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REPORT

GROUNDWATER MONITORING PLAN OU-2

Friedrichsohn Cooperage Site
153-155 Saratoga Avenue
Town of Waterford, New York

Prepared for: General Electric Company and SI Group, Inc.

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1.0 INTRODUCTION

This Groundwater Monitoring Plan provides the methodology and schedule for groundwater monitoring for Operable Unit 2 (OU-2) at the Friedrichsohn Cooperage inactive hazardous waste site (the Site) located at 153-155 Saratoga Avenue in the Town of Waterford, New York (see Figure 1.1 for the Site location).

This Groundwater Monitoring Plan has been prepared by Conestoga-Rovers & Associates (CRA) in accordance with an Order on Consent (Consent Order) between the New York State Department of Environmental Conservation (NYSDEC) and the Respondents (General Electric Company and SI Group, Inc.) to the Consent Order, which came effective January 28, 2013 (Index No. A5-0784-1202). The Consent Order required the Respondents to prepare a Groundwater Monitoring Plan for periodic monitoring of existing wells at OU-2.

This Groundwater Monitoring Plan has been prepared in general accordance with the following guidance, directives, and other publications, where appropriate:

- Consent Order, Index No. A5-0784-1202, January 2013
- Record of Decision, Site No. 546045, December 2012
- NYSDEC DER-10 Technical Guidance for Site Investigation and Remediation, May 2010
- Applicable provisions of the New York State Environmental Conservation Law (ECL) and associated regulations, including Title 6 of the New York Code of Rules and Regulations (6 NYCRR) Part 375
- United States Environmental Protection Agency (USEPA) guidance document entitled "Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Comprehensive Environmental Response, Compensation and Liability Act" (CERCLA), Interim Final (USEPA, 1988)
- Applicable provisions of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) regulations contained in Title 40 of the Code of Federal Regulations (CFR) Part 300

The Groundwater Monitoring Plan is organized as follows:

Section 1.0 - Introduction
Section 2.0 - Background Information
Section 3.0 - Groundwater Monitoring Plan

Section 4.0 - Waste Management

Section 5.0 - Schedule

Section 6.0 - Reporting

2.0 BACKGROUND INFORMATION

2.1 SITE LOCATION AND DESCRIPTION

The Site is located at 153-155 Saratoga Avenue, Waterford, Saratoga County, New York. A Site location map is presented as Figure 1.1. The Site is approximately 0.45 acres in size and has approximately 315 feet of frontage on Saratoga Avenue (Route 32). The Old Champlain Canal borders the Site on the side opposite the road. Residential properties are adjacent to the Site on Saratoga Avenue; residential and commercial properties are also located across from the Site on Saratoga Avenue. The Site is currently a vacant lot. The approximate boundaries of the Site are shown on Figure 2.1.

Access to the Site is limited by an 8-foot tall, lockable, chain-link fence that has been installed around the former Friedrichsohn Cooperage property. Warning signs have been installed on the fencing.

The Site is currently zoned as residential (R-75) and is served by the public water supply system and the public storm water and sanitary systems. The commercial properties across from the Site are located on property formerly known as the Friedrichsohn Cooperage Lot, which was used to store drums.

2.2 SITE HISTORY

A cooperage operated at this location from 1817 to 1991. During the early operations the cooperage made and refurbished wooden kegs and barrels. When the cooperage closed in 1991 the primary business had been cleaning and refurbishing metal drums. Industrial facilities in the area used materials shipped in drums in their industrial processes. Drums would be sent to the cooperage to be cleaned, repainted, and resold. The drum cleaning and refurbishing operations are alleged to be the source of the contamination that was identified at the Site.

During its most recent history, the cooperage operated out of five buildings at the Site. Three of the five buildings were constructed as slab-on-grade. Two of the buildings contained structures below grade. One of the buildings had a basement area, below grade, where the sumps were located. One of the buildings on the southwest end of the Site is labeled as a garage on historical drawings, and had an automobile service trench associated with it. The service trench is below grade and provided access to the undercarriage of vehicles.

Inspection and examination of the abandoned business in 1994 revealed many metal drums, and the buildings to be unstable and in poor condition. The USEPA conducted an emergency removal action between 1994 and 1996. The cooperage buildings were demolished, and clean fill was imported to replace contaminated soil that was removed. In the spring of 2008, NYSDEC collected samples of soil, groundwater, and surface water and sediment in the canal. The analytical results formed the basis for the listing of the Site in December 2008 as a Class 2 on the NYS Registry of Inactive Hazardous Waste Disposal Sites. The Site is currently divided into three OUs:

- OU-1 is comprised of the on-Site and off-Site soil at the former cooperage site, excluding the soil in the on-Site source area adjacent to the Canal that is part of OU-3
- OU-2 is comprised of on-Site and off-Site groundwater
- OU-3 is comprised of the sediments in the Old Champlain Canal between O'Connor Drive and Burton Avenue, as well as the adjacent on-Site source area and canal bank soil

The contaminants of concern (COCs) at the Site include polychlorinated biphenyls (PCBs), chlorinated volatile organic compounds (VOCs) (tetrachloroethane, trichloroethane, dichloroethene, vinyl chloride, and chlorobenzene), benzene, toluene, ethylbenzene, xylenes (BTEX), phenolic compounds (phenol and dimethylphenol), hexachlorobenzene, and metals (arsenic, barium, chrome, and lead).

NYSDEC issued Record of Decisions (RODs) in December 2012 for OU-1 and in March 2011 for OU-3. In the RODs, NYSDEC selected active remediation for OU-1 and OU- 3 that include soil and sediment removal and a site cover.

In January 2013, the Respondents and NYSDEC entered into a Consent Order to conduct and implement the selected remedies for OU-1 and OU-3 and to implement a groundwater monitoring program for OU-2. The objective of the OU-2 Groundwater Monitoring Plan is to present the details for a groundwater monitoring program that, when implemented, will be used to determine if an RI/FS will be necessary for OU-2.

2.3 SITE HYDROGEOLOGY

The site geology and hydrogeology is described in the Focused Remedial Investigation Feasibility Study (RI/FS) prepared by Malcolm Pirnie, Inc. and dated April 2010. A total of 2 overburden, 1 piezometer, 8 bedrock and 8 interface wells were installed in the vicinity of the Site for the RI/FS. Monitoring wells were installed on the north side of

158 Saratoga Avenue, along Saratoga Avenue, on the former Friedrichsohn property and across the Old Champlain Canal, which trends southwest to northeast. Monitoring well locations are shown on Figure 2.2.

The overburden generally consists of brown medium sandy fine gravel overlain by silty sand. The bedrock in the area of the site consists of Canajoharie shale. The depth to bedrock varies, and ranges from approximately 10 to 25 feet below ground surface (bgs) at the north of the Site, to 30 to 35 feet bgs on the southern side of the Canal.

The depth to water in overburden wells was found to range from approximately 4 to 15 feet below the top of well casing. The variability in water levels is reportedly due in part to differences in ground surface elevation.

The water level in the Old Champlain Canal was found to be at a similar elevation to the adjacent shallow groundwater. Fluctuations in canal water levels coincided with fluctuations in nearby groundwater levels with negligible time lag indicating that the canal is in direct hydraulic connection with the water table and likely influences the magnitude and direction of shallow groundwater flow in its vicinity.

Based on the groundwater level measurements from the existing bedrock monitoring well network, bedrock groundwater flow is to the south/southeast towards the Mohawk River.

Movement of water in the Old Champlain Canal is dependent on the operation of nearby locks, which are controlled by the New York State Canal Corporation (NYSCC). During the navigational season (approximately May to November) the water in the Old Champlain Canal is constantly in flux; the water level in the canal rises and falls and flows northeast or southwest depending on if the NYSCC has opened or closed nearby locks. The water level in the Old Champlain Canal rises and falls by a foot or more multiple times each day during the navigational season. During the non-navigational season (approximately November to April), the NYSCC typically drains the Old Champlain Canal of water.

2.4 GROUNDWATER QUALITY

For the RI, groundwater samples were collected between September 30, 2009 and October 8, 2009, from on- and off-site monitoring wells, as well as from an on-site piezometer (PES-1). Both shallow and deep samples were collected from PES-1. The samples were collected using low-flow sampling protocols. The shallow sample was collected by setting the pump intake within approximately two feet of the top of the piezometer screen and the deep sample was collected by setting the pump intake within approximately two feet of the bottom of the well screen. A groundwater sample was also collected from sanitary sewer line bedding on the southern side of the canal (GW-35).

No groundwater seeps were identified in the area between the canal and Garrett Field.

VOC concentrations exceeded the respective NYSDEC Class GA standards in eight groundwater samples. Five samples contained at least one SVOC at concentrations greater than the respective NYSDEC Class GA standards. PCB concentrations exceeded the NYSDEC Class GA standard (0.09 µg/L) in samples collected from two off-site wells (MW-5S and -6S), on site well MW-10, and the piezometer samples (PZ-top, PZ-bot). The highest PCB concentration (53,000 µg/L) was detected at the piezometer (PZ-top).

The groundwater samples collected from wells located on the 158 Saratoga Avenue property did not contain VOCs, SVOCs, or PCBs at concentrations exceeding the respective NYSDEC Class GA Standards.

Prior to initiating the RI, during the Preliminary Site Assessment, groundwater samples were collected from monitoring wells MW-1 through MW-6, in April 2008. In comparison to the previous results, nearly all VOC and SVOC concentrations decreased from April 2008 to October 2009. MW-5S and MW-6S were the only wells sampled in both 2008 and 2009 that contained PCBs. While the total PCB concentration at MW-5S decreased over time (1.3 µg/L to 0.47 µg/L), the total PCB concentration at MW-6S increased (44J µg/L to 200 µg/L).

3.0 GROUNDWATER MONITORING PLAN

Wells proposed for the OU-2 groundwater monitoring program are listed below and are shown on Figure 3.1.

- Upgradient overburden/ interface well - MW-2S
- Upgradient bedrock well - MW-2
- On-Site overburden/ interface wells - MW-07, MW-08, MW-10
- On-Site bedrock well - MW-09
- Downgradient overburden/ interface wells - MW-5S, MW-6S, MW-12S, MW-13S
- Downgradient bedrock wells - MW-5, MW-6

Monitoring well logs are presented in Appendix A. Details of the monitoring program and sampling protocols are presented in the following Sections.

3.1 WELL INSPECTIONS

Well inspections will be conducted to assess the condition of the proposed monitoring wells. Each well will be inspected for damage to the casing or riser, the well will be probed to determine the depth and to look for any obstructions in the well, and a water level will be obtained. The measured depth of the well will be compared to the well installation log to determine if there is a blockage in the well or if the well has experienced significant siltation. The ground surface area at the well will be inspected for potential breaches of the surface seal that could compromise the integrity of the well. A photo log will be taken at each well location and the condition of the well will be documented on a field form.

3.2 WELL REPAIR, SURVEY, AND REDEVELOPMENT

The need for any well repairs and resurveys will be identified based upon the results of the well inspections described above. Prior to performing any repairs on existing wells, a determination will be made regarding the importance of the particular well, the need to monitor the well and whether there is a suitable existing well that can be substituted into the monitoring program.

Should wells require redevelopment, they will be developed to a goal of 50 nephelometric turbidity units (NTUs) or less, if possible, prior to the first sampling round in accordance with the following protocol:

1) All personnel involved in well development will wear protective clothing including Tyvek coveralls, rubber boots and rubber gloves.
2) All wells will be developed to a goal of 50 NTUs or less, if possible, following installation, by bailing, pumping or air lift pumping.
3) Water levels in all wells will be measured to ±0.01 foot prior to development utilizing an electronic water level meter in accordance with Section 3.3.
4) After each well volume is removed, a sample will be collected and analyzed for turbidity, temperature, pH, and conductivity. Development will continue until two consecutive and consistent readings of temperature, pH, and conductivity are obtained and the turbidity is less than 50 NTUs, if possible. Readings will be considered consistent if consecutive conductivity, temperature, and pH values are within 10 percent of each other. In the event that these field conditions cannot be met, development will continue to a goal of less than 50 NTUs, if possible, or until a maximum of ten well volumes have been removed.
5) In wells where recharge is insufficient to conduct the development protocol described in Item 4 above, the well will be pumped/bailed to dryness on three consecutive days.
6) Acceptable methods of water extraction during development include bailers, peristaltic pumps, bladder pumps, Waterra pumps, centrifugal and submersible pumps. The development method selected will be based upon the well depth, the water level in the well, and the recharge characteristics.
7) All water extraction equipment will be cleaned in accordance with the protocols presented in Section 3.5.
8) All development water will be collected, stored, analyzed, and disposed of in accordance with State and Federal regulations.

3.3 HYDRAULIC WATER LEVEL MONITORING

Prior to collecting groundwater samples, water level measurements will be obtained at the 10 monitoring wells with an electronic water level indicator. The water level indicator will be decontaminated prior to use in accordance with the decontamination procedures outlined in Section 3.5. The electronic water level measurement method involves lowering a probe into a well which, upon contact with the water, completes an electric circuit. At the instant the circuit is closed, the water level indicator provides an audible and/or visual alarm which indicates that the water has been contacted. The cable of the probe(s) utilized will be graduated in 0.01 feet increments. Measurements will be obtained to ±0.01-foot accuracy.

3.4 GROUNDWATER SAMPLE COLLECTION AND ANALYSES

Groundwater sampling will be conducted using low-flow purge and sampling methods as described in EPA/540/S-95/504, dated April 1996 (see Appendix B). Based on the available groundwater data at the time of the preparation of this monitoring plan, monitoring wells, in general, will be sampled in order of decreasing groundwater quality as follows:

- Upgradient Wells (MW-2 and MW-2S)
- Downgradient Wells (MW-12S, MW-13S, MW-5S, MW-5, MW-6, MW-6S)
- On-Site Monitoring wells (MW-07, MW-08, MW-10, MW-09)

During purging of the well, turbidity will be measured in the field with a nephelometer and the field indicator parameters temperature, conductivity, and pH will be measured by a multi-meter monitor.

Groundwater samples will be submitted to an NYSDOH Environmental Laboratory Accreditation Program (ELAP) approved laboratory and analyzed for TCL VOCs, TCL SVOCs, TAL metals and PCBs. Samples will be collected and analyzed in accordance with the QAPP presented in Appendix C. All samples will be recorded on sample log sheets.

3.5 SAMPLING EQUIPMENT CLEANING

Reusable sampling equipment will be cleaned between sampling events and/or between wells using the following rinse sequence.

1) Wash and scrub with tap water and low phosphate detergent.
2) Rinse with tap water.
3) Rinse with methanol.

4) Thoroughly rinse with deionized demonstrated analyte-free water. The volume of water used must be at least five times the volume of solvent used in step 3).

5) Air dry for 15 minutes.

6) Following the final rinse, sampling equipment will be visually inspected to verify that it is free of particulates and other solid material which may contribute to possible sample cross-contamination. Fluids used for cleaning will not be recycled. Washwater, rinse water, and decontamination fluids will be collected and disposed of in accordance with applicable regulations.

4.0 WASTE MANAGEMENT

All purge or development water and decontamination fluids will be collected in 55-gallon DOT-approved drums, and transferred to an on-Site interim drum staging area. All wastes will be sampled and analyzed, and will be disposed of in accordance with State and Federal regulations.

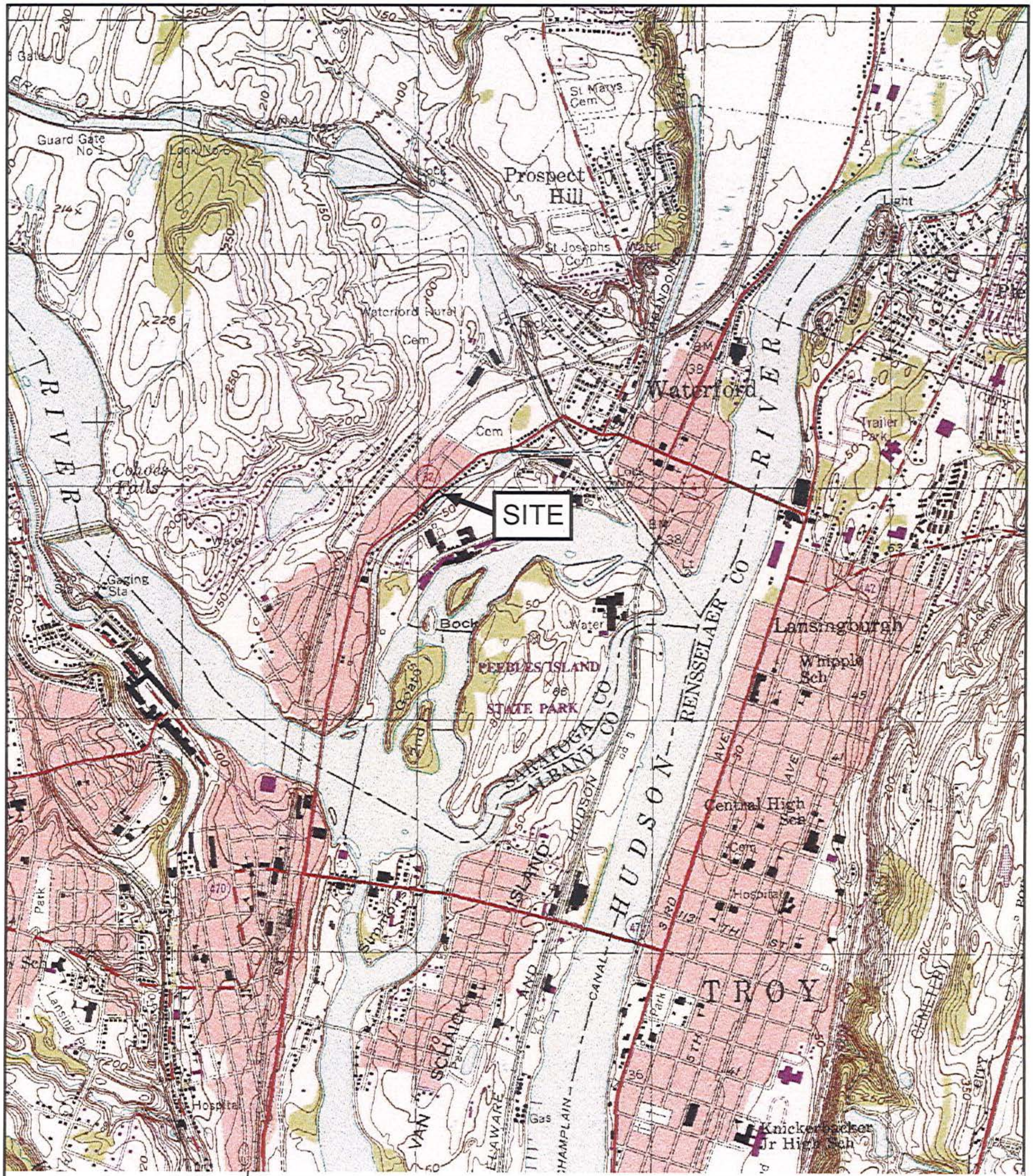
All coveralls, gloves, etc., will be collected in plastic bags for disposal.

5.0 SCHEDULE

Groundwater monitoring will be performed on a semi-annual basis. Groundwater monitoring will be scheduled to include one navigation season (May to November) and one non-navigation season (December to April) sampling event per 12 month period. Monitoring is proposed to be performed during the months of September and March. Immediately following completion of the remediation for OU-1 and OU-3, groundwater monitoring will be performed on a quarterly basis (March, June, September and December) for 18 months (total of six rounds) to monitor for potential changes in the groundwater quality due to the remediation activities.

6.0 REPORTING

A groundwater monitoring report will be prepared following each groundwater sampling event. The groundwater monitoring report will be in letter format and will include water level measurements, current and historical groundwater data in tabular format, comparison of groundwater results to NYSDEC Class GA groundwater standards, concentrations of parameters exceeding NYSDEC Class GA groundwater standards shown on data-box figures, laboratory report, and data validation memo. The report will also present a discussion of the groundwater quality results focusing on a comparison with the historical results presented in the RI/FS and results for previous sampling rounds. During the 18 month monitoring period following completion of the remediation for OU-1 and OU-3, the Respondents will discuss with NYSDEC the need to prepare an RI/FS for OU-2. If necessary, an RI/FS Work Plan will be prepared and submitted to NYSDEC within 60 days following receipt of the final round of groundwater sample results collected during the 18 month quarterly monitoring period.



USGS QUADRANGLE MAP
NORTH TROY, NEW YORK

figure 1.1

SITE LOCATION
GROUNDWATER MONITORING PLAN
FRIEDRICHSOHN COOPERAGE SITE
153-155 Saratoga Ave., Waterford, N.Y.

80987-98(004)GN-WA001 JUL 3/2013

SOURCE: FOCUSED REMEDIAL INVESTIGATION FEASIBILITY STUDY, MALCOLM PIRNIE, INC., FIGURE 2, APRIL 2010

figure 2.1

SITE PLAN
GROUNDWATER MONITORING PLAN
FRIEDRICHSOHN COOPERAGE SITE
153-155 Saratoga Ave., Waterford, N.Y.

SOURCE: FOCUSED REMEDIAL INVESTIGATION FEASIBILITY STUDY, MALCOLM PIRNIE, INC., FIGURE 9, APRIL 2010

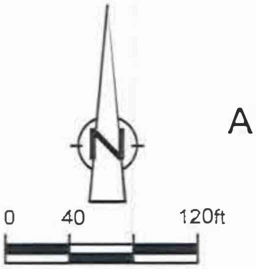


figure 2.2

APPROXIMATE MONITORING WELL LOCATIONS
GROUNDWATER MONITORING PLAN
FRIEDRICHSOHN COOPERAGE SITE
153-155 Saratoga Ave., Waterford, N.Y.

CRA

80987-98(004)GN-WA003 JUL 3/2013

SOURCE: FOCUSED REMEDIAL INVESTIGATION FEASIBILITY STUDY, MALCOLM PIRNIE, INC., FIGURE 9, APRIL 2010

figure 3.1

PROPOSED MONITORING WELL LOCATIONS
GROUNDWATER MONITORING PLAN
FRIEDRICHSOHN COOPERAGE SITE
153-155 Saratoga Ave., Waterford, N.Y.

APPENDIX A

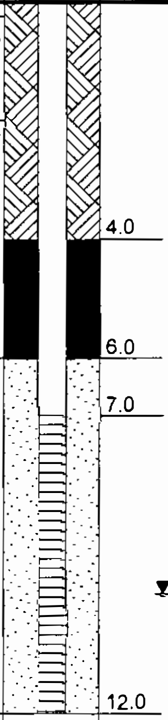
MONITORING WELL LOGS

MALCOLM PIRNIE

TEST BORING LOG

BORING No.MW-07

PROJECT	**Friedrichsohn Cooperage**	LOCATION	**Waterford, Saratoga County, NY**			SHEET	**1** OF **1**
CLIENT	**New York State Department of Environmental Conservation**					PROJECT No.	**0266382**
DRILLING CONTRACTOR	**Buffalo Drilling**					MEAS. PT. ELEV.	
PURPOSE	**Remedial Investigation**					GROUND ELEV.	
WELL MATERIAL	**Overburden**					DATUM	
DRILLING METHOD(S)	**Rotary**		SAMPLE	CORE	CASING	DATE STARTED	**9/1/09**
DRILL RIG TYPE	**HSA**	TYPE	**split spoon**		**pvc**	DATE FINISHED	**9/1/09**
GROUND WATER DEPTH	**10.0'**	DIA.	**"**		**2"**	DRILLER	**Joe Gardner**
MEASURING POINT		WEIGHT	**#**			PIRNIE STAFF	**D. Giroux**
DATE OF MEASUREMENT		FALL	**"**				



DEPTH FT.	SAMPLE TYPE, RECOVERY, NUMBER	BLOWS ON SAMPLE SPOON PER 6"	PID	GEOLOGIC DESCRIPTION KEY - Color, Major, Minor Moisture, Etc.	ELEV. / DEPTH	REMARKS
0–2	.5		0	Concrete. Brown Gravelly SAND (moist, compact).	0.3	
2–4	1		0	Brown Silty SAND, some gravel (moist, compact).	2.0	
4–6	1		0			
6–8	1		0	Brown Sandy angular GRAVEL (moist to wet, compact).	6.0	
8–10	.5		0			Odor at 8-10'.
10–12	.5		0			▼
12				Bedrock (shale).	12.0	

MALCOLM PIRNIE

TEST BORING LOG

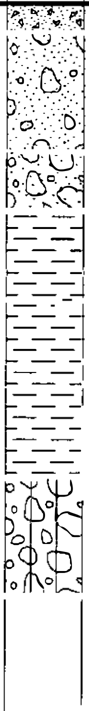
BORING No.MW-08

PROJECT	Friedrichsohn Cooperage	LOCATION	Waterford, Saratoga County, NY
CLIENT	New York State Department of Environmental Conservation		
DRILLING CONTRACTOR	Buffalo Drilling		
PURPOSE	Remedial Investigation		
WELL MATERIAL	Overburden		
GROUND WATER DEPTH	5.0'		
MEASURING POINT			
DATE OF MEASUREMENT			

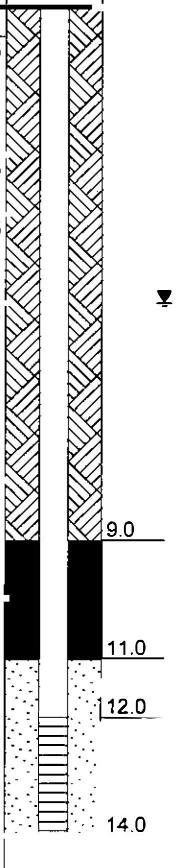
DRILLING METHOD(S)	Rotary		
DRILL RIG TYPE	HSA		

	SAMPLE	CORE	CASING
TYPE	split spoon		pvc
DIA.	"		2"
WEIGHT	#		
FALL	"		

SHEET	1 OF 1
PROJECT No.	0266382
MEAS. PT. ELEV.	
GROUND ELEV.	
DATUM	
DATE STARTED	9/1/09
DATE FINISHED	9/1/09
DRILLER	Joe Gardner
PIRNIE STAFF	D. Giroux



DEPTH FT.	SAMPLE TYPE, RECOVERY, NUMBER	BLOWS ON SAMPLE SPOON PER 6"	PID	GEOLOGIC DESCRIPTION KEY - Color, Major, Minor Moisture, Etc.	ELEV. DEPTH	REMARKS
				Concrete.		
	.5		0	Brown Gravelly SAND (dry to moist, loose).	0.5	
2						
				Black burned Sandy GRAVEL (moist, loose).	2.5	
	1.5		0			
				Tan Clayey SILT with subrounded gravel (moist, compact).	3.5	
4						
	.5		0	Gray Clayey SILT to Silty CLAY with angular gravel (wet, compact).	5.0	▼
6						
	.5		0			
8				Gray Silty, Sandy subrounded/angular GRAVEL (wet, loose).	8.0	
	.25		0			
10					10.0	
12						
14						
				BEDROCK (shale).		



MALCOLM PIRNIE	TEST BORING LOG	BORING No.MW-09

PROJECT	Friedrichsohn Cooperage	LOCATION	Waterford, Saratoga County, NY	SHEET	1 OF 1
CLIENT	New York State Department of Environmental Conservation			PROJECT No.	0266382
DRILLING CONTRACTOR	Buffalo Drilling			MEAS. PT. ELEV.	
PURPOSE	Remedial Investigation			GROUND ELEV.	
WELL MATERIAL	Bedrock			DATUM	

			SAMPLE	CORE	CASING		
DRILLING METHOD(S)	Rotary					DATE STARTED	9/2/09
DRILL RIG TYPE	HSA	TYPE				DATE FINISHED	9/8/09
GROUND WATER DEPTH	'	DIA.	"			DRILLER	Joe Gardner
MEASURING POINT		WEIGHT	#				
DATE OF MEASUREMENT		FALL	"			PIRNIE STAFF	D. Giroux

DEPTH FT.	SAMPLE TYPE, RECOVERY, NUMBER	BLOWS ON SAMPLE SPOON PER 6"	PID	GRAPHIC LOG	GEOLOGIC DESCRIPTION KEY - Color, Major, Minor Moisture, Etc.	ELEV. DEPTH	WELL Constr.	REMARKS
					No Sampling / Split Spoons Collected.			
2								
4								
6								
8								
10					Refusal at 15'			
12					5 7/8 roller bit to 20'. Set 4" PVC rock socket. Grout 15' to 20'.			
14					Drill to 59.5' with 3 7/8 roller bit. Set 49.5' riser, 10' screen; no sand pack.			
16								
18								

MALCOLM PIRNIE

TEST BORING LOG

BORING No.MW-10

PROJECT	Friedrichsohn Cooperage	LOCATION	Waterford, Saratoga County, NY	SHEET	1 OF 1
CLIENT	New York State Department of Environmental Conservation			PROJECT No.	0266382
DRILLING CONTRACTOR	Buffalo Drilling			MEAS. PT. ELEV.	
PURPOSE	Remedial Investigation			GROUND ELEV.	
WELL MATERIAL	Overburden			DATUM	

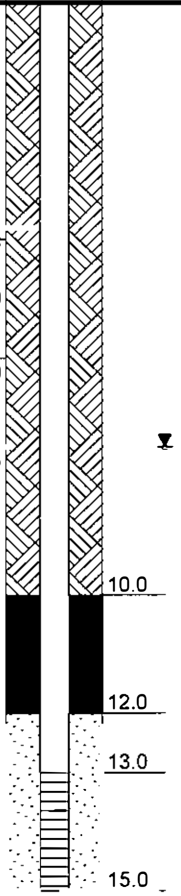
			SAMPLE	CORE	CASING
DRILLING METHOD(S)	Rotary				
DRILL RIG TYPE	HSA	TYPE	split spoon		pvc
GROUND WATER DEPTH	7.5'	DIA.	"		2"
MEASURING POINT		WEIGHT	#		
DATE OF MEASUREMENT		FALL	"		

DATE STARTED	9/3/09
DATE FINISHED	9/3/09
DRILLER	Joe Gardner
PIRNIE STAFF	D. Giroux

DEPTH FT.	SAMPLE TYPE, RECOVERY, NUMBER	BLOWS ON SAMPLE SPOON PER 6"	PID	GEOLOGIC DESCRIPTION KEY - Color, Major, Minor Moisture, Etc.	ELEV. DEPTH	REMARKS
	1.5		0	Brown Silty fine SAND (moist, compact).		
2	1.5		0			
4	0		5.6	Black burnt medium SAND (moist, loose). No recovery.	3.8 4.0	
6	.5		>9999	Brown/gray Silty SAND to Sandy SILT (moist, compact). Gray Sandy angular GRAVEL (wet, loose).	6.0 7.5	
8	.5		>9999			
10	.5		>9999			
12	.5		>9999			
14	.25		396		15.0	

GRAPHIC LOG

WELL Constr.



MALCOLM PIRNIE	**TEST BORING LOG**	**BORING No.MW-11**

PROJECT	**Friedrichsohn Cooperage**	LOCATION	**Waterford, Saratoga County, NY**		SHEET **1** OF **1**	
CLIENT	**New York State Department of Environmental Conservation**				PROJECT No.	**0266382**
DRILLING CONTRACTOR	**Buffalo Drilling**				MEAS. PT. ELEV.	
PURPOSE	**Remedial Investigation**				GROUND ELEV.	
WELL MATERIAL	**Bedrock**				DATUM	
DRILLING METHOD(S)	**Rotary**		SAMPLE	CORE	CASING	
DRILL RIG TYPE	**HSA**	TYPE			DATE STARTED	**9/10/09**
GROUND WATER DEPTH	'	DIA.	"		DATE FINISHED	**9/22/09**
MEASURING POINT		WEIGHT	#		DRILLER	**Joe Gardner**
DATE OF MEASUREMENT		FALL	"		PIRNIE STAFF	**D. Giroux**

DEPTH FT.	SAMPLE TYPE, RECOVERY, NUMBER	BLOWS ON SAMPLE SPOON PER 6"	PID	GRAPHIC LOG	GEOLOGIC DESCRIPTION KEY - Color, Major, Minor Moisture, Etc.	ELEV. DEPTH	WELL Constr.	REMARKS
					No Sampling / Split Spoons Collected.			
2								
4								
					0-10' Cobbles - tough to drill through.			
6								
8								
10					Refusal at 24.75'			
12					5 7/8 roller bit to 29.75'. Set 4" PVC rock socket. Grout 24.75' to 29.75'.			
14								
16					Drill to 119.5' with 3 7/8 roller bit. Set 100' riser, 20' screen; no sand pack.			
18								

MALCOLM PIRNIE

TEST BORING LOG

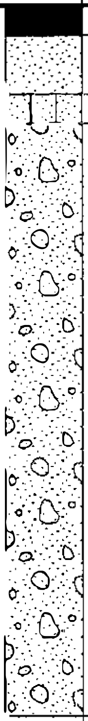
BORING No.MW-11S

PROJECT	**Friedrichsohn Cooperage**	LOCATION	**Waterford, Saratoga County, NY**	SHEET	**1** OF **1**
CLIENT	**New York State Department of Environmental Conservation**			PROJECT No.	**0266382**
DRILLING CONTRACTOR	**Buffalo Drilling**			MEAS. PT. ELEV.	
PURPOSE	**Remedial Investigation**			GROUND ELEV.	
WELL MATERIAL	**Overburden**			DATUM	

DRILLING METHOD(S)	**Rotary**		SAMPLE	CORE	CASING	DATE STARTED	**9/10/09**
DRILL RIG TYPE	**HSA**	TYPE	**split spoon**		**pvc**	DATE FINISHED	**9/10/09**
GROUND WATER DEPTH	**6.0'**	DIA.	"		**2"**	DRILLER	**Joe Gardner**
MEASURING POINT		WEIGHT	#			PIRNIE STAFF	**D. Giroux**
DATE OF MEASUREMENT		FALL	"				

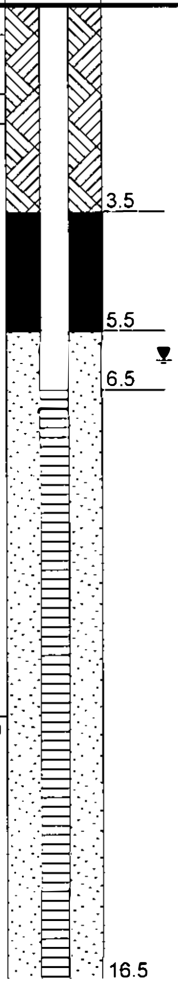
DEPTH FT.	SAMPLE TYPE, RECOVERY, NUMBER	BLOWS ON SAMPLE SPOON PER 6"	PID
0–2	.5		0
2–4	1		0
4–6	1		0
6–8	.5		0
8–10	.25		0
10–12	.25		0

GRAPHIC LOG



GEOLOGIC DESCRIPTION KEY - Color, Major, Minor Moisture, Etc.	ELEV. / DEPTH
Asphalt.	
Brown medium SAND (moist, loose).	0.5
Brown Silty SAND with gravel (moist, loose).	1.5
Brown Sandy GRAVEL to Gravelly SAND, some silt (moist to wet, loose).	2.0
	12.0
BEDROCK (shale).	

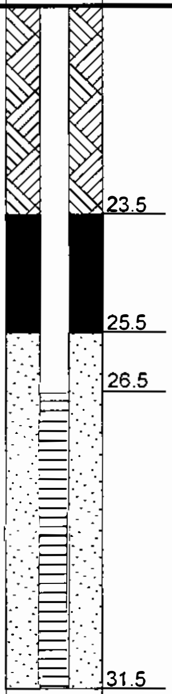
WELL Constr.



REMARKS

MALCOLM PIRNIE	TEST BORING LOG	BORING No.MW-12S
PROJECT **Friedrichsohn Cooperage**	LOCATION **Waterford, Saratoga County, NY**	SHEET **2** OF **2**
CLIENT **New York State Department of Environmental Conservation**		PROJECT No. **0266382**

DEPTH FT.	SAMPLE TYPE, RECOVERY, NUMBER	BLOWS ON SAMPLE SPOON PER 6"	PID	GRAPHIC LOG	GEOLOGIC DESCRIPTION KEY - Color, Major, Minor Moisture, Etc.	ELEV. DEPTH	WELL Constr.	REMARKS
22								
24					No recovery.	24.0		
26								
28					No Split Spoons taken below 28'.	28.0		
30								
					BEDROCK (shale).			



MALCOLM PIRNIE

TEST BORING LOG

BORING No.MW-12S

PROJECT	**Friedrichsohn Cooperage**	LOCATION	**Waterford, Saratoga County, NY**	SHEET	**1** OF **2**
CLIENT	**New York State Department of Environmental Conservation**			PROJECT No.	**0266382**
DRILLING CONTRACTOR	**Buffalo Drilling**			MEAS. PT. ELEV.	
PURPOSE	**Remedial Investigation**			GROUND ELEV.	
WELL MATERIAL	**Overburden**			DATUM	

			SAMPLE	CORE	CASING
DRILLING METHOD(S)	**Rotary**				
DRILL RIG TYPE	**HSA**	TYPE	**split spoon**		**pvc**
GROUND WATER DEPTH	**12.0'**	DIA.	"		**2"**
MEASURING POINT		WEIGHT	#		
DATE OF MEASUREMENT		FALL	"		

DATE STARTED	**9/15/09**
DATE FINISHED	**9/15/09**
DRILLER	**Joe Gardner**
PIRNIE STAFF	**D. Giroux**

DEPTH FT.	SAMPLE TYPE, RECOVERY, NUMBER	BLOWS ON SAMPLE SPOON PER 6"	PID	GRAPHIC LOG	GEOLOGIC DESCRIPTION KEY - Color, Major, Minor Moisture, Etc.	ELEV. DEPTH	WELL Constr.	REMARKS
	.5		0		Dark brown SAND with Silt and subrounded gravel (moist, loose).			
2	1		0		Brown medium SAND (moist, loose).	2.0		
4	1		0		Brown Silty SAND with gravel (moist, loose).	4.0		
6	.5		0		Brown Gravelly SAND with silt (moist, loose).	6.0		
8	0				No recovery. Rock.	8.0		
10	1		0		Brown Sandy SILT with fine gravel (moist, compact).	10.0		
					Brown Sandy, Silty fine to medium GRAVEL (moist, compact).	11.0		
12	1		0		Brown/gray Silty SAND with fine to medium subrounded gravel, trace clay (wet, loose to compact).	12.0		▼
14	1		0					
16								
18					Brown/gray Sandy GRAVEL with silt (wet, loose).	19.0		

MALCOLM PIRNIE

TEST BORING LOG

BORING No.MW-13S

PROJECT	Friedrichsohn Cooperage	LOCATION	Waterford, Saratoga County, NY	SHEET	1 OF 2
CLIENT	New York State Department of Environmental Conservation			PROJECT No.	0266382
DRILLING CONTRACTOR	Buffalo Drilling			MEAS. PT. ELEV.	
PURPOSE	Remedial Investigation			GROUND ELEV.	
WELL MATERIAL	Overburden			DATUM	

			SAMPLE	CORE	CASING		
DRILLING METHOD(S)	Rotary					DATE STARTED	9/15/09
DRILL RIG TYPE	HSA	TYPE	split spoon		pvc	DATE FINISHED	9/15/09
GROUND WATER DEPTH	16.0'	DIA.	"		2"	DRILLER	Joe Gardner
MEASURING POINT		WEIGHT	#			PIRNIE STAFF	D. Giroux
DATE OF MEASUREMENT		FALL	"				

DEPTH FT.	SAMPLE TYPE, RECOVERY, NUMBER	BLOWS ON SAMPLE SPOON PER 6"	PID	GRAPHIC LOG	GEOLOGIC DESCRIPTION KEY - Color, Major, Minor Moisture, Etc.	ELEV. / DEPTH	WELL Constr.	REMARKS
	.5		0		Dark brown medium SAND with silt (moist, loose).			
					Brown Silty SAND (moist, loose).	1.0		
2	1		0					
4	1		0					
					Brown medium SAND (moist, loose).	5.0		
6	1		0					
8	1		0					
10	.5		0					
12	1		0					
14	1		0					
16						16.0		▼
18					Split spoons every 5 ft.			

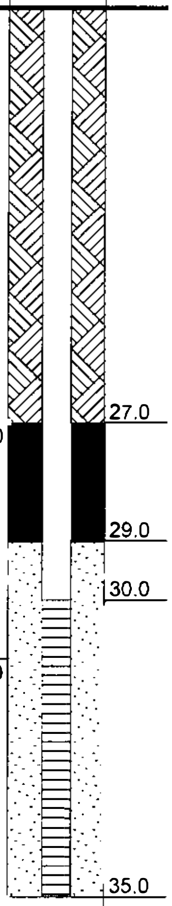
MALCOLM PIRNIE

TEST BORING LOG

BORING No.MW-13S

PROJECT	**Friedrichsohn Cooperage**	LOCATION	**Waterford, Saratoga County, NY**
SHEET	**2** OF **2**		
CLIENT	**New York State Department of Environmental Conservation**	PROJECT No.	**0266382**

DEPTH FT.	SAMPLE TYPE, RECOVERY, NUMBER	BLOWS ON SAMPLE SPOON PER 6"	PID	GRAPHIC LOG	GEOLOGIC DESCRIPTION KEY - Color, Major, Minor Moisture, Etc.	ELEV. DEPTH	WELL Constr.	REMARKS
22								
24								
26	1		0		Gray Silty SAND (wet, loose).			
						27.0		
28								
30	0.25		0		Crushed SHALE (wet, loose).			
						31.0		
32								
34								
					BEDROCK (shale).			



MALCOLM PIRNIE

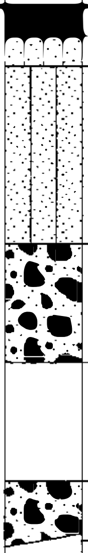
TEST BORING LOG

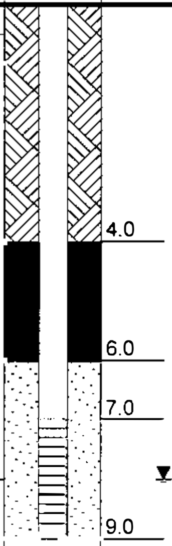
BORING No.MW-2S

PROJECT	Friedrichsohn Cooperage	LOCATION	Waterford, Saratoga County, NY	SHEET	1 OF 1
CLIENT	New York State Department of Environmental Conservation			PROJECT No.	0266382
DRILLING CONTRACTOR	Buffalo Drilling			MEAS. PT. ELEV.	
PURPOSE	Remedial Investigation			GROUND ELEV.	
WELL MATERIAL	Overburden			DATUM	

			SAMPLE	CORE	CASING		
DRILLING METHOD(S)	Rotary					DATE STARTED	9/14/09
DRILL RIG TYPE	HSA	TYPE	split spoon		pvc	DATE FINISHED	9/14/09
GROUND WATER DEPTH	8.0'	DIA.	"		2"	DRILLER	Joe Gardner
MEASURING POINT		WEIGHT	#			PIRNIE STAFF	D. Giroux
DATE OF MEASUREMENT		FALL	"				

DEPTH FT.	SAMPLE TYPE, RECOVERY, NUMBER	BLOWS ON SAMPLE SPOON PER 6"	PID	GRAPHIC LOG	GEOLOGIC DESCRIPTION KEY - Color, Major, Minor Moisture, Etc.	ELEV. DEPTH	WELL Constr.	REMARKS
					Asphalt.			
	1		0		Brown/black Sandy SILT (moist, compact).	0.5		
					Brown Silty SAND with subrounded/angular gravel (moist, compact).	1.0		
2								
	.5		0					
4					Brown Sandy subrounded/angular GRAVEL (moist, loose).	4.0	4.0	
	.25		0					
6					No recovery. Rock in split spoon shoe.	6.0	6.0	
							7.0	
	0							
8					Brown Silty, Sandy GRAVEL (wet, loose).	8.0	▼	
	.25		0					
						9.0	9.0	





APPENDIX B

LOW-FLOW PURGE AND SAMPLING METHODS EPA/540/S-95/504

United States
Environmental Protection
Agency

Office of
Research and
Development

Office of Solid Waste
and Emergency
Response

EPA/540/S-95/504
April 1996

EPA Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA Regional personnel and other environmental professionals engaged in ground-water sampling.

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I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic *units*. With time it became apparent that conventional water supply generalizations of *homogeneity* did not adequately represent field data regarding pollution of these subsurface resources. The important role of *heterogeneity* became increasingly clear not only in geologic terms, but also in terms of complex physical,

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[2] *University of Michigan*

Superfund Technology Support Center for Ground Water

National Risk Management Research Laboratory
Subsurface Protection and Remediation Division
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Technology Innovation Office
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Walter W. Kovalick, Jr., Ph.D.
Director

chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and *aquitards* or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-weter sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g., 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al., 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third *phase* as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al., 1990; McCarthy and Degueldre, 1993; Backhus et al., 1993; U. S. EPA, 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small so that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the *total* mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias *naturally* suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g., metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al., 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic *push* technologies (e.g., cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance, then some information regarding plume delineation in three-dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mantioned above and large drilling rigs. Detailed information on ground-water flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques is also recommended. With this information (together with other site characterization data) and a clear understanding of sampling objectives, then appropriate location, screen length, well diameter, slot size, etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQOs)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with *hybrid* variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objectives.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term *representativeness* applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

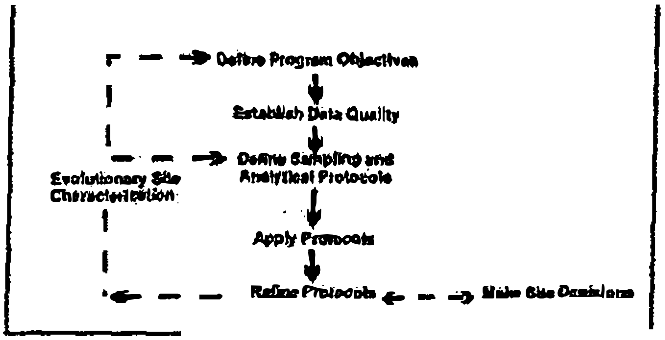

Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator-dependent methods) and the need to control avoidable errors.

1) Questions of Scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e., aquifer) and chemical properties over time or space are not statistically independent. In fact, samples taken in close proximity (i.e., within distances of a few meters) or within short time periods (i.e., more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g., monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these *over-sampling* concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g., wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore, the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases *well-point* diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that *short* (e.g., less than 1.6 m) screens be incorporated into the monitoring design where possible so that comparable results from one device to another might be expected. *Short*, of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g., auger, rotary, etc.) are generally considered to cause more disturbance than *direct-push* technologies. In either case, there may be a period (i.e., days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality *recovery* period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging and Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions is important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval, most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally, the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependant variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (i.e., dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the *mobile* load of contaminants present (dissolved and colloid-associated);
- minimal disturbance of the sampling point thereby minimizing sampling artifacts;
- less operator variability, greater operator control;

- reduced stress on the formation (minimal drawdown);
- less mixing of stagnant casing water with formation water;
- reduced need for filtration and, therefore, less time required for sampling;
- smaller purging volume which decreases waste disposal costs and sampling time;
- better sample consistency; reduced artificial sample variability.

Some disadvantages of low-flow purging are:

- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a *change in conditions* and trigger an *action*.

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground-water sampling procedure has evolved over many years of experience in ground-water sampling for organic and inorganic compound determinations and as such summarizes the authors' (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground-water monitoring and site characterization. The primary limitations to the collection of *representative* ground-water samples include: mixing of the stagnant casing and *fresh* screen waters during insertion of the sampling device or ground-water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device, etc.

A. *Sampling Recommendations*

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground-water flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g., flow-through cell) be used to establish the stabilization time for several parameters (e.g., pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:

- use low-flow rates (<0.5 L/min), during both purging and sampling to maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. *Equipment Calibration*

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacturer's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. *Water Level Measurement and Monitoring*

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed relative to ground elevation.

D. *Pump Type*

The use of low-flow (e.g., 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of *low* flow rates (i.e., < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause *significant* drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages and Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-driven pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other *grab* type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of *stagnant* water in the casing and the *dynamic* water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tends to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al. (1991), U. S. EPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over any other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g., 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a *fix* for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally *dissolved* [i.e., samples filtered with 0.45 µm filters]) concentrations of major ions and trace metals, 0.1 µm filters are recommended although 0.45 µm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and, therefore, affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 µm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should be continuously monitored during purging. The water quality indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, FSP, RCRA guidance document [U. S. EPA, 1992] or EPA SW-846 [U. S. EPA, 1982]). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon™ (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the FSP. The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g., clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected; i.e., a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e., two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water-bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (U. S. EPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

VII. Notice

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Figure 2. **Ground Water Sampling Log**

Project ______________ **Site** ______________ **Well No.** ____________ **Date** ____________________
Well Depth ____________ **Screen Length** __________ **Well Diameter** ________ **Casing Type** ____________
Sampling Device ______________ **Tubing type** ____________________ **Water Level** ______________
Measuring Point ________________ **Other Infor** ____
____

Sampling Personnel ____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc			Notes

Type of Samples Collected

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: Vol$_{cyl} = \pi r^2 h$, **Vol**$_{sphere} = 4/3\pi\ r^3$

Figure 3. **Ground Water Sampling Log** (with automatic data logging for most water quality parameters)

Project ____________ **Site** ____________ **Well No.** ____________ **Date** ____________

Well Depth ____________ **Screen Length** ____________ **Well Diameter** ____________ **Casing Type** ____________

Sampling Device ____________ **Tubing type** ____________ **Water Level** ____________

Measuring Point ____________ **Other Infor** ____________

____

Sampling Personnel ____

Time	Pump Rate	Turbidity	Alkalinity	[ ] Conc	Notes

Type of Samples Collected

____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

APPENDIX C

QUALITY ASSURANCE PROJECT PLAN

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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) presents the policies, organization, objectives, functional activities, and Quality Assurance (QA) and Quality Control (QC) activities designed to achieve the specific data quality goals associated with the Remedial Design/Remedial Action (RD/RA) and Groundwater Monitoring Plan (GWMP) for the Friedrichsohn Cooperage inactive hazardous waste site (the Site) located at 153-155 Saratoga Avenue in the Town of Waterford, New York. The RD/RA includes both the OU-1 and OU-3 upland areas and the OU-3 sediment. RD/RA work plans for the OU-1 and OU-3 Source Areas will be submitted separately from the RD/RA OU-3 Sediment work plan. This QAPP is intended to cover all sample collection activities for both RD/RA Work Plans and the Groundwater Monitoring Plan. This QAPP has been prepared in accordance with the following documents:

1) United States Environmental Protection Agency (USEPA) "Preparation Aids for the Development of Category III Quality Assurance Project Plans", EPA/600/8-91-005, February 1991.
2) New York State Department of Environmental Conservation (NYSDEC) Division of Hazardous Substance Regulation "RCRA Quality Assurance Project Plan Guidance", March 29, 1991
3) NYSDEC's "DER-10 Technical Guidance for Site Investigation and Remediation", May 3, 2010.

The objectives of the QAPP are to provide sufficiently thorough and concise descriptions of the measures to be applied during the RD/RA and groundwater monitoring programs such that the data generated will be of a known and acceptable level of precision and accuracy. The QAPP has been prepared to identify procedures for sample preparation and handling, sample chain-of-custody, laboratory sample analyses, and laboratory data reporting to be implemented during the remedial field activities to ensure the accuracy and integrity of the data generated.

Protocols for the collection of samples are presented in the Work Plans.

2.0 PROJECT DESCRIPTION

2.1 GENERAL

The objective is to satisfy the requirements of the Consent Order A5-0784-1202 (Order) executed on January 28, 2013 between NYSDEC and Respondents (General Electric Company and SI Group, Inc.).

The activities for the RD/RA and groundwater monitoring programs include the following:

- Predesign data collection including soil, sediment and groundwater sampling and analyses
- Routine groundwater monitoring for OU-2
- Active remediation including excavation of impacted soils and sediment
- Off-site transport and disposal of impacted soils and sediment
- Verification sampling following excavation
- Backfilling with clean imported soil
- Site restoration

2.2 SITE BACKGROUND

The Site location, description, and history are detailed in the Remedial Design/Remedial Action (RD/RA) Work Plan and the Groundwater Monitoring Plan.

3.0 PROJECT MANAGEMENT

The project management structure for QA/QC activities associated with the RD/RA and the groundwater monitoring program is discussed below, along with a brief description of the duties of the key personnel.

Patrick Rabideau/John Uruskyj - Project Manager

- Provides overall project management
- Participates in negotiations with the agencies involved
- Provides guidance to CRA's Project Manager

CRA Project Manager - Jamie Puskas

- Ensures professional services provided are cost effective and of the highest quality
- Ensures necessary resources are available on an as-required basis
- Participates in key technical negotiations with the agencies involved
- Provides managerial and technical guidance to the Project Engineer

CRA Design Coordinator - Jeff Daniel

- Provides day-to-day project management
- Provides managerial guidance to the project technical group
- Provides technical representation at meetings as appropriate
- Acts as liaison between the technical group and the client
- Acts as liaison with the agencies involved
- Prepares and reviews reports
- Conducts preliminary chemical data interpretation

CRA Quality Assurance/Quality Control Officer - Analytical Activities - Susan Scrocchi

- Overviews and reviews laboratory activities
- Determines laboratory data corrective action
- Performs analytical data validation and assessment
- Reviews laboratory QA/QC
- Assists in preparation and review of final report
- Provides technical representation for analytical activities

Quality Assurance/Quality Control Officer - Field Activities

- Provides immediate supervision of on-Site activities
- Provides field management of sample collection and field QA/QC
- Assists in preparation and review of final report
- Provides technical representation for field activities
- Is responsible for maintenance of the field equipment

Quality Assurance/Quality Control Site Coordinator - Field Activities

- The individual designated to be Site Coordinator will be specified prior to commencement of field activities
- Provides support to QA/QC Officer
- Conducts sample collection consistent with FSP and QAPP
- Manages subcontractors as directed by the QA/QC Officer

Laboratory Project Manager, Analytical Subcontractor

- Ensures resources of laboratory are available on an as-required basis
- Coordinates laboratory analyses
- Supervises laboratory's in-house chain of custody
- Schedules analyses of samples
- Oversees review of data
- Oversees preparation of analytical reports
- Approves final analytical reports prior to submission to CRA's QA/QC Officer

Laboratory Quality Assurance/Quality Control Officer, Analytical Subcontractor

- Overviews laboratory QA/QC
- Overviews QA/QC documentation
- Conducts detailed data review
- Decides laboratory corrective actions, if required
- Provides technical representation for laboratory QA/QC procedures

Laboratory Sample Custodian - Analytical Subcontractor

- Receives and inspects the sample containers
- Records the condition of the sample containers
- Signs appropriate documents

- Verifies chains of custody and their correctness
- Notifies laboratory project manager and laboratory QA/QC officer of sample receipt and inspection
- Assigns a unique laboratory identification number correlated to the field sample identification number, and enters each into the sample receiving log
- Initiates transfer of the samples to the appropriate lab sections with assistance from the laboratory project manager
- Controls and monitors access to and storage of samples and extracts

Primary responsibility for data quality rests with the QA/QC Officers. Ultimate responsibility for project quality rests with CRA's Project Manager. Independent QA will be provided by the laboratory's Project Manager and QA/QC Officer prior to release of the data to CRA.

The analytical laboratory chosen to perform the analyses will be certified by the New York State Department of Health (NYSDOH) through the environmental laboratory approval program for the appropriate categories of analysis. The name of the analytical laboratory and the laboratory QA/QC manual will be submitted to NYSDEC for review and approval prior to sample collection.

4.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective is to develop and implement procedures for sample collection and analyses of groundwater, soil and sediment which will provide data with an acceptable level of accuracy and precision.

The purpose of this Section is to define the QA goals required to meet the Data Quality Objectives (DQOs) of the project. QA goals for accuracy, precision, and sensitivity of analyses; and completeness, representativeness, and comparability of measurement data are established in the following sections.

The sampling and analysis program is summarized in Table 4.1.

4.1 LEVEL OF QA EFFORT

To assess the quality of data resulting from the field sampling program, field duplicate samples, field blank samples, samples for laboratory matrix spike/matrix spike duplicate (MS/MSD) analyses, trip blanks, and rinsate blank samples will be collected (where appropriate) and submitted to the contract laboratory.

For all field samples collected, field duplicate samples will be submitted at a frequency of one per 20 samples or in the event that a sampling round consists of less than 20 samples, one field duplicate will be collected. MS/MSD samples will be analyzed at a minimum frequency of one per 20 field samples. Rinsate blanks will be submitted at a frequency of one per 20 samples in the event that non-dedicated sampling equipment is used. Trip blanks will be submitted with each cooler containing aqueous samples for volatile organic compound (VOC) analyses.

The sampling and analysis program summarized in Table 4.1 lists the specific parameters to be measured, the number of samples to be collected and the level of QA effort required for each matrix.

Groundwaters, soil and sediment will be analyzed for VOCs, semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs) and metals. Sediment samples may also be analyzed for Total Organic Carbon (TOC). Some soil samples may also be analyzed for waste characterization.

Target quantitation limits for compounds to be tested are presented in Tables 4.2 and 4.3. TCLP regulatory limits and analytes to be tested are presented in Table 4.4.

MS and MSD samples will be analyzed as a check on the analytical method's accuracy and precision. Trip blank samples (for VOC determinations only) will be shipped by the laboratory to the Site and back to the laboratory without opening in the field. The trip blank will provide a measure of potential cross-contamination of samples resulting from shipment, handling and/or ambient conditions at the Site. Rinsate blank samples will be collected and analyzed as a check on the efficiency of the sampling device cleansing protocols.

4.2 ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSES

The fundamental QA objective with respect to the accuracy, precision and sensitivity of analytical data is to meet the QC acceptance criteria of each analytical protocol. Laboratory analytical parameters and methods are listed in Table 4.1 and target quantitation limits are listed in Tables 4.2 and 4.3.

The method accuracy (percent recovery) for groundwater, soil and sediment samples will be determined by spiking selected samples (matrix spikes) with representative spiking compounds as specified in the analytical methods. Accuracy will be reported as the percent recovery of the spiking compounds and will be compared to the criteria specified in the appropriate methods as identified in Section 8.0.

The precision of the methods (reproducibility between duplicate analyses) will be determined based on the analysis of field duplicate samples and the duplicate analysis of MS samples. Precision will be reported as relative percent differences (RPDs) between duplicate analyses; acceptance criteria will be as specified in the appropriate analytical methods identified in Section 8.0.

4.3 COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY

A completeness requirement of 90 percent will be targeted for the RD/RA and the GWMP work (see Section 13.1.3 for a definition of completeness).

The quantity of samples to be collected has been determined in an effort to effectively represent the population being studied.

Analytical methods selected for this study are consistent with those used for previous studies (if applicable) to assure comparability of the data. All standards used by the laboratory will be traceable to reliable sources and will be checked with an independent standard.

5.0 SAMPLING PROCEDURES

All monitoring and sampling activities will be performed in accordance with the FSP and the Groundwater Monitoring Plan.

Sampling equipment will be decontaminated as specified in the FSP. Required sample containers, sample preservation methods, maximum holding times, and filling instructions are summarized in Table 5.1. Sample containers will be purchased from a USEPA-certified manufacturer and will be precleaned (I-Chem Series 200 or equivalent).

6.0 SAMPLE CUSTODY AND DOCUMENT CONTROL

The following documentation procedures will be used during sampling and analysis to provide chain-of-custody control during transfer of samples from collection through storage and analysis. Record keeping documentation will include use of the following:

- Field log books (bound with numbered pages) to document sampling activities in the field
- Labels to identify individual samples
- Chain-of-custody record sheets to document sample IDs and analyses to be performed
- Laboratory sample custody log books
- Evidentiary files

6.1 FIELD LOG BOOK

Log books will be used in the field to record information. The field log book will be bound and the information will be entered in indelible ink. Each field log book page will be signed by the sampler. Field measurements and observations will assist in the interpretation of analytical results obtained and it is important that these measurements and observations be as complete as possible.

For each sample collected, the following will be recorded in indelible ink in the field log book if applicable:

i) Site location identification
ii) Depth interval of sample
iii) Unique sample identification number
iv) Date and time (in 24:00-hour time format) of sample collection
v) Weather conditions
vi) Designation as to the type of sample (groundwater, soil, sediment, etc.)
vii) Designation as to the means of collection (split spoon, etc.)
viii) Brief description of the sample
ix) Name of sampler
x) Analyses to be performed on sample

xi) Departure from established QA/QC field procedures
xii) Instrument problems
xiii) Other relevant comments such as odor, staining, texture, size of area sampled, etc.

6.2 SAMPLE LABELS

Sample labels are necessary to identify and prevent misidentification of the samples. The labels will be affixed to the sample container (not the caps) prior to the time of sampling. The labels will be filled out in waterproof ink at the time of collection. The labels will include the following information:

i) Sample number/identification code
ii) Name of collector
iii) Date and time of collection
iv) client and geographic location
v) Project number
vi) Required analysis
vii) Type of preservation

A unique sample numbering system will be used to identify each collected sample. This system will provide a tracking number to allow retrieval and cross-referencing of sample information. The sample numbering system to be used is described as follows:

Example: GW-80987-110513 - AA-XXX
where: GW - Designates sample type
(GW - Groundwater, SE - Sediment, S - Soil)
80987 - ID number unique to the project site
110513 - date of collection (mm,dd,yy)
AA - sampler initials
xxx - unique sample number

QC samples will also be numbered with a unique sample number.

Sample container labels will include sample number, place of collection, and date and time of collection.

6.3 FIELD INSTRUMENT CALIBRATION AND USE LOGS

Standardized instrument calibration logs for each field instrument will be maintained during sampling activities to demonstrate properly functioning equipment. Included in the log should be documentation of time of instrument use, operator, and any maintenance performed.

6.4 CHAIN-OF-CUSTODY RECORDS

Chain-of-custody forms will be completed for samples collected during the program. chain-of-custody forms will be completed to document the transfer of sample containers.

The chain-of-custody record, completed at the time of sampling, will contain, but not be limited to, the sample number, date, and time of sampling, and the name of the sampler. The chain-of-custody document will be signed, timed, and dated by the sampler when transferring the samples.

The chain-of-custody form will consist of four copies which will be distributed to the shipper, the receiving laboratory, and two copies to CRA. The shipper will keep one copy while the other three copies will be enclosed in a waterproof envelope within the cooler with the samples. The laboratory, upon receiving the samples, will complete the three remaining copies. The laboratory will maintain one copy for their records; one copy will be returned to CRA upon receipt of the samples by the laboratory; one copy will be submitted to CRA with the data deliverables package.

6.5 SAMPLE SHIPMENT

All samples will be refrigerated using wet ice at <6°C. Custody seals will be placed around each cooler and the coolers will then be sealed with packing tape for shipment to the analytical laboratory within 24 to 48 hours of collection by either commercial courier or Subcontractor personnel.

6.6 LABORATORY SAMPLE CUSTODY LOG BOOKS

Upon receipt of the sample coolers at the laboratory, each sample cooler and the custody seal will be inspected by the designated sample custodian. The condition of the cooler and the custody seal will be noted on the chain-of-custody record sheet by the sample custodian.

The sample custodian will record the temperature of one sample (or temperature blank) from each cooler and the temperature will be noted on the chain-of-custody. If the shipping cooler seal is intact, the sample containers will be accepted for analyses. The sample custodian will document the date and time of receipt of the container, and sign the form.

If damage or discrepancies are noticed (including sample temperature exceedances), they will be recorded in the remarks column of the record sheet, dated and signed. Any damage or discrepancies will be reported to the lab supervisor who will inform the lab manager and QA Officer before samples are processed.

6.7 EVIDENTIARY FILES

The laboratory will be responsible for maintaining analytical log books and laboratory data as well as a sample (on hand) inventory for submittal to CRA on an as-required basis. Raw laboratory data produced from the analysis of samples submitted for this program will be inventoried and maintained by the laboratory for a period of 5 years at which time CRA will advise the laboratory regarding the need for additional storage.

Evidentiary files for the entire project will be inventoried and maintained by CRA and will consist of the following:

i) Project-related plans
ii) Project log books
iii) Field data records
iv) Sample identification documents
v) Chain-of-custody records
vi) Report notes, calculations, etc.
vii) Laboratory data, etc.
viii) References, copies of pertinent literature

ix) Miscellaneous - photos, maps, drawings, etc.

x) Copies of final reports pertaining to the project

The evidentiary file materials will be the responsibility of CRA's Project Manager with respect to maintenance and document removal.

7.0 CALIBRATION PROCEDURES AND FREQUENCY

7.1 INSTRUMENT CALIBRATION AND TUNING

Calibration of instrumentation is required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet established reporting limits. Each instrument is calibrated with standard solutions appropriate to the type of instrument and the linear range established for the analytical method. The frequency of calibration and the concentration of calibration standards is determined by the manufacturers' guidelines, the analytical method, or the requirements of special contracts.

A bound notebook will be kept with each instrument requiring calibration in which will be recorded activities associated with QA monitoring and repairs programs. These records will be checked during periodic equipment review and internal and external QA/QC audits.

7.1.1 GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)

It is necessary to establish that a given GC/MS meets the standard mass spectral abundance criteria prior to initiating any ongoing sample analyses and data collection. This is accomplished through the analyses of tuning compounds as specified in the analytical methods.

Calibration of the GC/MS system will be performed daily at the beginning of the day or with each 12 hours of instrument operating time when more than 12 hours of instrument operating time is needed in 1 day.

All method-specified calibration criteria will be met prior to sample analyses. All calibrations will be performed using either average response factors or first-order linear regression (with a correlation coefficient requirement of 0.995). Higher order fits will not be allowed unless the laboratory can demonstrate that the instrument is working properly, and that the instrument response over the concentration range of interest is second-order.

Quantification of samples that are analyzed by GC/MS will be performed by internal standard calibration. For quantitation, the nearest internal standard **free of interferences** will be used.

7.1.2 GAS CHROMATOGRAPHY (GC)

Quantification for samples that are analyzed by GC with element selective detectors will be performed by external standard calibration. Standards containing the compounds of interest will be analyzed at a minimum of three concentrations to establish the linear range of the detector. Single point calibration will be performed at the beginning of each day and at every tenth injection. The response factors from the single point calibration will be checked against the average response factors from multi-level calibration. If deviations in response factors are greater than those allowed by the analytical method protocols, then system recalibration will be performed. Alternatively, fresh calibration standards will be prepared and analyzed to verify instrument calibration.

All method-specified calibration criteria will be met prior to sample analyses. All calibrations will be performed using either average response factors or first-order linear regression (with a correlation coefficient requirement of 0.995). Higher order fits will not be allowed unless the laboratory can demonstrate that the instrument is working properly, and that the instrument response over the concentration range of interest is second-order.

7.1.3 INSTRUMENTATION FOR INORGANIC ANALYSES

All method-specified calibration procedures will be performed and acceptance criteria will be met prior to sample analyses. Standard curves derived from data consisting of one reagent blank and a minimum of three concentrations [one reagent blank and one concentration for ion coupled plasma (ICP)] will be prepared for each inorganic analyte. Calibrations will be performed using either average response factors, or first-order linear regression (with a correlation coefficient requirement of 0.995).

The standard curve will be used with each subsequent analysis provided the standard curve is verified by using at least one reagent blank and one standard at a level normally encountered or expected in such samples. If the results of the verification are not within ±10 percent of the original curve, a new standard will be prepared and analyzed. If the results of the second verification are not within ±10 percent of the original standard curve, the analysis will be stopped, and the analyst will reject any data obtained after the last acceptable verification standard. A reference standard will be used to determine if the discrepancy is with the standard or with the instrument. Once the cause is identified, a new calibration curve will be performed before sample analyses can continue.

New standards will also be prepared on a quarterly basis at a minimum. All data used in drawing or describing the curve will be so indicated on the curve or its description. A record will be made of the verification.

7.1.4 FIELD INSTRUMENTATION

Field equipment used during the RD/RA or groundwater monitoring program will be calibrated both prior to and following the day's utilization in accordance with the manufacturer's instructions. The equipment will also be operated in accordance with the manufacturer's instructions. Records of calibrations of field equipment will be recorded in a bound field notebook.

8.0 ANALYTICAL PROCEDURES

8.1 ANALYTICAL METHODS

All groundwater, soil and sediment samples will be analyzed for the parameters listed in Tables 4.2,4.3 and 4.4 using the methods cited in Table 4.1. These methods have been selected to meet the DQOs for each sampling activity.

Data deliverables for this program will be as specified in Section 9.2.

8.2 COMPOUND IDENTIFICATION

Compounds which will be analyzed by GC/MS will be identified by comparison of the sample mass spectrum with the mass spectrum of a standard of the suspected compound (standard reference spectrum). Mass spectra for standard references should be obtained on the user's GC/MS within the same 12 hours as the sample analysis. These standard reference spectra may be obtained through analysis of the calibration standards. The following criteria will be satisfied to verify identification:

i) Elution of the sample component at the same GC relative retention time (RRT) as the standard component

ii) Correspondence of the sample component and the standard component mass spectrum

For GC determinations of specific analytes, the RRT of the unknown will be compared with that of an authentic standard. Since a true identification by GC is not possible, an analytical run for compound confirmation will be followed according to the specifications in the methods. Peaks will elute within daily retention time windows established for each indicator parameter to be declared a tentative or confirmed identification. Retention time windows are determined using standard protocols defined in each method.

8.3 QUANTITATION

The procedures for quantitation of analytes are discussed in the appropriate analytical methods. Sample results are calculated using either an external standard or an internal standard technique. External standard techniques directly compare the response from the sample to the response of the target analyte in the calibration standards. Internal standard technique utilizes the addition of a compound that resembles the target compound but is not commonly found in nature. This compound is added to all standards, samples, and QC samples. Quantitation is based on the ratio of the target compound in the sample to the response of the internal standard in the sample compared to a similar ratio derived for each calibration standard.

8.4 QUANTITATION LIMIT REQUIREMENTS

Targeted quantitation limits will be consistent with those presented in Tables 4.2 and 4.3. When matrix interferences are noted during sample analysis, actions will be taken by the laboratory to achieve the specified quantitation limits. Samples will not be diluted by more than a factor of five to reduce matrix effects. The laboratory will re-extract and/or use any of the cleanup techniques presented in the analytical methods to eliminate matrix interferences.

Samples may be diluted to a greater extent if the concentrations of analytes of concern exceed the calibration range of the instrument. In such cases, the laboratory QA/QC Officer will assure that the laboratory demonstrates good analytical practices and that such practices are documented in order to achieve the specified quantitation limits.

Soil and sediment results will be reported based on dry weight. The dry weight conversion will raise the targeted quantitation limit.

9.0 DATA REDUCTION, VALIDATION, ASSESSMENT, AND REPORTING

9.1 GENERAL

The contract laboratory will perform analytical data reduction and validation in-house under the direction of the laboratory QA Officer. The laboratory's QA Officer will be responsible for assessing data quality and advising of any data which were rated "preliminary" or "unacceptable" or other qualifications based on the QC criteria outlined in the analytical methods, which would caution the data user of possible unreliability. Data reduction, validation, and reporting by the laboratory will be conducted as detailed in the following:

- Raw data produced and checked by the responsible analysts is turned over for independent review by another analyst
- The area supervisor reviews the data for attainment of quality control criteria presented in the referenced analytical methods
- Upon completion of reviews and acceptance of the raw data by the laboratory operations manager, a computerized report will be generated and sent to the laboratory QA Officer
- The laboratory QA Officer will complete a thorough inspection of reports
- The laboratory QA officer and area supervisor will decide whether any sample reanalysis is required
- Upon acceptance of the preliminary reports by the laboratory QA officer, final reports will be generated and signed by the laboratory Project Manager

Validation of the analytical data pertaining to the monitoring wells will be performed by CRA's QA/QC Officer for analytical activities. The data validation will be performed utilizing guidance contained in the following documents: "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review", EPA 540/R-08-01, June 2008 and "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review", EPA 540/R-10-011, January 2010. Data analyzed using methods not covered in these documents will be validated using the general principles used in these documents, and the analytical requirements specified in the methods.

Assessment of analytical and in-house data will include checks on data consistency by looking for comparability of duplicate analyses, comparability to previous data from the same sampling location (if available), adherence to accuracy and precision control criteria detailed in this QAPP and anomalously high or low parameter values. Verification of 100 percent of QC sample results (both qualitative and quantitative) will be performed. Verification of the identification of 100 percent of sample results (both positive hits and non-detects) will be performed and 10 percent of investigative sample results will be recalculated.

A Data Usability Summary Report (DUSR) will be prepared and will present the results of the data validation, including a summary assessment of laboratory data packages, sample preservation and chain-of-custody procedures, and a summary assessment of precision, accuracy, representativeness, comparability, and completeness for each analytical method. The DUSR will be submitted to CRA's Project Manager.

Data from field measurements and sample collection activities that are used in project reports will be appropriately identified and appended to the report. Where data have been reduced or summarized, the method of reduction will be documented in the report. Field data will be audited for anomalously high or low values that may appear to be inconsistent with other data.

The qualifications of CRA's QA/QC Officer are presented in Attachment A.

9.2 LABORATORY REPORTING

Reporting and deliverables will be in accordance with NYSDEC Analytical Services Protocol (ASP) Category B. The minimum deliverables required by the laboratory are summarized in Table 9.1. Reporting and deliverables for waste characterization samples (Toxicity Characteristic Leaching Procedure [TCLP] and Resource Conservation and Recovery Act [RCRA] analyses) shall include, but not be limited to, all items listed in Table 9.2. The laboratory will also include an electronic data deliverable in EQuis 4-file format.

All sample data and corresponding QA/QC data as specified in the analytical methods will be maintained accessible to CRA either in hard copy or on magnetic tape or disk.

10.0 INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

10.1 QC FOR FIELD MEASUREMENTS

Quality control procedures for field measurements will be limited to a check of the reproducibility of the measurement in the field by obtaining multiple readings and by calibrating the instrument (where appropriate).

10.2 QC FOR LABORATORY ANALYSES

Specific procedures related to internal laboratory QC samples are described in the following subsections.

10.2.1 REAGENT BLANKS

A reagent blank will be analyzed by the laboratory at a frequency of one blank per analytical batch. The reagent blank, an aliquot of analyte-free water or solvent, will be carried through the entire analytical procedure.

10.2.2 MS/MSD ANALYSES

An MS/MSD sample will be analyzed for all methods at the frequency specified in Table 4.1. Acceptable criteria and analytes that will be used for matrix spikes are identified in the analytical methods. Percent spike recoveries will be used to evaluate analytical accuracy while percent relative standard deviation or the relative percent difference (RPD) between duplicate analyses will be used to assess analytical precision.

10.2.3 SURROGATE ANALYSES

Surrogates are organic compounds which are similar to the analytes of interest, but which are not normally found in environmental samples. Surrogates are added to samples to monitor the effect of the matrix on the accuracy of the analysis. Every blank, standard and environmental sample analyzed by GC or GC/MS, including MS/MSD samples, will be spiked with surrogate compounds prior to sample preparation.

The compounds that will be used as surrogates and the levels of recommended spiking are specified in the methods. Surrogate spike recoveries will fall within the control limits specified in the analytical methods. If surrogate recoveries are excessively low (<10 percent), the laboratory will contact CRA's QA/QC Officer for further instructions.

Dilution of samples to bring the analyte concentration into the linear range of calibration may dilute the surrogates out of the quantitation limit. Reanalysis of these samples is not required. Assessment of analytical quality in these cases will be based on the MS/MSD sample analysis results.

10.2.4 LCS SAMPLES

LCS samples (also known as QC Check Samples) will be analyzed to determine the accuracy of the analytical methods. LCS samples generally are prepared from standards that are from a different source than the calibration standards or are standard reference materials. The percent recoveries will be calculated and compared to the acceptance criteria. In most cases, sample analyses cannot proceed if the LCS acceptance criteria is not achieved. Corrective actions for outlying LCS data will be consistent with those specified in the methods.

10.3 QC FOR SAMPLING PROTOCOL

To assess the quality of data resulting from the field sampling program, field duplicate and field blank samples will be collected (where appropriate) and submitted to the analytical laboratory as samples.

10.3.1 FIELD DUPLICATE SAMPLES

Field duplicate samples will be collected at the frequency of one per 20 samples. These samples will be submitted "blind" to the laboratory for analysis, the results will be compared, and RPD values will be assessed against control limits of 50 percent for water samples and 100 percent for soil samples.

10.3.2 FIELD BLANK SAMPLES

Trip blanks for VOCs will be prepared by the laboratory using analyte-free water and submitted with the sample collection containers. The trip blanks will be kept unopened in the field with sample bottles. One trip blank will be transported to the laboratory with each cooler of aqueous VOC samples. The laboratory will analyze trip blanks as samples.

Rinsate blanks will be used to assess decontamination procedures of collection equipment used for multiple samples. The rinse blank will be prepared using analyte-free deionized water when non-dedicated equipment is used in the field. The rinse blanks will be analyzed by the laboratory as samples. Rinse blanks will be prepared at the frequency of one per 20 samples in the event that non-dedicated sampling equipment is used.

11.0 PERFORMANCE AND SYSTEM AUDITS AND FREQUENCY

11.1 LABORATORY

For the purpose of external evaluation, performance evaluation check samples are analyzed periodically by the laboratory. Internally, the evaluation of data from these samples is done on a continuing basis over the duration of a given project.

CRA's QA/QC Officer may carry out performance and/or systems audits to insure that data of known and defensible quality are consistently produced during this program.

Systems audits are qualitative evaluations of all components of field and laboratory quality control measurement systems. They determine if the measurement systems are being used appropriately. The audits may be carried out before systems are operational, during the program, or after completion of the program. Such audits typically involve a comparison of the activities given in the laboratory's QA/QC plan described herein, with activities actually scheduled or performed. A special type of systems audit is the data management audit. This audit addresses only data collection and management activities.

The performance audit is a quantitative evaluation of the measurement systems used for a monitoring program. It requires testing the measurement systems with samples of known composition or behavior to quantitatively evaluate precision and accuracy. A performance audit may be carried out by or under the auspices of the laboratory's QA/QC Officer without the knowledge of the analyst during each sampling event for this program.

It should be noted, however, that any additional external QA audits will only be performed if deemed necessary.

11.2 FIELD

Audits of field techniques will be conducted by CRA's Field QA/QC Officer. These audits will include review of the sample collection and instrument calibration logbooks and chain-of-custody documents. Field inspections will also be performed to review: sample collection and handling techniques; on-Site supplies of sampling equipment and standards availability of relevant project documents.

12.0 PREVENTIVE MAINTENANCE

Analytical instruments to be used in this project will be serviced by laboratory personnel at regularly scheduled intervals in accordance with the manufacturers' recommendations. Instruments may also be serviced at other times due to failure. Requisite servicing beyond the abilities of laboratory personnel will be performed by the equipment manufacturer or their designated representative.

Daily checks of each instrument will be performed by the analyst who has been assigned responsibility for that instrument. Manufacturers' recommended procedures will be followed in every case.

Maintenance procedures and schedules and instrument logbooks will be documented in bound notebooks and made available to CRA's project QA/QC Officer upon request.

13.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

13.1 QA MEASUREMENT QUALITY INDICATORS

13.1.1 PRECISION

Precision will be assessed by comparing the analytical results between duplicate spike or duplicate sample analyses. Precision as RPD will be calculated as follows for values significantly greater than the associated detection limit:

Matrix Spike/Matrix Spike Duplicate

$$\text{Precision} = \frac{\{D_2 - D_1\}}{\{D_1 + D_2/2\}} \times 100$$

D_1 = matrix spike recovery
D_2 = matrix spike duplicate recovery

Sample Duplicates

$$\text{Precision} = \frac{\{D_2 - D_1\}}{\{D_1 + D_2/2\}} \times 100$$

D_1 = original sample result
D_2 = duplicate sample result

For results near the associated detection limits, precision will be assessed based on the following criteria:

Precision = original result - duplicate result <Contract Required Detection Limits (CRDL)

13.1.2 ACCURACY

Accuracy will be assessed by comparing a set of analytical results to the accepted or "true" values that would be expected. In general, MS/MSD and check sample recoveries will be used to assess accuracy. Accuracy as percent recovery will be calculated as follows:

$$\text{Accuracy} = \frac{A-B}{C} \times 100$$

A = The analyte determined experimentally from the spike sample
B = The background level determined by a separate analysis of the unspiked sample
C = The amount of spike added

13.1.3 COMPLETENESS

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under normal conditions.

To be considered complete, the data set will contain QC check analyses verifying precision and accuracy for the analytical protocol. In addition, data are reviewed in terms of stated goals in order to determine if the database is sufficient.

When possible, the percent completeness for each set of samples will be calculated as follows:

$$\text{Completeness} = \frac{\text{valid data obtained}}{\text{total data planned}} \times 100 \text{ percent}$$

13.1.4 EXCEEDANCES

Procedures discussed previously will be followed for documenting deviations. In the event that a result deviates significantly from method established control limits, this deviation will be noted and its effect on the quality of the remaining data assessed and documented.

14.0 CORRECTIVE ACTION

The need for corrective action may be identified by system or performance audits or by standard QC procedures. The essential steps in the corrective action system will be:

- Checking the predetermined limits for data acceptability beyond which corrective action is required
- Identifying and defining problems
- Assigning responsibility for investigating the problem
- Investigating and determining the cause of the problem
- Determination of a corrective action to eliminate the problem (this may include reanalysis or resampling and analyses)
- Assigning and accepting responsibility for implementing the corrective action
- Implementing the corrective action and evaluating the effectiveness
- Verifying that the corrective action has eliminated the problem
- Documenting the corrective action taken

For each measurement system, the laboratory QA Officer will be responsible for initiating the corrective action and the laboratory supervisor will be responsible for implementing the corrective action.

15.0 QUALITY ASSURANCE REPORT TO MANAGEMENT

The CRA QA/QC Officer will receive reports on the performance of the measurement system and the data quality following each sampling round and at the conclusion of the project.

Minimally, these reports will include:

- Assessment of measurement quality indicator (i.e., data accuracy, precision, and completeness);
- Results of system audits
- QA problems and recommended solutions.

CRA's QA/QC Officer will be responsible within the organizational structure for preparing these periodic reports. The final report for the project will also include a separate QA section which will summarize data quality information contained in the periodic QA/QC reports to management, and present an overall data assessment and validation in accordance with the data quality objectives outlined in this QAPP.

16.0 REFERENCES

"Preparation Aids for the Development of Quality Assurance Project Plans", United States Environmental Protection Agency, Office of Research and Development, EPA/600/8-91/005, February 1991.

"RCRA Quality Assurance Project Plan Guidance", NYSDEC, August 1989.

"USEPA Region II CERCLA Quality Assurance Manual", Revision 1, October 1989.

"Test Methods for Evaluating Solid Waste" USEPA Office of Solid Waste, SW846 Third Edition, November 1986 (with revisions).

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

TABLE 4.1

SAMPLING AND ANALYSIS SUMMARY
REMEDIAL DESIGN/REMEDIAL ACTION
FRIEDRICHSOHN COOPERAGE SITE
TOWN OF WATERFORD, NEW YORK

Sample Matrix	*Analytical Parameters*	*Analytical Method*[1]	*Investigative Samples*	*Field Duplicates*	*Rinsate Blanks*	*Trip Blanks*	*MS/MSD*
Groundwater	TCL Volatiles plus TICs	SW-846 8260	TBD	1/20	1/20	1/Cooler	1/20
	TCL Semi-Volatiles plus TICs	SW-846 8270	TBD	1/20	1/20	-	1/20
	PCBs	SW-846 8082	TBD	1/20	1/20	-	1/20
	TAL Metals	SW-846 6010/7470	TBD	1/20	1/20	-	1/20
Soil	TCL Volatiles plus TICs	SW-846 8260	TBD	1/20	1/20	-	1/20
	TCL Semi-Volatiles plus TICs	SW-846 8270	TBD	1/20	1/20	-	1/20
	PCBs	SW-846 8082	TBD	1/20	1/20	-	1/20
	TAL Metals	SW-846 6010/7471	TBD	1/20	1/20	-	1/20
	TCLP Volatiles	SW-846 1311/8260	TBD	1/20	1/20	-	1/20
	TCLP Semi-Volatiles	SW-846 1311/8270	TBD	1/20	1/20	-	1/20
	TCLP Metals	SW-846 1311/6010/7471	TBD	1/20	1/20	-	1/20
	Ignitability	SW-846 1010	TBD	1/20	1/20	-	1/20
	Cyanide, Reactive (as Total)	SW-846 9014	TBD	1/20	1/20	-	1/20
	Corrosivity by pH (S. U.)	SW-846 9045	TBD	1/20	1/20	-	1/20
	Sulfide, Reactive (as Total)	SW-846 9030	TBD	1/20	1/20	-	1/20
Sediment	TCL Volatiles plus TICs	SW-846 8260	TBD	1/20	1/20	-	1/20
	TCL Semi-Volatiles plus TICs	SW-846 8270	TBD	1/20	1/20	-	1/20
	PCBs	SW-846 8082	TBD	1/20	1/20	-	1/20
	TAL Metals	SW-846 6010/7471	TBD	1/20	1/20	-	1/20
	TOC	Lloyd Kahn	TBD	1/20	1/20	-	1/20

Notes:

(1)	Methods referenced from "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods", SW-846, Third Edition, 1986 (Revised 9/94). Analysis of Water and Wastes", EPA-600/4-79-020, March 1983; for chloride, sulfate, nitrate-nitrite
MS	Matrix Spike.
MSD	Matrix Spike Duplicate.
PCBs	Polychlorinated Biphenyls.
TAL	Target Analyte List.
TCL	Target Compound List.
TICs	Tentatively Identified Compounds.
-	Not applicable.
TCLP	Toxicity Characterization Leaching Procedure.

TABLE 4.2

ORGANIC COMPOUND LIST AND PRACTICAL QUANTITATION LIMIT (PQL) REMEDIAL DESIGN/REMEDIAL ACTION FRIEDRICHSOHN COOPERAGE SITE TOWN OF WATERFORD, NEW YORK

	CAS Number	*Quantitation Limits*	
		Water (µg/L)	*Soil/Sediment (µg/Kg)*
TCL Volatiles			
1,1,2,2-Tetrachloroethane	79-34-5	10	10
1,1,2-Trichloroethane	79-00-5	10	10
1,1-Dichloroethane	75-34-3	10	10
1,1-Dichloroethylene	75-35-4	10	10
1,2-Dibromo-3-chloropropane	96-12-8	10	10
1,2-Dibromoethane	106-93-4	10	10
1,2-Dichloroethane	107-06-2	10	10
1,2-Dichloropropane	78-87-5	10	10
Bromodichloromethane	75-27-4	10	10
Bromoform	75-25-2	10	10
Carbon tetrachloride	56-23-5	10	10
Chlorobenzene	108-90-7	10	10
Chloroethane	75-00-3	10	10
Chloroform	67-66-3	10	10
cis-1,3-Dichloropropene	10061-01-5	10	10
Dibromochloromethane	124-48-1	10	10
Dichlorodifluoromethane	75-71-8	10	10
m-Dichlorobenzene	541-73-1	10	10
Bromomethane	74-83-9	10	10
Chloromethane	74-87-3	10	10
Methylene chloride	75-09-2	10	10
o-Dichlorobenzene	95-50-1	10	10
p-Dichlorobenzene	106-46-7	10	10
Tetrachloroethylene	127-18-4	10	10
trans-1,2-Dichloroethylene	156-60-5	10	10
trans-1,3-Dichloropropene	10061-02-6	10	10
Trichloroethylene	79-01-6	10	10
Trichlorofluoromethane	75-69-4	10	10
Vinyl chloride	75-01-4	10	10
4-Methyl-2-pentanone	108-10-1	10	10
2-Butanone	78-93-3	10	10
Benzene	71-43-2	10	10
Ethylbenzene	100-41-4	10	10
Styrene	100-42-5	10	10
Toluene	108-88-3	10	10
Xylene(total)	1330-20-7	10	10
1,1,1-Trichloroethane	71-55-6	10	10
2-Hexanone	591-78-6	10	10
Acetone	67-64-1	10	10
Carbon disulfide	75-15-0	10	10
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	10	10
Methyl Acetate	79-20-9	10	10
Methyl tert-Butyl Ether	1634-04-4	10	10
cis-1,2-Dichloroethene	156-59-2	10	10
Cyclohexane	110-82-7	10	10
Methylcyclohexane	108-87-2	10	10
Isopropylbenzene	98-82-8	10	10
1,2,4-Trichlorobenzene	120-82-1	10	10
TCL Semi-Volatiles			
2,4,6-Trichlorophenol	88-06-2	10	330
2,4-Dichlorophenol	120-83-2	10	330
2,4-Dimethylphenol	105-67-9	10	330
2,4-Dinitrophenol	51-28-5	25	830
2-Chlorophenol	95-57-8	10	330
4,6-Dinitro-o-cresol	534-52-1	25	830
o-Nitrophenol	88-75-5	10	330

TABLE 4.2

ORGANIC COMPOUND LIST AND PRACTICAL QUANTITATION LIMIT (PQL) REMEDIAL DESIGN/REMEDIAL ACTION FRIEDRICHSOHN COOPERAGE SITE TOWN OF WATERFORD, NEW YORK

		Quantitation Limits	
	CAS Number	*Water (µg/L)*	*Soil/Sediment (µg/Kg)*
p-Chloro-m-cresol	59-50-7	10	330
Pentachlorophenol	87-86-5	25	830
Phenol	108-95-2	10	330
p-Nitrophenol	100-02-7	25	830
Bis(2-ethylhexyl) phthalate	117-81-7	10	330
Butyl benzyl phthalate	85-68-7	10	330
Diethyl phthalate	84-66-2	10	330
Dimethyl phthalate	131-11-3	10	330
Di-n-butyl phthalate	84-74-2	10	330
Di-n-octyl phthalate	117-84-0	10	330
2,4-Dinitrotoluene	121-14-2	10	330
2,6-Dinitrotoluene	606-20-2	10	330
Isophorone	78-59-1	10	330
Nitrobenzene	98-95-3	10	330
Acenaphthene	83-32-9	10	330
Acenaphthylene	208-96-8	10	330
Anthracene	120-12-7	10	330
Benzo[a]anthracene	56-55-3	10	330
Benzo[a]pyrene	50-32-8	10	330
Benzo[b]fluoranthene	205-99-2	10	330
Benzo[ghi]perylene	191-24-2	10	330
Benzo[k]fluoranthene	207-08-9	10	330
Chrysene	218-01-9	10	330
Dibenz[a,h]anthracene	53-70-3	10	330
Fluoranthene	206-44-0	10	330
Fluorene	86-73-7	10	330
Indeno(1,2,3 cd)pyrene	193-39-5	10	330
Naphthalene	91-20-3	10	330
Phenanthrene	85-01-8	10	330
Pyrene	129-00-0	10	330
2-Chloronaphthalene	91-58-7	10	330
Hexachlorobenzene	118-74-1	10	330
Hexachlorobutadiene	87-68-3	10	330
Hexachlorocyclopentadiene	77-47-4	10	330
Hexachloroethane	67-72-1	10	330
2,4,5-Trichlorophenol	95-95-4	25	830
2-Methylnaphthalene	91-57-6	10	330
3,3'-Dichlorobenzidine	91-94-1	10	330
4-Chlorophenyl phenyl ether	7005-72-3	10	330
Bis(2-chloroethoxy)methane	111-91-1	10	330
Bis(2-chloroethyl)ether	111-44-4	10	330
Dibenzofuran	132-64-9	10	330
m-Nitroaniline	99-09-2	25	830
N-Nitrosodiphenylamine	86-30-6	10	330
N-Nitrosodipropylamine	621-64-7 1	10	330
o-Cresol	95-48-7	10	330
o-Nitroaniline	88-74-4	25	830
p-Chloroaniline	106-47-8	10	330
p-Cresol	106-44-5	10	330
p-Nitroaniline	100-01-6	25	830
Benzaldehyde	100-52-7	10	330
2,2'-oxybis(1-Chloropropane)	108-60-1	10	330
Acetophenone	98-86-2	10	330
Caprolactam	105-60-2	10	330
1,1'-Biphenyl	92-52-4	10	330
4-Bromophenyl-phenylether	101-55-3	10	330
Atrazine	1912-24-9	10	330
Carbazole	86-74-8	10	330

TABLE 4.2

ORGANIC COMPOUND LIST AND
PRACTICAL QUANTITATION LIMIT (PQL)
REMEDIAL DESIGN/REMEDIAL ACTION
FRIEDRICHSOHN COOPERAGE SITE
TOWN OF WATERFORD, NEW YORK

		Quantitation Limits	
	CAS Number	*Water (µg/L)*	*Soil/Sediment (µg/Kg)*
PCBs			
Aroclor-1016	12674-11-2	1.0	33
Aroclor-1221	11104-28-2	1.0	67
Aroclor-1232	11141-16-5	1.0	33
Aroclor-1242	53469-21-9	1.0	33
Aroclor-1248	12672-29-6	1.0	33
Aroclor-1254	11097-69-1	1.0	33
Aroclor-1260	11096-82-5	1.0	33
Aroclor-1262	37324-23-5	1.0	33
Aroclor-1268	11100-14-4	1.0	33

Notes:

PCBs - Polychlorinated Biphenyls.
TCL - Target Compound List.

TABLE 4.3

INORGANIC COMPOUND LIST AND PRACTICAL QUANTITATION LIMIT (PQL) REMEDIAL DESIGN/REMEDIAL ACTION FRIEDRICHSOHN COOPERAGE SITE TOWN OF WATERFORD, NEW YORK

Parameters	*CAS Number*	*Quantitation Limits*	
		Water (µg/L)	*Soil/Sediment (µg/Kg)*
TAL Metals			
Aluminum	7429-90-5	200	20
Antimony	7440-36-0	60	6.0
Arsenic	7440-38-2	10	1.0
Barium	7440-39-3	200	20
Beryllium	7440-41-7	5.0	0.5
Cadmium	7440-43-9	5.0	0.5
Calcium	7440-70-2	5000	500
Chromium	7440-47-3	10	1.0
Cobalt	7440-48-4	50	5.0
Copper	7440-50-8	25	2.5
Iron	7439-89-6	100	10
Lead	7439-92-1	5.0*	0.5
Magnesium	7439-95-4	5000	500
Manganese	7439-96-5	15	1.5
Mercury	7439-97-6	0.2	0.1
Nickel	7440-02-0	40	4.0
Potassium	7440-09-7	5000	500
Selenium	7782-49-2	5.0	0.5
Silver	7440-22-4	10	1.0
Sodium	7440-23-5	5000	500
Thallium	7440-28-0	10	1.0
Vanadium	7440-62-2	50	5.0
Zinc	7440-66-6	20	2.0
General Chemistry			
TOC	7440-44-0	-	1.0

Note:

TOC	Total Organic Carbon.
TAL	Target Analyte List.

TABLE 4. 4

WASTE CHARACTERIZATION COMPOUND LIST AND REGULATORY LIMITS
REMEDIAL DESIGN/REMEDIAL ACTION
FRIEDRICHSOHN COOPERAGE SITE
TOWN OF WATERFORD, NEW YORK

Parameters	*Regulatory Limits*
TCLP Volatiles (mg/L)	
Vinyl chloride	0.2
1,1-Dichloroethene	0.7
Chloroform	6.0
1,2-Dichloroethane	0.5
2-Butanone	200
Carbon Tetrachloride	0.5
Trichloroethene	0.5
Benzene	0.5
Tetrachloroethene	0.7
Chlorobenzene	100
TCLP Semi-Volatiles (mg/L)	
Pyridine	5.0
1,4-Dichlorobenzene	7.5
2-Methylphenol	200
3- and/or 4-Methylphenol	200
Hexachloroethane	3.0
Nitrobenzene	2.0
Hexachlorobutadiene	0.5
2,4,6-Trichlorophenol	2.0
2,4,5-Trichlorophenol	400
2,4-Dinitrotoluene	0.13
Hexachlorobenzene	0.13
Pentachlorophenol	100
TCLP Metals (mg/L)	
Silver	5.0
Arsenic	5.0
Barium	100
Cadmium	1.0
Chromium	5.0
Lead	5.0
Mercury	0.2
Selenium	1.0
RCRA Characteristics	
Ignitability (° F)	<140
Cyanide, Reactive (as Total) (mg/Kg)	250
Corrosivity by pH (S. U.)	2.0-12.5
Sulfide, Reactive (as Total) (mg/Kg)	500
Total Polychlorinated Biphenyls (µg/Kg)	
Aroclor-1016	33
Aroclor-1221	67
Aroclor-1232	33
Aroclor-1242	33
Aroclor-1248	33
Aroclor-1254	33
Aroclor-1260	33
Aroclor-1262	33
Aroclor-1268	33

Note:

TCLP Toxicity Characteristic Leaching Procedures.
RCRA Resource Conservation and Recovery Act.

TABLE 5.1

SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIME PERIODS
REMEDIAL DESIGN/REMEDIAL ACTION
FRIEDRICHSOHN COOPERAGE SITE
TOWN OF WATERFORD, NEW YORK

Matrix	*Analyses*	*Sample Containers* [1]	*Preservation*	*Maximum Holding Time*	*Notes*
Water					
	TCL VOCs	Three 40 mL Teflon lined septum vials	Cool <6°C, HCl to pH<2	14 Days to analyses	Fill completely, no air bubble
	TCL SVOCs	Two 1 liter amber glass bottles per analysis	Cool <6°C	7 Days to extraction 40 days from extraction to analysis	Fill to neck of bottles
	PCBs	Two 1 liter amber glass bottles per analysis	Cool <6°C	7 Days to extraction 40 days from extraction to analysis	Fill to neck of bottles
	TAL Metals (Except Mercury)	One 1 liter plastic bottle	HNO_3 to pH<2, Cool <6°C	6 Months from collection to analysis	Fill to neck of bottles
	Mercury	One 1 liter plastic bottle	HNO_3 to pH<2, Cool <6°C	28 Days to analysis	Fill to neck of bottles
Soil/Sediment					
	TCL VOCs	Three terracores (or equivalent)[2] One 2oz jar[3]	Cool <6°C	48 Hours for preservation 14 Days to analyses	Fill per directions
	TCL SVOCs	One 4 oz. glass jar	Cool <6°C	14 Days to extraction 40 days from extraction to analysis	Fill to neck of bottles
	PCBs	One 4 oz. glass jar	Cool <6°C	14 Days to extraction 40 days from extraction to analysis	Fill to neck of bottles
	TAL Metals (Except Mercury)	One 4 oz. glass jar	Cool <6°C	6 Months from collection to analysis	Fill to neck of bottles
	Mercury	One 4 oz. glass jar	Cool <6°C	28 Days to analysis	Fill to neck of bottles
	TOC	One 4 oz. glass jar	Cool <6°C	28 Days to analysis	Fill to neck of bottles
Soil Waste Characterization					
	TCLP VOCS	Three 40 mL Teflon lined septum vials	Cool <6°C	7 days from collection to leaching 7 days from leaching to analysis	Fill completely, no air bubble
	TCLP SVOCS	1 L Amber	Cool <6°C	5 days from receipt to leaching 7 days from leaching to extraction 40 days from extraction to analysis	Fill to neck of bottles
	TCLP Metals (except Mercury)	1-500 ml HDPE	Cool <6°C	180 days from receipt to leaching 180 days from leaching to analysis	Fill to neck of bottles
	TCLP Mercury	1-500 ml HDPE	Cool <6°C	5 days from receipt to leaching 28 days from leaching to analysis	Fill to neck of bottles
	RCRA Characteristics	2-500ml HDPE	Cool <6°C	Analyze immediately	Fill to neck of bottles

Notes:

(1)	Multiple parameters on a single sample with identical preservation requirements may be combined into one single sample container.
(2)	Sediment samples may be too wet for Terracores and should be collected as a bulk sample
(3)	For dry weight determination and sediment collection, if necessary.
PCBs	Polychlorinated Biphenyls.
TAL	Target analyte list.
TCL	Target compound list.
SVOC	Semi-Volatile Organic Compound.
VOC	Volatile Organic Compound.
TCLP	Toxicity Characteristic Leaching Procedure.
RCRA	Resource Conservation and Recovery Act.

TABLE 9.1

LABORATORY REPORTING DELIVERABLES - FULL
REMEDIAL DESIGN/REMEDIAL ACTION
FRIEDRICHSOHN COOPERAGE SITE
TOWN OF WATERFORD, NEW YORK

A detailed report narrative should accompany each submission, summarizing the contents and results.

A. Chain of Custody Documentation and Detailed Narrative (1)

B. Sample Information
  - i) date collected
  - ii) date extracted or digested
  - iii) date analyzed
  - iv) analytical method and reference

C. Data (including all raw data and CLP-like summary forms)
  - i) samples
  - ii) laboratory duplicates (2)
  - iii) method blanks
  - iv) spikes; spike duplicates (2) (3)
  - v) surrogate recoveries (2)
  - vi) internal standard recoveries
  - vii) calibration
  - viii) any other applicable QC data (e.g., serial dilutions)
  - ix) TICs (if applicable)

D. Miscellaneous
  - i) method detection limits and/or instrument detection limits
  - ii) percent solids (where applicable)
  - iii) metals run logs
  - iv) standard preparation logs
  - v) sample preparation logs

All sample data and its corresponding QA/QC data shall be maintained accessible to CRA either in hard copy or on magnetic tape or disc (computer data files). All solid sample results must be reported on a dry-weight basis.

Notes:

(1) Any quality control (QC) outliers must be addressed and corrective action taken must be specified.
(2) Laboratory must specify applicable control limits for all quality control sample results.
(3) A blank spike must be prepared and analyzed with each sample batch.
TICs Tentatively Identified Compounds.

TABLE 9.2

LABORATORY REPORTING DELIVERABLES - STANDARD
REMEDIAL DESIGN/REMEDIAL ACTION
FRIEDRICHSOHN COOPERAGE SITE
TOWN OF WATERFORD, NEW YORK

A detailed report narrative should accompany each submission, summarizing the contents and results.

A. Chain of Custody Documentation and Detailed Narrative (1)

B. Sample Information
   1. date collected
   2. date extracted or digested
   3. date analyzed
   4. analytical method and reference

C. Final Results
   1. samples
   2. laboratory duplicates (2)
   3. method blanks
   4. spikes, spike duplicates (2) (3)
   5. surrogate recoveries (2)
   6. internal standard recoveries
   7. tentatively identified compounds (TICs) (if applicable)

D. Miscellaneous
   1. method detection limits and/or instrument detection limits
   2. percent solids (where applicable)
   3. metals run logs
   4. sample preparation logs

All sample data and its corresponding quality assurance/quality control (QA/QC) data shall be maintained accessible to CRA either in hard copy or on magnetic tape or disc (computer data files). All solid sample results must be reported on a dry-weight basis.

Notes:

(1) Any QC outliers must be addressed and corrective action taken must be specified.

(2) Laboratory must specify applicable control limits for all QC sample results.

(3) A blank spike must be prepared and analyzed with each sample batch.

ATTACHMENT A

QA/QC OFFICER QUALIFICATIONS

SUSAN SCROCCHI, B.S.

EDUCATION

B.S.	Chemistry, Canisius College, 1983

Other Training

USEPA Region II Training Course for CLP Organic Data Validation,
Westchester Community College, Dr. John Samuelian, March 1997
40-Hour HAZWOPER OSHA Training (per 29 CFR 1910.120), 2000
8-Hour HAZWOPER Refresher OSHA Training (per 29 CFR 1910.120), Annually

EMPLOYMENT HISTORY

2000-Present	Conestoga-Rovers & Associates, Niagara Falls, NY
1996-00	Project Chemist, CRA Services
1983-96	Senior Organic Chemist, Advanced Environmental Services, Inc., Niagara Falls, NY

PROFESSIONAL REGISTRATIONS/AFFILIATIONS

Member, American Chemical Society

PROFILE OF PROFESSIONAL ACTIVITIES

- Stack Testing:
  - set up field gas chromatograph for on-site analyses
  - help develop methods for detection of various compounds in the field
- Innovative Technologies
  - Set up Gas Chromatographs (GCs) for the CRA Treatability Laboratory
  - Developed and conducted GC analyses for treated and untreated samples to monitor the removal of organic compounds
  - Performed training and oversight of organic extractions involving various matrices
- Project Chemist:
  - Oversight and review of analytical testing in support of NPDES projects
  - Assessment and validation of ASP, CLP, and SW-846 analytical data
  - Liaison with analytical laboratories in support of various investigative and remedial projects
  - Preparation of analytical laboratory bidding documents
  - Preparation of analytical Quality Assurance Project Plans (QAPPs)
  - Preparation of site sampling and analysis plans
  - Performance of laboratory audits and assessments
  - Prepared a Laboratory Quality Control Manual for an application for National Environmental Laboratory Accreditation Program (NELAP) approval

  - Training of plant personnel to perform required analytical methods for NELAP approval
- Senior Organic Chemist:
  - Provided administrative support for all department chemists and technicians
  - Provided a quality control check of all analytical data prior to submission
  - Prepared and maintained all analytical Standard Operating Procedures
  - Provided technical support for clients and agency personnel
  - Evaluated and developed new methods as needed
  - Technically proficient in all areas of organic testing, including sample extraction techniques and operation of gas chromatographs (GC) and gas chromatograph/mass spectrometers (GC/MS)
  - Proficient at performing routine maintenance and repairs on GC and GC/MS systems
- Database:
  - Basic training in database using Microsoft Access
  - Able to generate flat files
  - Import data and maintain the Shell database
- ISO Internal Auditor:
  - Internal ISO 9001 Auditor performing quality system checks on filing, document control, and other internal quality system guidelines