHS / Cool ≤6°C	14 Days
Nitrogen, Ammonia	SM 4500-NH3 B+G-11	250 mL plastic or glass	H_2SO_4 to pH<2, Cool ≤6°C	28 Days
Nitrogen, Total Kjeldahl (TKN)	EPA 351.2	250 mL plastic or glass	H_2SO_4 to pH<2, Cool ≤6°C	28 Days
Nitrogen, NO2 +NO3	SM 4500-NO3 F-11	250 mL plastic or glass	H_2SO_4 to pH<2, Cool ≤6°C	28 Days
Nitrogen, Nitrite	SM 4500-NO3 F-11 USGS I-4540-85 EPA 300.0 SW-846 9056A	250 mL plastic or glass	Cool ≤6°C	48 Hours

Key:

HNO_3 – Nitric Acid
H_2SO_4 – Sulfuric Acid
GTLC - Glass, Teflon lined cap
GTLS - Glass, Teflon lined septum
$(NH_4)_2SO_4$ – ammonium sulfate
NaOH - Sodium Hydroxide
$Na_2S_2O_3$ - Sodium Thiosulfate
ZHS - Zero Headspace

Table 24-1a Summary of Sampling Container, Preservation and Holding Time Requirements

Aqueous				
Parameter Group	**Available Method(s)**	**Container**	**Preservation**	**Holding Time**
Nitrogen, Nitrate*	SM 4500-NO3 F-11 EPA 300.0 SW-846 9056A	250 mL plastic or glass	Cool ≤6°C	48 Hours[1]
Odor	SM 2150 B-11	500 mL plastic or glass	None required	No stated holding time
Oil & Grease (HEM, SGT-HEM)	EPA 1664A	2 x 1 L Amber GTLC	HCl or H_2SO_4 to pH<2, Cool ≤6°C	28 Days
PCBs	EPA 608/608.3 SW-846 8082A	2 x 1 L Amber GTLC	Cool ≤6°C	1 year extract/ 1 year analyze
Pesticides	EPA 608/608.3 SW-846 8081B	2 x 1 L Amber GTLC	Cool ≤6°C	7 Days extract/ 40 Days analyze
pH	SM 4500-H B-11 SW-846 9040C	250 mL plastic or glass	None required	Analyze immediately (15 minutes)
Phenols	EPA 420.4 SW-846 9066	250 mL GTLC	H_2SO_4 to pH<2, Cool ≤6°C	28 Days
Phosphate, ortho-	SM 4500-P E-11 EPA 300.0 SW-846 9056A	250 mL plastic or glass	Cool ≤6°C	Filter within 15 minutes (in field); 48 Hours
Phosphorous, Total	SM 4500-P B5-11 + E-11	500 mL plastic or glass	H_2SO_4 to pH<2, Cool ≤6°C	28 Days
Solids, Dissolved (TDS)	SM 2540 C-11	500 mL plastic or glass	Cool ≤6°C	7 Days
Solids, Settleable	SM 2540 F-11	1 L plastic or glass	Cool ≤6°C	48 Hours
Solids, Suspended (TSS)	SM 2540 D-11	500 mL plastic or glass	Cool ≤6°C	7 Days
Solids, Total	SM 2540 B-11	500 mL plastic or glass	Cool ≤6°C	7 Days
Solids, Volatile (TVS)	EPA 160.4	500 mL plastic or glass	Cool ≤6°C	7 Days
Sulfate	ASTM D516 EPA 300.0 SW-846 9056A	250 mL plastic or glass	Cool ≤6°C	28 Days
Sulfide	SM 4500-S B,C+F-11	500 mL plastic or glass	NaOH to pH>9, Zinc acetate, Cool ≤6°C	7 Days
Surfactants (MBAS)	SM 5540 C-11	1 L plastic or glass	Cool ≤6°C	48 Hours
Temperature	SM 2550 B-11	250 mL plastic or glass	None	Analyze immediately (15 minutes)
Total Organic Carbon (TOC)	SM 5310 C-11	250 mL plastic or glass	H_2SO_4 to pH<2, Cool ≤6°C	28 Days
Total Organic Halides (TOX)	SW-846 9020B	250 mL Amber or glass	H_2SO_4 to pH<2, Cool ≤6°C	28 Days
Turbidity	SM 2130 B-11	250 mL plastic or glass	Cool ≤6°C	48 Hours
Volatile Fatty Acids	SW-846 8015D Mod.	2 x 40mL GTLS Vials	ZHS, Cool ≤6°C	7 Days

Key:

HNO_3 – Nitric Acid
H_2SO_4 – Sulfuric Acid
GTLC - Glass, Teflon lined cap
GTLS - Glass, Teflon lined septum
$(NH_4)_2SO_4$ – ammonium sulfate
NaOH - Sodium Hydroxide
$Na_2S_2O_3$ - Sodium Thiosulfate
ZHS - Zero Headspace

Table 24-1a Summary of Sampling Container, Preservation and Holding Time Requirements				
Aqueous				
Parameter Group	**Available Method(s)**	**Container**	**Preservation**	**Holding Time**
Volatile Organics – Chlorinated Source	EPA 524.2 EPA 624/624.1 SW-846 8260C	2 (GW/WW) or 3 (DW) x 40mL GTLS Vials	Ascorbic Acid, HCl pH<2 / ZHS / Cool ≤6°C	14 Days
Volatile Organics – Unchlorinated Source	EPA 524.2 EPA 624/624.1 SW-846 8260C	2 (GW/WW) or 3 (DW) x 40mL GTLS Vials	HCl pH<2/ ZHS / Cool ≤6°C	14 Days
Volatile Organics, including Acrolein & Acrylonitrile	EPA 624/624.1	2 x 40mL GTLS Vials	ZHS, Cool ≤6°C	72 hours
Volatiles (DW)-unpreserved	EPA 524.2	3 x 40mL GTLS Vials	ZHS, Cool ≤6°C	24 hours
Volatiles (NPW)-unpreserved	EPA 8260C	2 x 40mL GTLS Vials	ZHS, Cool ≤6°C	7 days

1. *For Nitrate in drinking water samples (as per 40 CFR 141): If the sample source is chlorinated and kept at 4°C, the holding time for a sample is extended to 14 days.*

Table 24-1b Summary of Sampling Container, Preservation and Holding Time Requirements				
Soils				
Parameter Group	**Available Method(s)**	**Container**	**Preservation**	**Holding Time**
Alcohols	SW-846 8015D	2 oz. GLTC	Cool ≤6°C	14 Days
Ammonia	SM 4500-NH_3 B+G	2 oz. GLTC	Cool ≤6°C	28 Days
Base Neutral / Acids	SW-846 8270D	4 oz. GLTC	Cool ≤6°C	14 Days extract/ 40 Days analyze
Bromide	SW-846 9056A	2 oz. GLTC	Cool ≤6°C	28 days
Chloride	SW-846 9056A	2 oz. GLTC	Cool ≤6°C	28 days
Cyanide, Total	SW-846 9012B Modified	2 oz. GLTC	Cool ≤6°C	14 Days
Diesel Range Organics	SW-846 8015D	4 oz. GLTC	Cool ≤6°C	14 Days extract/ 40 Days analyze
Extractable Organic Halides (EOX)	SW-846 9023	2 oz. GLTC	Cool ≤6°C	28 Days
Extractable Petroleum Hydrocarbons (EPH-DRO)	NJ EPH Method 10.08 Rev 3	4 oz. GLTC	Cool ≤6°C	14 Days extract/ 40 Days analyze
Formaldehyde	SW-846 8315A	2 oz. GLTC	Cool ≤6°C	72 hours leach/ extract ASAP/ 72 hours analyze
Gasoline Range Organics	SW-846 8260C Modified	4 oz. GLTC	Cool ≤6°C	14 Days
Herbicides	SW-846 8151A	4 oz. GLTC	Cool ≤6°C	14 Days extract/ 40 Days analyze
Hexavalent Chromium	SW-846 3060A & 7196A	2 oz. GLTC	Cool ≤6°C	30 Days extract, 7 Days analyze
Ignitibility	SW-846 1030	2 oz. GLTC	Cool ≤6°C	None stated

Key:

HNO_3 – Nitric Acid
H_2SO_4 – Sulfuric Acid
GTLC - Glass, Teflon lined cap
GTLS - Glass, Teflon lined septum
$(NH_4)_2SO_4$ – ammonium sulfate
NaOH - Sodium Hydroxide
$Na_2S_2O_3$ - Sodium Thiosulfate
ZHS - Zero Headspace

Table 24-1b Summary of Sampling Container, Preservation and Holding Time Requirements				
Soils				
Parameter Group	**Available Method(s)**	**Container**	**Preservation**	**Holding Time**
Mercury	SW-846 7471B	2 oz. GLTC	Cool ≤6°C	28 Days
Metals (except Mercury)	SW-846 6020A/B	2 oz. GLTC	Cool ≤6°C	180 Days
Nitrogen, Nitrate	SW-846 9056A	2 oz. GLTC	Cool ≤6°C	48 hours
Nitrogen, Nitrite	SW-846 9056A	2 oz. GLTC	Cool ≤6°C	48 hours
Nitrogen, Total Kjeldahl (TKN)	EPA 351.2	2 oz. GLTC	Cool ≤6°C	28 Days
Oil & Grease (HEM)	SW-846 9071B	2 oz. GLTC	Cool ≤6°C	28 Days
PCBs	SW-846 8082A	4 oz. GLTC	Cool ≤6°C	1 year extract/ 1 year analyze
Pesticides	SW-846 8081B	4 oz. GLTC	Cool ≤6°C	14 Days extract/ 40 Days analyze
pH	SW-846 9045D	2 oz. GLTC	Cool ≤6°C	Analyze immediately (15 minutes)
Phenols	SW-846 9066	2 oz. GTLC	Cool ≤6°C	28 Days
Phosphate, ortho-	SW-846 9056A	2 oz. GLTC	Cool ≤6°C	48 hours
Phosphorous, Total	SM 4500-P B5-11 + E-11	2 oz. GLTC	Cool ≤6°C	28 Days
Sulfides	SW-846 9034	2 oz. GLTC	Cool ≤6°C	7 Days
Sulfate	SW-846 9038 / SW-846 9056A	2 oz. GLTC	Cool ≤6°C	28 Days
Total Organic Carbon (TOC)	Lloyd Kahn	2 oz. GLTC	Cool ≤6°C	14 Days
Volatile Organics (low level)	SW-846 8260C	3 encores or Terracore kit; 2 vials in water, 1 methanol GTLS Vial	Freeze, <-7°C, Cool ≤6°C	48 hours freeze or preserve, 14 Days analyze
Volatile Organics (high level)	SW-846 8260C	1 methanol GTLS Vial	Cool ≤6°C	14 Days analyze

Table 24-1c Summary of Sampling Container, Preservation and Holding Time Requirements				
Wipes				
Parameter Group	**Available Method(s)**	**Container**	**Preservation**	**Holding Time**
Mercury	SW-846 7471B	1 x Sterile Pad & Distilled Water	Distilled water	28 Days
Metals (w/out Mercury)	SW-846 6020A/B	1 x Sterile Pad & Distilled Water	Distilled water	180 Days
PCB	SW-846 8082A	1 x Sterile Pad	1:4 Acetone/Hexane	1 year

Key:

HNO_3 – Nitric Acid
H_2SO_4 – Sulfuric Acid
GTLC - Glass, Teflon lined cap
GTLS - Glass, Teflon lined septum
$(NH_4)_2SO_4$ – ammonium sulfate
NaOH - Sodium Hydroxide
$Na_2S_2O_3$ - Sodium Thiosulfate
ZHS - Zero Headspace

Table 24-1d Summary of Sampling Container, Preservation and Holding Time Requirements				
TCLP and SPLP				
Parameter Group	**Available Method(s)**	**Container**	**Preservation**	**Holding Time**
TCLP/SPLP Base Neutral/Acids	SW-846 1311 / 1312 & 8270D	4 oz. GLTC	Cool ≤6°C	14 Days leach, 7 Days extract, 40 Days analyze
TCLP/SPLP Herbicides	SW-846 1311 / 1312 & 8151A	4 oz. GLTC	Cool ≤6°C	14 Days leach, 7 Days extract, 40 Days analyze
TCLP/SPLP Mercury	SW-846 1311 / 1312 & 7470A	4 oz. GLTC	Cool ≤6°C	28 Days leach, 28 Days analyze[2]
TCLP/SPLP Metals (except Mercury)	SW-846 1311 / 1312 & 6020A/B	4 oz. GLTC	Cool ≤6°C	180 Days leach, 180 Days analyze[2]
TCLP/SPLP Pesticides	SW-846 1311 / 1312 & 8081B	4 oz. GLTC	Cool ≤6°C	14 Days leach, 7 Days extract, 40 Days analyze
TCLP/SPLP PCBs	SW-846 1311 / 1312 & 8082A	4 oz. GLTC	Cool ≤6°C	1 year leach, 1 year extract, 1 year analyze
SPLP Cyanide	SW-846 1312/ 9012B	4 oz. GLTC	Cool ≤6°C	14 Days leach, 14 Days analyze[3]
SPLP Volatiles	SW-846 1312 & 8260C	25g Encore	Cool ≤6°C	48 Hours leach, 14 Days analyze[4]
TCLP Volatiles (soil)	SW-846 1311 & 8260C	2 oz. GLTC	Cool ≤6°C	48 Hours leach, 14 Days analyze[4]
TCLP Volatiles (aq)	SW-846 1311 & 8260C	2-40mL GTLS Vials	Cool ≤6°C	48 Hours filter, 14 Days analyze[4]

2. Must preserve Metals & Mercury leachates with HNO_3 to pH<2

3. Must preserve Cyanide leachates with NaOH to pH>12

4. Must preserve Volatiles leachates with HCl to pH<2 to use a 14-day holding time. Otherwise, holding time is 7 days

Table 24-1e Summary of Sampling Container, Preservation and Holding Time Requirements				
Air				
Parameter Group	**Available Method(s)**	**Container**	**Preservation**	**Holding Time**
Aldehydes & Carbonyls	EPA TO-11A	DNPH-Coated Silica-Gel Sorbent tubes	Cool ≤6°C	14 Days extract, 30 days analyze
Volatile Organics	NJDEP LLTO-15 EPA TO-15	1 or 6 L Canister	None required	15 Days after evacuation[5], 30 Days after collection
Methane/Ethane	EPA 18	Tedlar bag or 1 L/6 L Canister	None required	Bag: 48 hours; Cans: 30 Days

5. If using NJDEP LLTO-15, canister must be back to the lab within 15 days of evacuation

Key:

HNO_3 – Nitric Acid
H_2SO_4 – Sulfuric Acid
GTLC - Glass, Teflon lined cap
GTLS - Glass, Teflon lined septum
$(NH_4)_2SO_4$ – ammonium sulfate
NaOH - Sodium Hydroxide
$Na_2S_2O_3$ - Sodium Thiosulfate
ZHS - Zero Headspace

Table 24-1f Summary of Sampling Container, Preservation and Holding Time Requirements				
Microbiology				
Parameter Group	**Available Method(s)**	**Container**	**Preservation**	**Holding Time[6]**
(Non-Potable Water)				
E. coli	SM 9221 B.2+ SM 9221 F-06	2 x 100 mL sterile plastic	$Na_2S_2O_3$, Cool 1.1-3.9°C	8 Hours – sampling to incubator
Fecal Coliform*	SM 9221 E-06 SM 9222 D-97	2 x 100 mL sterile plastic	$Na_2S_2O_3$, Cool 1.1-3.9°C	8 Hours – sampling to incubator
Heterotrophic Plate Count	SM 9215 B	2 x 100 mL sterile plastic	$Na_2S_2O_3$, Cool 1.1-3.9°C	8 Hours – sampling to incubator
Total Coliform	SM 9221 B-06 SM 9222 B-97	2 x 100 mL sterile plastic	$Na_2S_2O_3$, Cool 1.1-3.9°C	8 Hours – sampling to incubator
(Potable Water)				
Heterotrophic Plate Count	SM 9215 B	2 x 100 mL sterile plastic	$Na_2S_2O_3$, Cool 1.1-3.9°C	8 Hours – sampling to incubator
Total Coliform/ E. coli	SM 9222 B + SM 9221 E + MUG / SM 9223 B	2 x 100 mL sterile plastic	$Na_2S_2O_3$, Cool 1.1-3.9°C	8 Hours – sampling to incubator

6. Note: If samples are for public recreational bathing samples including but not limited to fresh water bathing samples, the holding time is limited to 6 hours.

References:
Standard Methods
USEPA SW-846
Individual Methods (referenced in table)
40 CFR 141 (Drinking Water)
40 CFR 136 (Wastewater)
N.J.A.C. 8:26

Key:
HNO_3 – Nitric Acid
H_2SO_4 – Sulfuric Acid
GTLC - Glass, Teflon lined cap
GTLS - Glass, Teflon lined septum
$(NH_4)_2SO_4$ – ammonium sulfate
NaOH - Sodium Hydroxide
$Na_2S_2O_3$ - Sodium Thiosulfate
ZHS - Zero Headspace

Section 25:
HANDLING SAMPLES AND TEST ITEMS

25.1 Sample Receipt

When samples are received at the laboratory, the chain-of-custody is reviewed, condition is documented, samples are given unique identifiers, and they are logged into the sample tracking system.

25.1.1 Chain of Custody

The chain of custody or sample submission sheets from the field is reviewed. This documentation is completed in the field and provides a written record of the handling of the samples from the time of collection until they are received at the laboratory. Section 24 – "Collection of Samples" outlines what information is needed on this record. The chain of custody form also provides information on what type of testing is being requested and can act as an order for laboratory services in the absence of a formal contract. An example chain of custody form can be found in Figure 25-1. Chain of custody and any additional records received at the time of sample submission are maintained by the laboratory. The Chain of Custody is scanned and filed in the project folder.

25.1.1.1 Legal Chain of Custody

The laboratory accepts samples identified for legal/evidentiary purposes.

25.2 Sample Acceptance

The full procedure is outlined in SOPs 1.0800 - "Sample Custody & Handling". The following information is included:

Upon arrival at the laboratory, the log-in staff member examines the sampler container(s) for their physical integrity (e.g., custody seals intact, bottles and containers not damaged, etc.). The log-in staff verifies the condition of the received samples and the Chain of Custody (COC) based on the following information:

- Sample Identification on COC matches bottle label
- Sampling date and time
- Analyses requested
- Number of containers for each sample
- Sufficient sample volume
- Proper preservation used/verified
- Temperature of samples in cooler upon receipt
- Samples received within hold time
- Date and time custody of samples was transferred to the laboratory
- Deliverables requirement
- Verbal and hard copy due dates

The log-in staff assigns an IAL project number to reference each document and ensure data reporting uniformity. The project number and sample numbers are input into a preliminary log-in program in the sample receiving area that allows for the generation of sample bottle labels. Each label contains the sample ID number, the analysis to be performed and the number of jars received.

In addition, the laboratory has non-conformance/corrective action procedures to handle samples that don't meet the requirements above or show signs of damage, contamination or inadequate preservation. The Sample Receipt Verification Form (SRV) is used to document that the following were verified:

- cooler temperature
- bottle(s) and bottle labels intact
- no missing/extra bottles
- sufficient sample volume received
- pH check
- correct preservation
- sufficient hold time
- sub-contracting requirements and details
- corrective action requirement

The laboratory checks samples for the conditions above, where appropriate, to evaluate sample acceptance. Criteria regarding preservation, holding time and sample volume requirements can be found in Section 24 – "Collection of Samples" Table 25-1. If these conditions are not met, the client is contacted prior to any further processing, then 1) the sample is rejected as agreed with the client, 2) the decision to proceed is documented and agreed upon with the client, 3) the condition is noted on the SRV.

25.2.1 Preservation Checks

The following preservation checks are performed and documented upon receipt:

25.2.1.1 *Thermal preservation:*

a) For temperature preservation, the acceptable range is from just above freezing to 6 °C.

b) Samples that are delivered to the lab the same day as they are collected are likely not to have reached a fully chilled temperature. This is acceptable if the samples were received on ice and the chilling process has begun.

c) Record on the receipt form if ice is present and the temperature.

25.2.1.2 *pH checks:*

a) The pH of samples requiring acid/base preservation is checked upon sample receipt or upon initiation of analysis.

25.3 Sample Identification

Samples, including subsamples, extracts and digestates, are uniquely identified in a permanent chronological record in the database to prevent mix-up and to document receipt of all sample containers.

Samples are assigned sequential numbers that reference more detailed information kept in the LIMS.

The full procedure is outlined in SOP 1.0800 - "Sample Custody, Handling, Preservation, and Storage". The following information is included:

- Client or project name
- Date and time of receipt at lab
- Unique laboratory identification number
- Signature or initials of person making the entries

In addition, the following information is maintained and linked to the log-in record:

- Date and time of sampling linked to the date and time of laboratory receipt.
- Unique field identification number linked to the laboratory sample ID
- Analyses requested (including applicable approved method numbers) linked to the laboratory sample ID.

All documentation received regarding the sample, such as memos or chain of custody, are retained scanned and then filed in the project folder.

25.4 Sample Aliquots / Subsampling

In order for analysis results to be representative of the sample collected in the field, the laboratory has subsampling procedures. The procedures are outlined in SOP 4.0400 – "Aliquoting Samples for Analysis".

25.5 Sample Storage

Storage conditions are monitored for any required criteria, verified, and the verification recorded in logbooks.

Samples that require thermal preservation are stored under refrigeration that is +/- 2°C of the specified preservation temperature unless regulatory or method specific criteria require something different. For samples with a specified storage temperature of 4°C, storage at a temperature above the freezing point of water to 6°C is acceptable.

Samples are held secure, as required. Samples are accessible only to laboratory personnel.

Samples are stored apart from standards, reagents, food or potentially contaminating sources, and such that cross-contamination is minimized. All portions of samples, including extracts, digestates, leachates, or any product of the sample is maintained according to the required conditions.

25.6 Sample Disposal

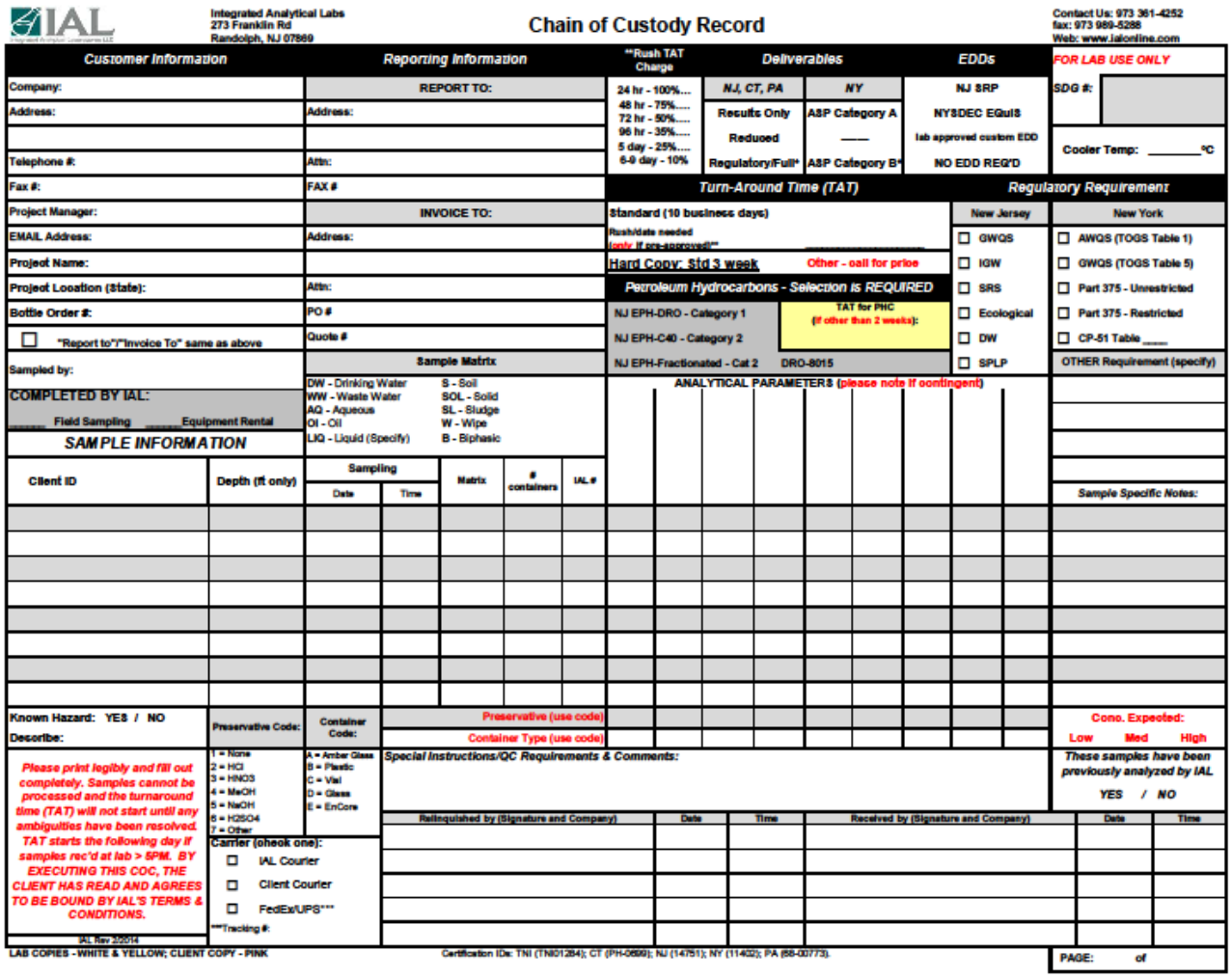
Sample disposal is performed 60 days after sample receipt at IAL, depending upon the volume of samples in-house. The samples are not disposed of if the final hardcopy report has not gone out, if samples are still on hold in the project, or if a client has made arrangements with the laboratory to retain samples longer.

IAL maintains a specific waste storage area to control waste material. Samples disposal procedures are outlined in SOP 1.1600 – "Hazardous Waste Disposal".

25.7 Sample Transport

Samples that are transported under the responsibility of the laboratory, where necessary, are done so safely and according to storage conditions. This includes moving bottles within the laboratory. Specific safety operations are addressed outside of this document.

Figure 25-1: Example Chain-of-Custody



IAL
Integrated Analytical Labs
273 Franklin Rd
Randolph, NJ 07869

Chain of Custody Record

Contact Us: 973 361-4252
fax: 973 989-5288
Web: www.ialonline.com

Customer Information | Reporting Information | **Rush TAT Charge | Deliverables | EDDs | FOR LAB USE ONLY

Company: | REPORT TO:
Address: | Address:
Telephone #: | Attn:
Fax #: | FAX #
Project Manager: | INVOICE TO:
EMAIL Address: | Address:
Project Name: | Attn:
Project Location (State): | PO #
Bottle Order #: | Quote #
☐ "Report to"/"Invoice To" same as above
Sampled by:
COMPLETED BY IAL: _____ Field Sampling _____ Equipment Rental

Rush TAT Charge: 24 hr - 100%... | 48 hr - 75%.... | 72 hr - 50%.... | 96 hr - 35%.... | 5 day - 25%.... | 6-9 day - 10%

Deliverables: NJ, CT, PA: Results Only | Reduced | Regulatory/Full* — NY: ASP Category A | ——— | ASP Category B*

EDDs: NJ SRP | NYSDEC EQuIS | lab approved custom EDD | NO EDD REQ'D

SDG #:

Cooler Temp: _____°C

Turn-Around Time (TAT)

Standard (10 business days)
Rush/date needed (only if pre-approved)** _____
Hard Copy: Std 3 week — Other - call for price

Regulatory Requirement

New Jersey	New York
☐ GWQS	☐ AWQS (TOGS Table 1)
☐ IGW	☐ GWQS (TOGS Table 5)
☐ SRS	☐ Part 375 - Unrestricted
☐ Ecological	☐ Part 375 - Restricted
☐ DW	☐ CP-51 Table _____
☐ SPLP	OTHER Requirement (specify)

Petroleum Hydrocarbons - Selection is REQUIRED
NJ EPH-DRO - Category 1
NJ EPH-C40 - Category 2
NJ EPH-Fractionated - Cat 2 | DRO-8015
TAT for PHC (if other than 2 weeks):

Sample Matrix
DW - Drinking Water | WW - Waste Water | AQ - Aqueous | OI - Oil | LIQ - Liquid (Specify)
S - Soil | SOL - Solid | SL - Sludge | W - Wipe | B - Biphasic

ANALYTICAL PARAMETERS (please note if contingent)

SAMPLE INFORMATION

Client ID	Depth (ft only)	Sampling Date	Sampling Time	Matrix	# containers	IAL #	Sample Specific Notes:

Known Hazard: YES / NO
Describe:

Preservative Code: 1 = None | 2 = HCl | 3 = HNO3 | 4 = MeOH | 5 = NaOH | 6 = H2SO4 | 7 = Other

Container Code: A = Amber Glass | B = Plastic | C = Vial | D = Glass | E = EnCore

Preservative (use code)
Container Type (use code)

Cons. Expected: Low Med High

Special Instructions/QC Requirements & Comments:

These samples have been previously analyzed by IAL: YES / NO

Please print legibly and fill out completely. Samples cannot be processed and the turnaround time (TAT) will not start until any ambiguities have been resolved. TAT starts the following day if samples rec'd at lab > 5PM. BY EXECUTING THIS COC, THE CLIENT HAS READ AND AGREES TO BE BOUND BY IAL'S TERMS & CONDITIONS.

Relinquished by (Signature and Company)	Date	Time	Received by (Signature and Company)	Date	Time

Carrier (check one):
☐ IAL Courier
☐ Client Courier
☐ FedEx/UPS***
***Tracking #:

IAL Rev 2/2014
LAB COPIES - WHITE & YELLOW; CLIENT COPY - PINK
Certification IDs: TNI (TN01284); CT (PH-0690); NJ (14751); NY (11402); PA (68-00773).
PAGE: of

Section 26:
QUALITY ASSURANCE FOR ENVIRONMENTAL TESTING

IAL has procedures for monitoring the validity of the testing it performs. The qualities of test results are recorded in such a way that trends are detectable, and where practicable, are statistically evaluated. To evaluate the quality of test results, the laboratory utilizes certified reference materials and/or internal quality control using secondary reference materials, participation in proficiency testing programs, replicate or confirmation analyses and correlation of results for different characteristics of a sample.

In addition to procedures for calibration, the laboratory monitors quality control measurements such as blanks, laboratory control samples (LCS), matrix spikes (MS), duplicates, surrogates and internal standards to assess precision and accuracy. Proficiency Testing samples are also analyzed to assess laboratory performance. See Appendix I – "Proficiency Testing"

Quality control data are analyzed and, when found to be outside pre-defined criteria, action is taken to correct the problem and to prevent incorrect results from being reported. Data associated with quality control data outside of criteria and still deemed reportable will be qualified so the end user of the data may make a determination of the usability of the data - see Section 27 – "Reporting of Results".

26.1 Essential Quality Control Procedures

The quality control procedures specified in test methods are followed by laboratory personnel. The most stringent of control procedures is used in cases where multiple controls are offered. If it is not clear which is the most stringent, that mandated by test method or regulation is followed.

For test methods that do not provide acceptance criteria for an essential quality control element or where no regulatory criteria exist, acceptance criteria are developed. These limits can be found in Appendix D.

Written procedures to monitor routine quality controls including acceptance criteria are located in the test method SOPs, except where noted, and include such procedures as:

- use of laboratory control samples to monitor test variability of laboratory results;
- use of laboratory control samples and blanks to serve as positive and negative controls for chemistry methods
- use of calibrations, continuing calibrations, certified reference materials and/or PT samples to monitor accuracy of the test method;
- measures to monitor test method capability, such as limit of detection, limit of quantitation, and/or range of test applicability, such as linearity;
- use of regression analysis, internal/external standards, or statistical analysis to reduce raw data to final results;
- use of reagents and standards of appropriate quality and use of second source materials as appropriate;

- procedures to ensure the selectivity of the test method for its intended use;
- use of sterility checks for equipment, media and dilution water for microbiology; and
- use of positive and negative culture controls for microbiology.

26.2 Internal Quality Control Practices

Analytical data generated with QC samples that fall within all prescribed acceptance limits indicate the test method is deemed to be in control.

QC samples that fall outside QC limits indicate the test method are deemed to be out of control (nonconforming) and that corrective action is required and/or that the data are qualified (see Section 12 – "Control of Nonconforming Environmental Testing Work" and Section 14 - "Corrective Actions").

Detailed QC procedures and QC limits are included in test method standard operating procedures (SOPs).

26.2.1 General Controls

The following general controls are used:

26.2.1.1 Positive and Negative Controls such as:

a) Blanks (negative)
b) Laboratory control sample (positive)
c) Sterility checks and control cultures (positive and negative).

26.2.1.2 Selectivity is assured through:

a) absolute and relative retention times in chromatographic analyses;
b) two-column confirmation when using non-specific detectors;
c) use of acceptance criteria for mass-spectral tuning (found in test method SOPs);
d) use of the correct method according to its scope assessed during method validation; and
e) use of reference cultures (positive and negative) from a recognized manufacturer (where applicable).

26.2.1.3 Consistency, Variability, Repeatability, and Accuracy are assured through:

a) proper installation and operation of instruments according to manufacturer's recommendations or according to the processes used during method validation;
b) monitoring and controlling environmental conditions (temperature, access, proximity to potential contaminants);

c) selection and use of reagents and standards of appropriate quality; and

d) cleaning glassware appropriate to the level required by the analysis as demonstrated with method blanks (SOP 1.1200)

e) following SOPs and documenting any deviation, assessing for impact, and treating data appropriately;

f) testing to define the variability and/or repeatability of the laboratory results, such as replicates;

g) use of measures to assure the accuracy of the test method, including calibration and/or continuing calibrations, use of certified reference materials, proficiency test samples, or other measures; and

h) use of duplicate plate counts on positive samples (microbiology only).

26.2.1.4 Test Method Capability (also see Section 21 – "Environmental Methods and Method Validation") is assured through:

a) establishment of the limit of detection where appropriate;

b) establishment of the limit of quantitation or reporting level; and/or

c) establishment of the range of applicability such as linearity.

26.2.1.5 Data reduction is assured to be accurate by:

a) selection of appropriate formulae to reduce raw data to final results such as regression;

b) following specific procedures for data reduction such as manual integration procedures; and

c) periodic review of data reduction processes to assure applicability.

26.2.1.6 Sample Specific controls are used to evaluate the effect of sample matrix on the performance of the selected analytical method (not a measure of laboratory performance):

Examples:
- Matrix Spike and Matrix Spike Duplicate (MS/MSD)
- Surrogate Spikes
- Sample Duplicates

Note: For organics analyses, MS/MSDs may be shared between multiple preparation batches. MS/MSDs may be used for up to 20 samples and for a maximum of 14 days. Clients always have the option to send in their own samples for use as the MS/MSD. This practice is encouraged when sample matrix effects for a site need to be determined.

26.2.1.7 The following tables summarize the key elements of a quality control system for a laboratory performing chemistry and microbiology testing.

Section 27:
REPORTING THE RESULTS

The result of each test performed is reported accurately, clearly, unambiguously, and objectively and complies with all specific instructions contained in the test method.

Laboratory results are reported in a test report that includes all the information requested by the client and necessary for the interpretation of the test results and all information required by the method used.

Data are reported without qualification if they are greater than the lowest calibration standard, lower than the highest calibration standard, and without compromised sample or method integrity.

27.1 Test Reports

The report format has been designed to accommodate each type of test performed and to minimize the potential for misunderstanding or misuse. The laboratory does not issue multiple reports for the same samples where there is different information on each report unless required to meet regulatory needs and approved by the Quality Assurance Manager.

Each test report generated contains the following information:

NOTE: Some regulatory reporting requirements or formats, such as monthly operating reports, may not require all items listed below; however, the laboratory shall provide all the required information to their client for use in preparing such regulatory reports.

a) a title;

b) the name and address of the laboratory, phone number and name of contact person;

c) unique identification of the test report, such as a serial number, on each page and a pagination system that ensures that each page is recognized as part of the test report and a clear identification of the end of the report, such as 3 of 10

d) the name and address of the client;

e) the identification of the method used;

f) a description of, the condition of, and unambiguous identification of the sample(s) tested, including the client identification code;

g) the date of sample receipt when it is critical to the validity and application of the results, date and time of sample collection, dates the tests were performed, the time of sample preparation and analysis if the required holding time for either activity is less than or equal to 72 hours;

h) the test results, units of measurement, an indication of when results are reported on any basis other than as received (e.g. dry weight), failures identified. See Appendix F for a list of laboratory qualifiers.

i) the name, function, and signature or an equivalent electronic identification of the person authorizing the test report, and the date of issue;

j) where relevant, a statement to the effect that the results relate only to the samples;

k) A statement that the report shall not be reproduced except in full without written approval of the laboratory.

27.2 Supplemental Test Report Information

When necessary for interpretation of the results or when requested by the client, test reports include the following additional information:

a) deviations from, additions to, or exclusions from the test method, information on specific test conditions, such as environmental conditions, and any non-standard conditions that may have affected the quality of the results, and any information on the use and definitions of data qualifiers;

b) a statement of compliance/non-compliance when requirements of the management system are not met, including identification of test results that did not meet the laboratory and regulatory sample acceptance requirements, such as holding time, preservation, etc.;

c) where applicable and when requested by the client, a statement on the estimated uncertainty of the measurement;

d) where appropriate and needed, opinions and interpretations. When opinions and interpretations are included, the basis upon which the opinions and interpretations are documented. Opinions and interpretations are clearly marked as such in the test report.

e) additional information which may be required by specific methods or client;

f) qualification of results with values outside the calibration range as appropriate.

In addition to the items above, for test reports that contain the results of sampling, the following is provided when necessary for the interpretation of the results:

a) the date of sampling;

b) unambiguous identification of the material sampled;

c) the locations of the sampling, including diagrams, sketches, or photographs;

d) a reference to the sampling plan and procedures used;

e) details of any environmental conditions during sampling that may affect the interpretations of the test results;

f) any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned.

27.3 Environmental Testing Obtained from Subcontractors

Test results obtained from tests performed by subcontractors are clearly identified on the test report by subcontractor name and/or accreditation number.

The subcontractors report their results in writing or electronically. The subcontractor's report is appended to final report. See IAL SOP 1.4100 - "Subcontracting Analyses to Outside Sources".

27.4 Transmission of Results

After QC review, all test results transmitted by telephone, fax, telex, email, or other electronic means comply with the requirements of the TNI Standard and associated procedures to protect the confidentiality and proprietary rights of the client. Results are sent to clients within ten (10) business days unless a special turnaround time is requested. Prior lab approval is required for expedited turn-around times. See Section 21- "Environmental Methods and Method Validation"

27.4.1 Hardcopy Deliverables

Hardcopy, paper reports are created by the Report Generation Department using data generated by the laboratory. Reports are scanned and saved in electronic format, all hard copy reports for archival storage.

Reports are sent via courier, US Mail, UPS, FedEx, or electronically to the project manager as directed on the client chain of custody. Reports are sent only to individuals as stated on the chain of custody or as directed by the client.

Hard copy reports are sent to the client within fifteen (15) business days of sample receipt at the laboratory. Special turn-around times are available based on client needs and laboratory capabilities. Prior lab approval is required for expedited turn-around times.

27.4.2 Electronic Data Deliverables

Electronic data deliverables are produced when the final report is generated. The final report and EDD are reviewed and verified for accuracy by the Electronic Data Deliverable Coordinator.

27.5 Amendments to Test Reports

Material amendments to a test report after it has been issued are made only in the form of another document or data transfer. All supplemental reports meet all the requirements for the initial report and the requirements of this *Quality Manual*.

Amended test reports include the statement, 'Addendum', 'Revision' or an equivalent form of wording to assure they can be differentiated from other test reports.

When it is necessary to issue a complete new report, the new report is uniquely identified and contains a reference to the original that it replaces.

Section 28:
APPENDICIES

Appendix A:
Ethics and Data Integrity Policy

To ensure work is of the highest integrity, employees are required to conduct all business with integrity and in an ethical manner. Each employee is responsible and accountable for the integrity and validity of their own work. It is the responsibility of each staff member and manager to uphold the highest ethical standard of professional conduct in the performance of all duties. Fabrication or falsification of work results are direct assaults on the integrity of the laboratory and will not be tolerated.

Ethics and Data Integrity Policy training will be conducted annually. Training documents may be found at Q:\Training\Data Integrity and Ethics.

Appendix B:
Employee Flow Chart

Laboratory Director
Michael H. Leftin, Ph.D.

Chief Financial Officer
Frank Russomanno

Sales & Office	
Brenda Barone	
Purchasing/Office Manager	
Sales	*Office*
A. Belkin	J. Falconer
S. Reduker	Y. Ferreira
E. Spahr	P. Larson
	K. Ventre

QA/QC & Air
Lauren Jenkins
QA & Air Manager
QC
A. Denno
J. Begraft
Air
P. Jenkins
J. Schmitt
D. Mitchell
J. Walukiewicz

Client Services	
Kim James	
Senior Project Manager	
Client Services	*Drivers*
K. Falconer	J. Grennan
M. Foschini	G. Martelli
O. Pacella	N. Rodrigues
D. Walsh	D. Rubino
open	B. Pooser
	R. Capps (on call)
	R. Manzo (on call)
	S. Ruggeri (on call)

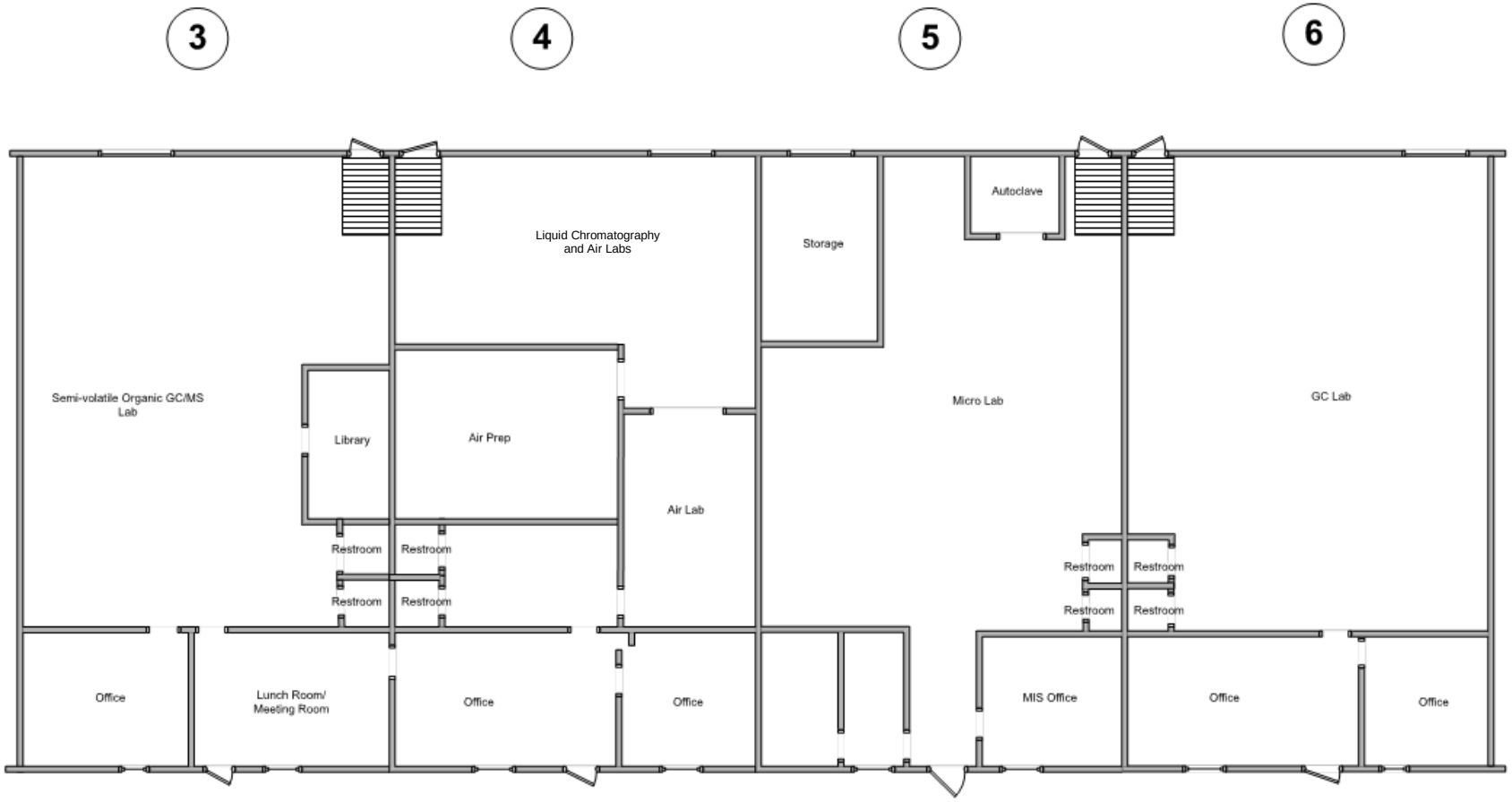
Organics	
Jim Shen, Manager	
Team Leaders	
B. Berberian	X. Wang
J. Fatras	I. Bogush
M. Janowski	
Analysts & Assistants	
K. Chan	T. Nguyen
X. Chen	D. Pei
S. Jakubanis	S. Pillala
B. Ma	J. Szylar
J. Mazurkiewicz	Y. Zhang
E. McFadden	

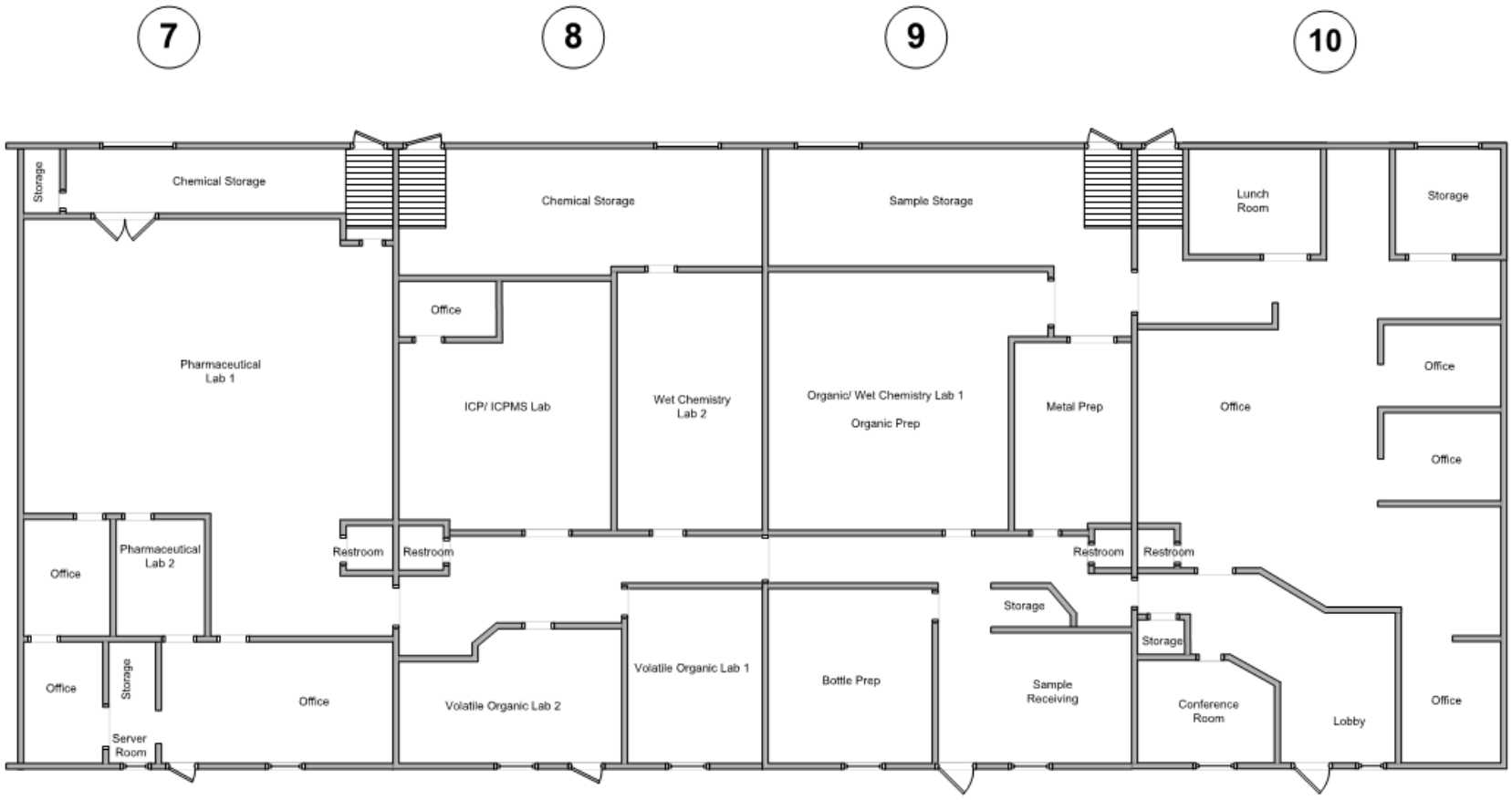
Metals
En Ma, Manager
D. Kopcso
D. Mansingh
F. Ramos

MIS
Angela Chang, Director
S. Fu

General Chemistry/ Extractions/ Microbiology	
Robert Blank, Manager	
F. Agudelo	F. Lowell
L. Cui	J. Munoz
A. Delmundo	J. Newton
E. Delmundo	D. Palermo
S. Hack	D. Szachara
	C. Wright

Appendix C:
Laboratory Floor Plan




7
8
9
10
Storage
Chemical Storage
Chemical Storage
Sample Storage
Lunch Room
Storage
Office
Pharmaceutical Lab 1
ICP/ ICPMS Lab
Wet Chemistry Lab 2
Organic/ Wet Chemistry Lab 1
Organic Prep
Metal Prep
Office
Office
Office
Pharmaceutical Lab 2
Restroom
Restroom
Restroom
Restroom
Office
Storage
Storage
Office
Storage
Office
Volatile Organic Lab 2
Volatile Organic Lab 1
Bottle Prep
Sample Receiving
Conference Room
Lobby
Office
Server Room

Appendix D:
Quality Control Acceptance Limits

Appendix D: Quality Control Acceptance Limits					
Method	**LCS Recovery**	**MS/MSD Recovery**	**MS/MSD RPD**	**Surrogate Recovery**	**ISTD**
Air					
EPA TO-15	70-130% for most, 40-160% for Acetone; 1,4-Dioxane; Hexachloro-butadiene; Naphthalene; 1,2,4-Trichlorobenzene	N/A	N/A	N/A	+100%,-50%
NJ LLTO-15	60-140% for 90%; Y qualify failures in sample results	N/A	N/A	N/A	+100%,-50%
TO-11A	75-125%	75-125%	25%	N/A	N/A
EPA 18	N/A	70-130%	N/A	N/A	N/A
EPA 8315A	75-125%	75-125%	20%	N/A	N/A
Volatiles					
EPA 524.2	70-130%	N/A	N/A	70-130%	+100%,-50%
EPA 624	Method defined	Method defined	30%	*laboratory statistically derived limits	+100%, -50%
EPA 8260C	*laboratory statistically derived limits	*laboratory statistically derived limits	*laboratory statistically derived limits	*laboratory statistically derived limits	+100%, -50%
Semi-Volatiles					
EPA 625	*laboratory statistically derived limits	*laboratory statistically derived limits	20%	*laboratory statistically derived limits	+100%, -50%
EPA 8270D			*laboratory statistically derived limits		

*Laboratory statistically derived limits are kept on file by the QA Officer and the Organics Manager. These limits are derived using Shewhart statistical charting and are updated every 6 months.

Appendix D Quality Control Acceptance Limits					
Method	**LCS Recovery**	**MS/MSD Recovery**	**MS/MSD RPD**	**Surrogate Recovery**	**Internal Standard**
GC					
EPA 608	Method defined	Method defined	Method defined	*laboratory statistically derived limits	N/A
EPA 8081B	*laboratory statistically derived limits	*laboratory statistically derived limits	*laboratory statistically derived limits	*laboratory statistically derived limits	N/A
EPA 8082A	*laboratory statistically derived limits	*laboratory statistically derived limits	*laboratory statistically derived limits	*laboratory statistically derived limits	N/A
EPA 8015D	40-140% (TPH-DRO) 70-130% (Glycols, Acids, Alcohols)	30-150%	50% (TPH-DRO, Glycols, Alcohols) 30% (Acids)	*laboratory statistically derived limits	N/A
RSK-175	70-130%	30-150%	50%	N/A	N/A
EPA 504.1	70-130%	70-130%	35%	N/A	N/A
EPA 8011	70-130%	70-130%	40%	N/A	N/A
NJ EPH	40-140% (C9-25%-140%)	40-140% (C9-25%-140%)	50%	40-140%	N/A
Metals					
EPA 6020A	80-120%	75-125%	20%	N/A	70-130%
EPA 200.8	80-120%	75-125%	20%	N/A	60-125%
EPA 7470A	80-120%	75-125%	20%	N/A	N/A
EPA 7471B	80-120%	75-125%	20%	N/A	N/A
EPA 245.1	80-120%	75-125%	20%	N/A	N/A
Wet Chemistry					
All methods except BOD	90-110%	75-125%	20%	N/A	N/A
BOD	85-115%	N/A	N/A	N/A	N/A

*Laboratory statistically derived limits are kept on file by the QA Officer and the Organics Manager. These limits are derived using Shewhart statistical charting and are updated every 6 months.

Appendix E:
Laboratory Accreditation/Certification/Recognition

Integrated Analytical Laboratories, LLC maintains the following certifications and accreditations with numerous state and national entities:

Organization	Laboratory Identification Number
TNI (The NELAC Institute)	TNI01284
EPA	NJ00438
New Jersey DEP	14751
New York ELAP	11402
Pennsylvania DEP	68-00773
Connecticut DPH	PH-0699

If accreditation is terminated or suspended, the laboratory will immediately cease to use the certificate number reference in any way and inform clients impacted by the change.

Certificates of certification are conspicuously displayed in IAL's lobby and scanned copies are posted on IAL's website at www.ialonline.com

Appendix F:
Data Qualifiers and Flags

QUALIFIER	DEFINITION
B	Indicates the analyte was found in the associated method blank as well as in the sample. Indicates probable laboratory contamination.
C	Analyte is a common laboratory contaminant.
D	Indicates a diluted analysis was performed.
E	Concentration exceeds upper level of calibration range for instrument.
J	Indicates an estimated concentration. This flag is used when the concentration in the sample is below the RL but above the MDL. Also estimated concentration for Tentatively Identified Compounds (TICs).
N	Presumptive evidence of compound. Used when identifying analytes in GC/MS TIC analyses.
U	Compound analyzed for but not detected at RL.
X **Metals Only**	Indicates samples analyzed for total and dissolved metals differ at ≤20% RPD.
Y **Air Only**	Indicates flagged analyte failed in the Reporting Limit Laboratory Control Sample (RLLCS) on either/both the clean canister certification analysis day or sample run day
Y **BOD Only**	Indicates DO depletion in the BOD blank is >0.20ppm
Z	Indicates internal standard failure. Sample results are either biased high or biased low.
FLAG	**DEFINITION**
*	When attached to a compound name, indicates this analyte was analyzed by Method SW-846 8270D SIM
*	When attached to quality control data, indicates values outside QC limits
^	When attached to a compound name, indicates this analyte was analyzed by Method SW-846 8011 or EPA 504.1
$	When attached to quality control data, indicates values outside of New Jersey DKQP Limits

Appendix G:
Chemistry

G.1 Method Validation

Reference methods are validated by determining the MDL, LOD and/or LOQ by procedures outlined below, and determining precision and bias by using the demonstration of capability procedures

a) Limit of Detection (LOD)

The Limit of Detection (LOD) is the laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility. The LOD will be determined by conducting an MDL study, as specified in section c.

LODs are not required for any component for which spiking solutions or quality control samples are not available. These include, but are not limited to, pH, dissolved oxygen, volatile solids (TVS), dissolved solids (TDS), temperature, specific conductance, color and odor.

b) Limit of Quantitation

The Limit of Quantitation (LOQ) is known as the Reporting Limit (RL) at IAL. This value is the minimum amount of a substance that can be reported with 100% confidence. IAL uses the lowest point of their calibration curve for the RL value

LOQ values are not required for components or properties for which spiking solutions or QC samples are not available. These include, but are not limited to, pH, temperature, TDS, TVS and Total Solids.

c) Method Detection Limit

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than the blank and is determined from analysis of a sample in a given matrix containing the analyte.

The MDL for an analytical procedure may vary as a function of sample type. The procedure requires a complete, specific, and well defined analytical method. It is essential that all sample processing steps of the analytical method be included in the determination of the method detection limit.

The MDL obtained by this procedure is used to judge the significance of a single measurement of a future sample.

The MDL procedure was designed for applicability to a broad variety of physical and chemical methods. To accomplish this, the procedure was made device- or instrument-independent.

Procedure for Determining MDLs:

1. Make an estimate of the initial detection limit using one of the following:

    i. The mean determined concentration plus three times the standard deviation of a set of method blanks.

    ii. The concentration value that corresponds to an instrument signal-to-noise ratio in the range of 3 to 5.

    iii. The concentration equivalent to three times the standard deviation of replicate instrumental measurements of spiked blanks.

    iv. That region of the calibration where there is a significant change in sensitivity, i.e., a break in the slope of the calibration.

    v. Instrumental limitations

    vi. Previously determined MDL.

    It is recognized that the experience of the analyst is important to this process. However, the analyst must include the above considerations in the initial estimate of the detection limit.

2. Select a spiking level:

    i. Typically 2 – 10 times the estimated MDL in Section 1.

    ii. Spiking levels more than 10 times the estimated detection limit may be required for analytes with very poor recovery (e.g., for an analyte with 10% recovery, spiked at 100 micrograms/L, with mean recovery of 10 micrograms/L; the calculated MDL may be around 3 micrograms/L.

Therefore, in this example, the spiking level would be 33 times the MDL, but spiking lower may result in no recovery at all).

3. Initial MDL - Preparation & Analysis:

   i. Process a minimum of seven (7) spiked samples and seven (7) method blank samples through all steps of the method.

   ii. The samples used for the MDL must be prepared in at least three (3) batches on three (3) separate calendar dates and analyzed on three (3) separate calendar dates (preparation and analysis days may overlap).

   iii. Common MDLs for multiple instruments using the same analytical method (e.g. Volatiles by EPA 624.1 by GC/MS) are handled as follows:

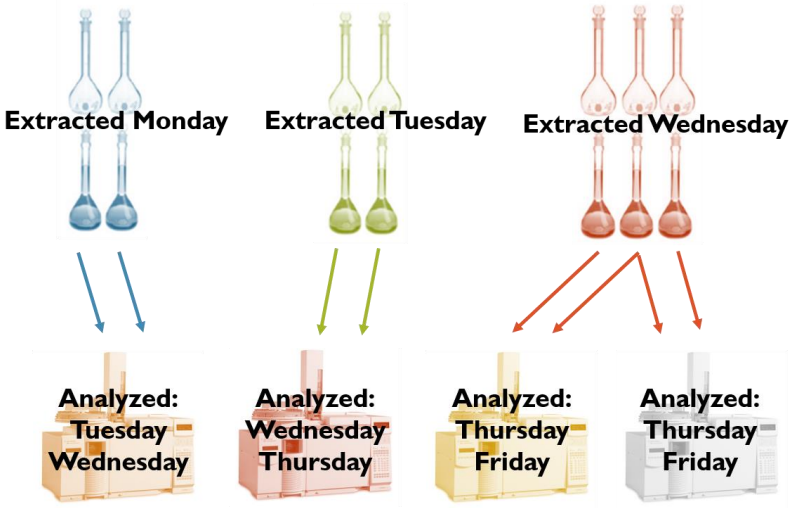
      a. If there are multiple instruments that will be assigned the same MDL, then the sample analyses must be distributed across all the instruments.

      b. A minimum of two spiked samples and two method blank samples prepared and analyzed on different calendar dates is required for each instrument. Each analytical batch may contain one spiked sample and one method blank sample run together. A spiked sample and a method blank sample may be analyzed in the same batch, but are not required to be.

      c. The same prepared extract may be analyzed on multiple instruments so long as the minimum requirement of seven preparations in at least three separate batches is maintained.

      d. If there are multiple analysts for the same tests, each analyst should run a portion of the MDL study

      e. Example Initial MDL workflow for multiple instruments:



iv. Evaluate the spiking level:

a. If any result for any individual analyte from the spiked samples does not meet the method qualitative identification criteria or does not provide a numerical result greater than zero, then repeat the spiked samples at a higher concentration.

4. Calculations:

i. Make all computations as specified in the analytical method and express the final results in the method-specified reporting units.

ii. Calculate the sample standard deviation (S) of the replicate spiked sample measurements and the sample standard deviation of the replicate method blank measurements from all instruments to which the MDL will be applied. Microsoft Excel may be used to calculation standard deviation using the "=STDEV(value1, value2, etc)" formula function.

iii. Calculate the MDL_S (the MDL based on spiked samples) as follows:

$$MDL_S = t_{(n-1,\ 1-\alpha=0.99)} \times S_s$$

MDL_S = the MDL based on spike samples

$t_{(n-1,\ 1-\alpha=0.99)}$ = the Student's t-value appropriate for a single-tailed 99th percentile t statistic and a standard deviation estimate with n-1 degrees of freedom. See Table G-1.

S_s = sample standard deviation of the replicate spiked sample analyses

Table G-1: Student's T Values at the 99% Confidence Level

Number of Aliquots (n)	Degrees of Freedom (n-1)	T Value
7	6	3.143
8	7	2.998
9	8	2.896
10	9	2.821
11	10	2.764
16	15	2.602
21	20	2.528
26	25	2.485
31	30	2.457
32	31	2.453
48	47	2.408
50	49	2.405
61	60	2.390
64	63	2.387
80	79	2.374
96	95	2.366
100	99	2.365

Full table available: http://www.itl.nist.gov/div898/handbook/eda/section3/eda3672.htm

iv. Calculate MDL_b (MDL based on method blanks) as follows:

a. If none of the method blanks give numerical results for an individual analyte, the MDL_b does not apply. A numerical result includes both positive and negative results, including results below the current MDL, but not results of "ND" (not detected) commonly observed when a peak is not present in chromatographic analysis.

b. Ongoing MDL only: If some (but not all) of the method blanks for an individual analyte give numerical results, set the MDL_b equal to the highest method blank result. If more than 100 method blanks are available, set MDL_b to the level that is no less than the 99th percentile of the method blank results. For "n" method blanks where n ≥ 100, sort the method blanks in rank order. The (n * 0.99) ranked method blank result (round to the nearest whole number) is the MDL_b.

For example, to find MDL_b from a set of 164 method blanks where the highest ranked method blank results are … 1.5, 1.7, 1.9, 5.0, and 10, then 164 x 0.99 = 162.36 which rounds to the 162nd method blank result. Therefore, MDL_b is 1.9 for n =164 (10 is the 164th result, 5.0 is the 163rd result, and 1.9 is the 162nd result).

Alternatively, you may use spreadsheet algorithms to calculate the 99th percentile to interpolate between the ranks more precisely. The excel formula for this is (with example data being in rows B2 through B221):

=PERCENTILE(B2:B221,0.99)

c. If all the method blanks for an individual analyte give numerical results, then calculate the MDL_b as:

$$MDL_b = \bar{X} \times t_{(n-1,\ 1-\alpha=0.99)} \times S_b$$

$\bar{X}$ = mean of the method blank results (use zero in place of the mean if the mean is negative)

MDL_b = the MDL based on blanks

$t_{(n-1,\ 1-\alpha=0.99)}$ = the Student's t-value appropriate for a single-tailed 99th percentile t statistic and a standard deviation estimate with n-1 degrees of freedom. See Table G-1.

S_b = sample standard deviation of the replicate method blank sample analyses

5. Select the greater of MDL_s or MDL_b as the MDL.

   NOTE: Statistical outlier removal procedures should not be used to remove data for the initial MDL determination, since the total number of observations is small and the purpose of the MDL procedure is to capture routine method variability. However, documented instances of gross failures (e.g., instrument malfunctions, mislabeled samples, cracked vials) may be excluded from the calculations, provided that at least seven spiked samples and seven method blanks are available. (The rationale for removal of specific outliers must be documented and maintained on file with the results of the MDL determination.)

6. Ongoing Data Collection

   i. Quarterly MDL verification

      a. Samples must be run each quarter for each analytical method. The laboratory will be exempt from running quarterly MDL samples and method blanks during quarters when no samples are analyzed using that method. Verification is used to determine if the detection limit has significantly drifted over time. Methods which have substantial overlap in procedure, e.g. EPA 608.3 and SW-846 8082A for PCBs, will only be required to complete one set of MDLs and verifications which can be applied to both methods.

      b. Prepare and analyze a minimum of two (2) spiked samples on each instrument, for each analyst, in separate batches, using the same spiking concentration used in Section 2.

      c. If any analytes are repeatedly not detected in the quarterly spiked sample analyses, or do not meet the qualitative identification criteria of the method (e.g. RSD value used for LCS recovery), then this is an indication that the spiking level is not high enough and should be adjusted upward.

      d. It is not necessary to analyze additional/separate method blanks together with the spiked samples (aside from the method blank used for the batch), the method blank population should include all of the routine method blanks analyzed with each batch during the course of sample analysis.

      e. Quarters are defined as:

         Quarter 1 = January to March
         Quarter 2 = April to June
         Quarter 3 = July to September
         Quarter 4 = October to December

      f. The MDL_s and MDL_b must be calculated annually.

ii. Annual MDL evaluation

a. After on-going MDL is calculated, compare this value to the MDL from the previous year.

b. If value is within 0.5 to 2.0 times the existing MDL, the MDL need not be changed.

c. If value is NOT within 0.5 to 2.0 times the existing MDL, the MDL must be changed.

7. Considerations

i. If the method is altered in a way that can be reasonably expected to change its sensitivity, then re-determine the initial MDL, and restart the ongoing data collection.

ii. If the method blank has a gross failure which can be explained as out of the ordinary, the blank value need not be used. Rationale must be documented.

iii. If a new instrument is added to a group of instruments:

a. Analyze a minimum of two spiked replicates and two method blank replicates on the new instrument. If both method blank results are below the existing MDL, then the existing MDL_b is validated.

b. Combine the new spiked sample results with the existing spiked sample results and recalculate the MDL_s. If the recalculated MDL_s is within 0.5 to 2.0 times the existing MDL_s, then the existing MDL_s is validated. If either of these two conditions is not met, then calculate a new MDL.

iv. Low-volume tests

a. If a test does not receive samples for a quarter, MDL spikes need not be run

b. If <7 spikes are collected for the year, run an initial MDL

8. Documentation

The analytical method used must be specifically identified by number or title and the MDL for each analyte expressed in the appropriate method reporting units. Data and calculations used to establish the MDL must be able to be reconstructed upon request. The sample matrix used to determine the MDL must also be identified with MDL value. Document the mean spiked and recovered analyte levels with the MDL. The rationale for removal of outlier results, if any, must be documented and maintained on file with the results of the MDL determination.

d) Precision and Bias

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms.

Bias is the systematic error that contributes to the difference between the mean of a significant number of test results and the accepted reference value.

Precision and bias using non-reference, modified reference or laboratory-developed methods are established using the procedure outlined below and compared to the criteria established by the client (when requested), the method, or the laboratory.

Precision and bias are determined by processing samples through all phases of the method (sample preparation, cleanup, analysis, etc.) and are evaluated across the analytical calibration range of the method. This study is performed for all quality system matrices for which the test is to be used.

The laboratory shall evaluate the precision and bias of a reference method for each analyte of concern for each quality system matrix according to the procedure found in Appendices G.2 & H.2, "Demonstration of Capability".

e) Accuracy

Accuracy is defined as the degree of conformity of a measure to a standard or a true value. For example, if an analytical standard is analyzed at a 200 parts per billion (ppb) concentration level and the result is determined to be 199, the analysis is deemed accurate

f) Selectivity

Selectivity is the capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances (EPA-QAD).

The laboratory evaluates selectivity through procedures defined in the test method SOPs. These procedures include second column confirmation, evaluation of retention time windows, mass spectral tuning, and ICP interference checks.

G.2 Demonstration of Capability

Demonstration of Capability (DOC): A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

Before reporting any data with a given method, a satisfactory DOC is performed. Thereafter, each analyst demonstrates continuing proficiency through the procedures outlined in Ongoing Demonstration of Capability.

a) Initial Demonstration of Capability (IDOC)

An IDOC is performed:

- Before using any method
- Each time there is a change in instrument type, personnel or method and
- If the laboratory or analysts has not performed the method in a twelve-month period.

All IDOC(s) for each analyst is documented in the employees' folder. The document identifies the analyst(s) involved in preparation and/or analysis; matrix; analyte(s), class of analyte(s), or measured parameter(s); the method(s) performed; the laboratory-specific SOP used for analysis (including revision number); the date(s) of analysis; and a summary of the results used to calculate the mean recovery and standard deviations.

All raw data, preparation records, and calculations for each IDOC are retained and are available for review.

When the method specifies a procedure to be followed, only that procedure will be used. If no procedures are specified the laboratory uses its own procedure, which is documented below:

b) Ongoing Demonstration of Capability

After the demonstration of capability is completed, on-going proficiency is maintained and demonstrated at least annually. Each analyst is expected to consistently meet the QC requirements of the method, the laboratory SOP, client requirements and/or the TNI Standard. Ongoing DOCS are documented in the employee's folder, and all records related to the demonstration are retained.

The laboratory uses the following to demonstrate ongoing DOC:

G.3 Calibration

Section 22 includes information on calibration of support equipment. This Section covers calibration of analytical equipment.

Initial instrument calibration and continuing instrument calibration verification are an important part of ensuring data of known and documented quality. If more stringent calibration requirements are included in a mandated method or by regulation, those calibration requirements override any requirements outlined here or in laboratory SOPs. Generally, procedures and criteria regarding instrument calibrations are provided in test methods.

G.3.1 Initial Instrument Calibration

- *Records*:

  Initial instrument calibration includes calculations, integrations, acceptance criteria, and associated statistics referenced in the test method SOP.

Sufficient raw data records are collected to allow reconstruction of the initial instrument calibration. These include, at a minimum, calibration date, test method, instrument, analysis date, analyte names, analysts signature or initials, concentration and response, calibration curve or response factor, or unique equation or coefficient used to reduce instrument responses to concentration.

- *Number of Standards and Concentrations*:

  If the reference or mandated method does not specify the number of calibration standards to use, the minimum number is three, not including blanks or a zero standard.

  The lowest calibration standard is the lowest concentration for which quantitative results can be reported without qualification. The lowest calibration standard is at or below the Limit of Quantitation (LOQ) and is greater than the Limit of Detection. Results that are less than the LOQ are considered to have increased uncertainty, and are either reported with a qualifier code (J) or explained in the case narrative.

  The highest calibration standard is the highest concentration for which quantitative results can be reported. Data reported exceeding the highest calibration standard without dilutions is considered to have increased uncertainty and are reported with a qualifier code (E) or reanalyzed and explained in the case narrative.

- *Evaluation, Verification and Corrective Action*

  All initial instrument calibrations are verified with a standard obtained from a second source traceable to a national standard when commercially available. If a second source is not available, a standard prepared from a different lot may be used. All certificates are retained on file.

  Criteria for the acceptance of an initial instrument calibration is established (e.g., correlation coefficient or relative percent difference) and defined in the test method SOP. The criteria used are appropriate to the calibration technique.

  Any samples that are analyzed after an unacceptable initial calibration are re-analyzed or the data are reported with qualifiers, appropriate to the scope of the unacceptable condition (see Section 12 – "Control of Nonconforming Environmental Testing").

  Quantitation is always determined from the initial calibration unless the test method or applicable regulations require quantitation from the continuing instrument calibration verification.

  Corrective actions are performed when the initial calibration results are outside acceptance criteria. Calibration points are not dropped from the middle of the curve. If the cause cannot be determined, the calibration curve is re-prepared. If the low or high calibration point is dropped from the curve, the working curve is adjusted and sample results outside the curve are qualified.

G.3.2 Continuing Instrument Calibration

- *Records*

  The calculations and associated statistics for continuing instrument calibration are included or referenced in the test method SOPs.

  Sufficient raw data records are retained to allow reconstruction of the continuing instrument calibration verification. Continuing instrument calibration verification records connect the continuing verification date to the initial instrument calibration.

- *Frequency*

  Calibration is verified for each compound, element, or other discrete chemical species. For multi-component analytes, such as Aroclors, chlordane, toxaphene, or total petroleum hydrocarbons, a representative chemically related substance or mixture is used.

  Calibration verifications are performed:

  - at the beginning and end of each analytical batch, except for instances when an internal standard is used. For methods employing internal standards, one verification is performed at the beginning of the analytical batch. Some methods have more frequent CCV requirements (see specific SOPs). Many inorganic methods require the CCV to be analyzed after every 10 samples.
  - whenever it is expected that the analytical system may be out of calibration or might not meet verification acceptance criteria.
  - when the time period for calibration or the most recent calibration verification has expired.
  - for all analytical systems that have a calibration verification requirement. Requirements can be found in the test method SOPs. Many inorganic methods require the CCV to be analyzed after every 10 samples.

- Evaluation, Verification and Corrective Actions

  The validity of the initial calibration is verified prior to sample analysis by use of a continuing instrument calibration verification (CCV) standard.

  Corrective action is initiated for CCV results that are outside of acceptance criteria (see Section 12 – "Control of Nonconforming Environmental Testing").

G.3.3 Unacceptable Continuing Instrument Calibration Verifications

If routine corrective action for continuing instrument calibration verification fails to produce a second consecutive (immediate) calibration verification within acceptance criteria, then a new calibration is performed or acceptable performance is demonstrated after corrective action with two consecutive calibration verifications.

For any samples analyzed on a system with an unacceptable calibration, some results may be useable if qualified and under the following conditions:

a) If the acceptance criteria are exceeded high (high bias) and the associated samples are below detection, then those sample results that are non-detects may be reported as non-detects.

Appendix H:
Microbiology

H.1 Method Validation

Methods are validated for Microbiology. The laboratory will compare the results of these tests with the data quality objectives stated by the client. The data must be equal to or better than the stated DQOs.

The laboratory will confirm the validation by participating in a proficiency test program (See Appendix I – "Proficiency Testing") with acceptable results and retain the records of the validation for five years past the date of last use of the method.

H.2 Demonstration of Capability

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

Before reporting any data with a given method, a satisfactory initial DOC (IDOC) is performed. Thereafter, each analyst will demonstrate continuing proficiency through the procedures outlined in Ongoing Demonstration of Capability.

a) Initial Demonstration of Capability (IDOC)

An IDOC is performed:

- before using any method;
- each time there is a change in instrument type, personnel or method; and
- if the laboratory or analysts has not performed the method in a twelve-month period.

The IDOC(s) for each analyst is documented in the employee folder. The document identifies the analyst(s) involved in preparation and/or analysis; matrix; analyte(s), class of analyte(s), or measured parameter(s); the method(s) performed; the laboratory-specific SOP used for analysis (including revision number); the date(s) of analysis; and a summary of the results used to calculate the mean recovery and standard deviations.

All raw data, preparation records, and calculations for each DOC are retained and are available for review.

When methods specify a procedure to be followed, only those procedures will be used. If no procedures are specified the laboratory uses its own procedure, which is documented below:

- The target organism(s) shall be diluted in a volume of clean quality system matrix (a sample in which no target organisms or interferences are present at concentrations that will impact the results of a specific method). This matrix shall be sterile phosphate or sterile peptone solution unless specified by the manufacturer. Prepare at least four (4) aliquots at the concentration

specified, or if unspecified, to the countable range for plate methods or working range for most probable number (MPN) type methods.

- At least four (4) aliquots shall be prepared and analyzed according to the method either concurrently or over a period of days.

- Using all of the results, convert these results to logarithmic values, then calculate the mean recovery and standard deviation of the log converted results in the appropriate reporting units for each organism of interest. When it is not possible to determine mean and standard deviations, such as for presence/absence, the laboratory shall assess performance against established and documented criteria.

- For qualitative tests, acceptable performance in a blind study, either internally or externally generated, may be used to meet this Standard, provided that the study consists of a minimum of a blank, a negative culture, and a positive culture for each target organism or metabolite.

- Compare the information from above to the corresponding acceptance criteria for precision and accuracy in the method (if applicable) or in laboratory-generated acceptance criteria (if there are not established mandatory criteria). If all parameters meet the acceptance criteria, the analysis of actual samples may begin. If any one of the parameters does not meet the acceptance criteria, the performance is unacceptable for that parameter.

- When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst shall proceed according to i) or ii) below.
  i) Locate and correct the source of the problem and repeat the initial DOC for all parameters of interest beginning with b) above.
  ii) Repeat the initial DOC for all parameters that failed to meet criteria

b) Ongoing Demonstration of Capability

After the demonstration of capability is completed, on-going proficiency is maintained and demonstrated at least annually. Each analyst is expected to consistently meet the QC requirements of the method, the laboratory SOP, client requirements and/or the TNI standard. Ongoing DOCS are documented in the employee folder and all records related to the demonstration are retained.

The laboratory uses the following to demonstrate ongoing DOC:

- Performing another initial demonstration of capability.

- Analysis of one sample or clean matrix that is fortified with a known quantity of the target organism, with results meeting the laboratory acceptance criteria for accuracy and, where applicable to the testing technique, also meeting the observational details expected for the presumptive, confirmed and completed phases defined in the method.

- Analysis of one sample in duplicate for each target organism and test, with results meeting the laboratory acceptance criterion for precision.

- Acceptable results for one-single-blind proficiency test sample for target organisms in each field of accreditation.

H.3 Calibration

Section 22.2.2 includes information on calibration of support equipment. This section covers calibration of analytical equipment.

The laboratory has methods that describe how the support equipment are calibrated and verified.

H.3.1 Specific Equipment Requirements

- *Autoclave*

  The laboratory initially evaluates the performance of each autoclave before first use by establishing its functional properties and performance.

  Autoclaves meet specified method temperature tolerances of ±1° C. Pressure cookers shall not be used for sterilization of growth media.

  With each use:

  - The laboratory ensures that the sterilization temperature is reached by using a maximum registering thermometer.

  - The laboratory records date, contents, maximum temperature reached, pressure, time in sterilization mode, total run and analyst's initials.

  - Temperature sensitive tape is used with the contents of each autoclave run to indicate that the autoclave contents have been processed.

  On a monthly basis, when the autoclave is in use, the laboratory verifies that the autoclave is effectively sterilizing the contents by using Geobacillus stearothermophilis.

  The autoclave mechanical timing device is checked quarterly against a stopwatch and the actual time elapsed documented.

  Autoclave maintenance, which is performed by service contract is performed annually. The activities include a pressure check and verification of temperature device.

- *Volumetric Equipment*

  Equipment with movable parts such as automatic dispensers, dispensers/diluters, and mechanical hand pipettes are verified for accuracy quarterly.

Equipment such as filter funnels, bottles, non-Class A glassware, and other containers with volumetric markings (including sample analysis vessels) are verified once per lot prior to first use. The volume of the disposable volumetric equipment, such as sample bottles, and disposable pipettes are checked once per lot.

- *UV instruments Used for Sanitization*

  UV instruments are tested quarterly for effectiveness by pour plate technique.

  Bulbs are replaced when the output is less than 70% of original for light tests or if count reduction is less than 99% for a plate containing 200 to 300 organisms.

- *Water Baths and Incubators*

  On each day of use, the temperature of incubators and water baths is recorded twice a day, at least four hours apart.

Appendix I:
Proficiency Testing

I.1 Proficiency Testing (PT) Guidelines

When seeking to obtain or maintain accreditation, the laboratory shall successfully complete two initial or continuing PT studies for each required field of proficiency testing within the most recent three rounds attempted. Once granted accreditation status, the laboratory shall continue to complete PT studies for each field of proficiency testing and maintain a history of at least two acceptable PT studies for each field of proficiency testing out of the most recent three.

For initial accreditation, the laboratory must successfully analyze two sets of PT studies, the analyses to be performed at least 15 calendar days apart from the closing date of one study to the shipment date of another study for the same field of proficiency testing.

The analysis dates of successive PT samples for accreditation shall be at least five (5) months apart and no longer than seven (7) months apart unless the PT sample is being used for corrective action to reestablish successful history in order to maintain continued accreditation, or is being used to reinstate accreditation after suspension/revocation, in which case the analysis dates of successive PT samples for accreditation Field of Proficiency Testing (FoPT) shall be at least fifteen (15) days apart. Failure to meet the semiannual schedule is regarded as a failed study. Initial or continuing PT Studies must meet all applicable criteria described in this chapter and associated appendices.

The following procedure shall be followed upon receipt of PT samples at the laboratory:

b) All proficiency samples will be reviewed by the QA Officer upon receipt.
c) Samples will be logged into the IAL computer system, refer to IAL SOP1.3800, Sample Identification and Storage Conditions for the IAL sample log-in procedure.
d) PT samples will be distributed by the QA Officer to the department manager along with all necessary paperwork.

If at any time a study is failed, the Lab Manager, QA Officer and Department Supervisor will determine the cause for the failure and take any necessary corrective action. This will be documented in the PT Study records and in a Corrective Action Report. A copy of this corrective action report shall be forwarded to NJDEP Office of Quality Assurance. After the first failure and 15 days after the initial PT, the lab may choose to analyze another PT sample as part of corrective action. This is not required.

If the lab fails two out of the three most recent studies for a given field of proficiency testing, its performance is considered unacceptable under the TNI PT standard for that field. Additional PT samples will be analyzed 15 days after the most recent failed study to try and avoid the loss of certification of the parameter.

I.2 Analysis Requirements

The laboratory shall analyze PT samples in the same manner as used for routine environmental samples using the same staff, sample tracking, sample preparation and

analysis methods, standard operating procedures, calibration techniques, quality control procedures and acceptance criteria.

Note: The laboratory is permitted to analyze the same PT sample for any accreditation or experimental FoPT by multiple methods so long as those test methods are within the same field of accreditation matrix. If the laboratory is accredited for multiple test methods that use the same technology within a field of accreditation, the laboratory is not required to analyze a PT sample for each test method, except for fields of accreditation for the drinking water accreditation matrix for which a PT sample per test method is required. The laboratory may analyze and report the PT sample by one test method and an acceptable performance score for that test method will be acceptable for all test methods that use that same technology within that field of accreditation. When the laboratory reports an analytical result for an accreditation FoPT within the same field of accreditation and accreditation matrix by more than one test method using the same technology, an unacceptable score for either test method will result in an unacceptable score for all test methods for that accreditation FoPT.

Prior to the closing date of a study, laboratory personnel, including corporate personnel, shall not:

a) subcontract the analysis of any PT sample or a portion of a PT sample to another laboratory for any accreditation or experimental FoPT.
b) knowingly receive and analyze any PT sample or portion of a PT sample from another laboratory for which the results of the PT sample are intended for use for initial or continued accreditation.
c) communicate with any individual at another laboratory concerning the analysis of the PT sample prior to the closing date of the study.
d) attempt to obtain the assigned value of any accreditation or experimental FoPT from the PTP.

I.3 Reporting Requirements

The laboratory shall evaluate and report the analytical result for accreditation or experimental FoPT as follows:

a) For instrument technology that employs a multi-point calibration, the laboratory shall evaluate the analytical result to the value of the lowest calibration standard established for the test method used to analyze the PT sample. The working range of the calibration under which the PT sample is analyzed shall be the same range as used for routine environmental samples.

    i. A result for any PT at a concentration above or equal to the lowest calibration standard shall be reported as the resultant value.
    ii. A result for any PT at a concentration less than the lowest calibration standard shall be reported as less than the value of the lowest calibration standard.

b) For instrument technology (such as ICP-AES or ICP-MS) that employ standardization with a zero point and a single point calibration standard, the

laboratory shall evaluate the analytical result to the limit of quantitation (LOQ) established for the test method used to analyze the PT sample. The LOQ for the PT shall be the same as used for routine environmental samples.

i. A result for any PT at a concentration above or equal to the LOQ shall be reported as the resultant value.
ii. A result for any PT at a concentration less than the LOQ shall be reported as less than the value of the LOQ.

The laboratory shall report the analytical results for accreditation and experimental FoPTs to the PT Provider (PTP) on or before the closing date of the study using the reporting format specified by PTP. All reports are subject to the same data retention policy as client samples. See Section 16, "Control of Records".

On or before the closing date of the study, the laboratory shall authorize the PTP to release the laboratory's final evaluation report directly to the NJDEP (the laboratory's Primary Accreditation Body) and other ABs under which IAL holds certification..

Appendix J:
Glossary

Absolute Pressure:
Pressure measured with reference to the surrounding atmospheric pressure, usually expressed in units of kPa or PSI. Zero gauge pressure is equal to atmospheric (barometric) pressure.

Accreditation Body:
The territorial, state or federal agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation.

Accreditation Field of Proficiency Testing:
Same as "Field of Proficiency Testing".

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 that are due to sampling and analytical operations; a data quality indicator. For example, if an analytical standard is analyzed at a 200 parts per billion (ppb) concentration level and the result is determined to be 199, the analysis is deemed accurate. When applied to a set of observed values, accuracy will be a combination of a random component and of a common systematic error (or bias) component (See Appendix G – "Chemistry")

Analysis Date:
The calendar date of analysis associated with the analytical result reported for an accreditation or experimental field of proficiency testing.

Analyst:
The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Uncertainty:
A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.

Assessment:
The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation).

Audit:
A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.

Audit Accuracy (air):
The difference between the analysis of a sample provided in an audit canister and the nominal value as determined by the audit authority divided by the audit value and expressed as a percentage.

Batch:
Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples.

Bias:
The systematic or persistent distortion of a measurement process, which causes errors in one direction (See Appendix G – "Chemistry").

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 See also Equipment Rinsate, Method Blank, Trip Blank.

Calibration:
A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards.
In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI). In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve:
The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.

Calibration Standard:
A substance or reference material used for calibration.

Certified Reference Material (CRM):
Reference material, accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute.

Chain of Custody Form:
Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes:
The number and types of containers
The mode of collection
The collector
Time of collection
Preservation
Requested analyses.
See also Legal Chain of Custody Protocols.

Confirmation:
Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to:

- Second column confirmation
- Alternate wavelength
- Derivatization
- Mass spectral interpretation
- Alternative detectors
- Additional cleanup procedures.

Cryogen:
A refrigerant used to obtain sub-ambient temperatures in the VOC concentrator and/or on front of the analytical column. Typical cryogens are liquid nitrogen (bp -195.8°C), liquid argon (bp -185.7°C), and liquid CO_2 (bp -79.5°C).

Control Sample:
A QC sample introduced into a process to monitor the performance of the system.

Data Quality Objectives (DQOs):
A statement of the overall level of uncertainty that a decision-maker is willing to accept in results derived from environmental data. This is qualitatively distinct from quality measurements such as precision, bias, and detection limit.

Data Reduction:
The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more useful form.

Data Validation:
The process of evaluating the available data against the project DQOs to make sure that the objectives are met. Data validation may be very rigorous, or cursory, depending on project DQOs. The available data reviewed will include analytical results, field QC data and lab QC data, and may also include field records.

Demonstration of Capability:
A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

Duplicate:
See Matrix Duplicate, Field Duplicate, Matrix Spike Duplicate.

Duplicate Precision (air):
Precision determined from the analysis of two samples taken from the same canister. The duplicate precision is determined as the absolute value of the difference between the canister analyses divided by their average value and expressed as a percentage**.**

Dynamic Calibration:
Calibration of an analytical system using calibration gas standard concentrations in a form identical or very similar to the samples to be analyzed and by introducing such standards into the inlet of the sampling or analytical system from a manifold through which the gas standards are flowing.

Dynamic Dilution:
Means of preparing calibration mixtures in which standard gas(es) from pressurized cylinders are continuously blended with humidified zero air in a manifold so that a flowing stream of calibration mixture is available at the inlet of the analytical system.

Equipment Blank:
See Equipment Rinsate.

Equipment Rinsate:
A sample of analyte-free media which has been used to rinse the sampling equipment. It is collected after completion of decontamination and prior to sampling. This blank is useful in documenting adequate decontamination of sampling equipment.

Field of Accreditation:
Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Field Duplicates:
Independent samples, which are collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed independently. These duplicates are useful in documenting the precision of the sampling process.

Field of Proficiency Testing (FoPT):
Analytes for which a laboratory is required to successfully analyze a PT sample in order to obtain or maintain accreditation, collectively defined as: matrix, technology/method, analyte.

Finding:
An assessment conclusion referenced to a laboratory accreditation standard and supported by objective evidence that identifies a deviation from a laboratory accreditation standard requirement.

Gauge Pressure:
Pressure measured with reference to absolute zero pressure, usually expressed in units of kPa, or PSI.

Holding Times:
The maximum time that can elapse between two (2) specified activities.

Internal Standard (IS or ISTD):
A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

Laboratory Control Sample (LCS) (however named, such as laboratory fortified blank, spiked blank, or QC check sample):
A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

Legal Chain of Custody Protocols:
Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain of Custody Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.

Limit Of Detection (LOD):
The laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility.

Limit Of Quantitation (LOQ):
The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence.

Matrix:
The component or substrate (e.g., surface water, drinking water) which contains the analyte of interest.

Matrix Duplicate:
A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision.

Matrix Spike (MS) (spiked sample or fortified sample):
A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicates (MSD) (spiked sample or fortified sample duplicate):
A replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Method:
A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.

Method Blank:
A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. For a method blank to be acceptable for use with the accompanying samples, the concentration in the blank of any analyte of concern should not be higher than the highest of either:

- The method detection limit, or
- Five percent of the regulatory limit for that analyte, or
- Five percent of the measured concentration in the sample.

Correction of sample results using values from the method blank is strictly prohibited.

Method Detection Limit (MDL):
The minimum concentration of a substance 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 type containing the analyte. The MDL can vary depending on the type of sample being analyzed or dilution prior to analysis due to matrix interferences or high contamination in the sample matrix.

MS-SCAN:
Mass spectrometric mode of operation in which the gas chromatograph (GC) is coupled to a mass spectrometer (MS) programmed to SCAN all ions repeatedly over a specified mass range.

MS-SIM:
Mass spectrometric mode of operation in which the GC is coupled to a MS that is programmed to scan a selected number of ions repeatedly [i.e., selected ion monitoring (SIM) mode].

National Institute of Standards and Technology (NIST):
A federal agency of the US Department of Commerce's Technology Administration that is designed as the United States national metrology institute (NMI).

Organic-Free Reagent Water:
For volatiles, all references to water in the methods refer to water in which an interferant is not observed at the method detection limit of the compounds of interest. Organic-free reagent water can be generated by passing tap water through a carbon filter bed containing about 1 pound of activated carbon. A water purification system may be used to generate organic-free deionized water. Organic-free reagent water may also be prepared by boiling water for 15 minutes and, subsequently, while maintaining the temperature at 90°C, bubbling a contaminant-free inert gas through the water for 1 hour. For semi-volatiles and non-volatiles, all references to water in the methods refer to water in which an interferant is not observed at the method detection limit of the compounds of interest. Organic-free reagent water can be generated by passing tap water through a carbon filter bed containing about 1 pound of activated carbon. A water purification system may be used to generate organic-free deionized water.

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 (See Appendix G – "Chemistry").

Preservation:
Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis.

Primary Accreditation Body (Primary AB):
The accreditation body responsible for assessing a laboratory's total quality system, on-site assessment, and PT performance tracking for fields of accreditation. IAL's Primary AB is NJDEP.

Procedure:
A specified way to carry out an activity or process. Procedures can be documented or not.

Proficiency Testing (PT):
A means to evaluate a laboratory's performance under controlled conditions relative to a given set of criteria, through analysis of unknown samples provided by an external source.

Proficiency Testing Program (PT Program):
The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of results and the collective demographics and results summary of all participating laboratories.

Proficiency Testing Sample (PT Sample):
A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within the specified acceptance criteria.

Proficiency Testing Study (PT Study):
A single complete sequence of circulation of proficiency testing samples to all participants in a proficiency test program.

Project:
Single or multiple data collection activities that are related through the same planning sequence.

Protocol:
A detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) which must be strictly followed.

Qualitative Accuracy:
The degree of measurement accuracy required to correctly identify compounds with an analytical system.

Quality Assurance:
An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

Quality Assurance Project Plan (QAPP):
An orderly assemblage of detailed procedures designed to produce data of sufficient quality to meet the data quality objectives for a specific data collection activity.

Quality Control:
The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality.

Quality Control Sample:
A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control.

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

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 quality assurance (QA) and quality control (QC) activities.

Quality System Matrix:
These matrix definitions are to be used for purposes of batch and quality control requirements:

> ***Air and Emissions***:
> Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter, or other device.
>
> ***Aqueous***:
> Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, ground water effluents, and TCLP or other extracts.

Chemical Waste:
A product or by-product of an industrial process that results in a matrix not previously defined.

Drinking Water:
Any aqueous sample that has been designated a potable or potential potable water source.

Non-Aqueous Liquid:
Any organic liquid with <15% settleable solids.

Saline/Estuarine:
Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Solids:
Includes soils, sediments, sludges and other matrices with >15% settleable solids.

Quantitative Accuracy:
The degree of measurement accuracy required to correctly measure the concentration of an identified compound with an analytical system with known uncertainty.

Raw Data:
The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records.

RCRA:
The Resource Conservation and Recovery Act.

Reagent Blank:
See Method Blank.

Reagent Grade:
Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents, which conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.

Reagent Water:
Water that has been generated by any method which would achieve the performance specifications for ASTM Type II water. For organic analyses, see the definition of organic-free reagent water. See IAL SOP 1.1700

Reference Material:
A material containing known quantities of target analytes in solution or in a homogeneous matrix. It is used to document the bias of the analytical process.

Reference Standard:
Standard used for the calibration of working measurement standards in a given organization or at a given location

Replicate Precision (air):
Precision determined from two canisters filled from the same air mass over the same time period and determined as the absolute value of the difference between the analyses of canisters divided by their average value and expressed as a percentage.

Sampling:
Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Selectivity:
The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system.

Sensitivity:
The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.

Split Samples:
Aliquots of sample taken from the same container and analyzed independently. In cases where aliquots of samples are impossible to obtain, field duplicate samples should be taken for the matrix duplicate analysis. These are usually taken after mixing or compositing and are used to document intra- or inter-laboratory precision.

Standard:
The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies.

Standard Addition:
The practice of adding a known amount of an analyte to a sample immediately prior to analysis. It is typically used to evaluate interferences.

Standard Operating Procedures:
A written document that details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks.

Surrogate:
An organic compound which is similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which is not normally found in environmental samples.

Technology:
A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability:
The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.

Trip Blank:
A sample of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organics samples.

Verification:
Confirmation by examination and objective evidence that specified requirements have been met.

> NOTE: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment. The result of verification leads to a decision either to restore in service, to perform adjustment, to repair, to downgrade, or to declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.

LAST PAGE OF DOCUMENT